

# Climate Change and Sea-Level Rise: Potential Impacts on the Socio-Economic Role of First Landing State Park for the Region

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# Executive Summary

First Landing State Park (FLSP) is located in Virginia Beach, Virginia along the Chesapeake Bay. It is a highly populated park that is part of a larger system with the Virginia Beach community and is important for the local and state economies. The wicked problem addressed in this case study is to assess the impacts of climate change and sea level rise (SLR) on the potential impacts of the socio-economic role of the park for the Virginia Beach region. The system of Virginia Beach and FLSP includes an economic balance that is fragile to physical and societal changes threatening the park and community.

The multiple models created, including the two conceptual models and the stock-and-flow model, have clearly outlined how the systems are interconnected. FLSP and VDCR are the main stakeholders being addressed due to the ownership of the park and their ability to make influential decisions. The goal to maintain FLSP's natural land while providing educational and recreational activities for locals and tourists in order to maintain FLSP's socio-economic role in the community during a time of sea level rise (SLR) and climate change. The common goal statement and participatory thought experiment are crucial for the outcome of the study, but it is equally important that the stakeholders are aware of the system fragilities and associated hazards discussed. Both the park and local businesses are fragile to losing attraction and closure. The visitors are fragile to their desire to travel. The hazards include SLR, the amount of people, economic stability, restrictions and social pressure. The study looks more in depth at the fragilities and the hazards associated with them.

A spectrum of possible futures was then analyzed based on the fragilities hazards discussing two main scenarios. SLR is a threat that will happen, despite an unknown time line. FLSP and Virginia Beach will become inundated from the sea which will ruin the tourist industry that allows for the community to thrive. Economic growth and economic recessions are futures that greatly varying from desirable to undesirable. These possible futures show that changes need to be made in order to avoid the undesirable. Interventions were explored to potentially increase the likelihood of maintaining FLSP socio-economic role.

The interventions reviewed in this study included implications that could delay the effects of SLR and those that could increase the economy of both the park and or Virginia Beach. Natural interventions to increase elevation of the park's most vulnerable areas could slow inundation but would also go against the park's desire to maintain the natural environment. Virtual interventions explore the need for an increasing presence virtually and the ways in which this could increase socio-economy of the region. Further economic interventions discussed increasing the relationship between FLSP and Virginia Beach to increase the chance to having a supportive environment.

The recommendations made to FLSP to address SLR, societal pressures, and economic interventions. Recognizing that sea level is a continuous threat; that the missions of the park and state agencies are to maintain the natural environment; that the park and surrounding community have a limited lifespan. As well as that there is technology that allows for virtual spaces to have interactive activities similar to in-person activities; tourism is fragile to the emotions of people traveling due to societal pressures leading to people change their desire to travel; and economic loss can occur from this changing desire as well as from budgeting and economic changes. While acknowledging that FLSP provides a major revenue source for the state park system and Virginia Beach has many small businesses and other tourist attractions to encourage community growth. FLSP and local businesses are interconnected and are important economically to one-another. It is recommended that the Virginia Department of Conservation and Recreation and First Landing State Park:

- Allow natural inundation to occur and use this natural process as an educational experience

and encourage tourists to come and learn about the changing environment.

- The Virginia Department of Conservation and Recreation update the already existing virtual platform to include more information and park videos on the parks page. And for the park's staff to post events, health and safety information, and fun activities or facts about the park on a regular basis on Twitter, Instagram, and other current social media platforms.
- FLSP work with organizations to create a virtual community platform where there could be a space for a facilitation of knowledge sharing. This space should be able to facilitate discussion between experts of the park and the people trying to learn and participate in the park to provide a park-like experience.
- Take the new virtual space and include a membership fee for some of the content or costs for virtual programming. This would maintain revenue flow during off seasons or when people cannot travel.
- Create engagement with the community by having some local businesses host booths on the park property to sell food and merchandise. The park could also provide more transportation between oceanfront and the park to increase tourists flow around the area.

## 1 Introduction

First Landing State Park, originally Seashore State Park, is a highly populated park that is known for its history, its unique array of habitats, and variety of outdoor activities for its visitors. First Landing State Park (FLSP) is located in the northeastern corner of Virginia Beach, Virginia in the United States (Fig. 1). Bringing in over one million visitors a year, the park plays an important socio-economic role in Virginia Beach, the surrounding communities, and the Commonwealth of Virginia. The study area of this project is FLSP along with the surrounding areas impacted by the socio-economy of the park. FLSP is a 2,888-acre piece of land, containing 1.5 miles of beaches located on the mouth of the Chesapeake Bay. The park also houses other unique features including back dunes, tidal marshes, swamps, and a maritime forest community. It is the northernmost limit for semi-tropical species and the southernmost limit for temperate species. Migratory birds use this land as a necessary nesting ground (DCR, 2020).

### 1.1 History of the Land

The location now called Virginia Beach and FLSP was once home to the Chesapeake Indian Tribe, a name given by the tribe's ancestors. In order to establish the importance of the park to Virginia Beach residents and tourists, it was important to learn about the rich history of the area. Powhatan's were told of a conquering threat from the east, and knowing of only the Chesapeake people, slaughtered them about 1606-1607. The ships of English colonists arrived from London in April of 1607 and were recognized as the eastern threat. The Powhatan's are still in the area and work to represent the late Chesapeake Indian tribe to atone for their mistake (FLSP, n.d.a). To do so, the Powhatan Tribe worked with Virginia State and FLSP to place the remains of the Chesapeake Indians in a burial ground in the park. People come to this spot to pay respects to the tribe and learn of the past culture.

FLSP has a rich history from the native people to the English colonists. The park is named for the location in which the first English Colonists landed in 1607. A cross was later placed



Figure 1: First Landing State Park, Fort Story, Broad Bay, and a small portion of the city of Virginia Beach, Virginia, USA pictured here to show the varying environments. The satellite map was taken from Google Earth, 2020.

here to symbolize the landing of the Christian colonists' landing site. Now FLSP, was originally named Seashore State Park and was opened in 1936 alongside 5 other original state parks by the Civilian Conservation Corp to give work to unemployed men. They built roads, trails, 6 cabins, and administrative and maintenance buildings. The park has grown and shrunk over the years, first expanding to 3,437-acres along the Atlantic Coast and Chesapeake Bay, then sections were purchased as Fort Story expanded during the threat of World War II. In 1999, Seashore State Park was renamed as First Landing State Park to recognize the first landing of the colonists. The park today is 2,888-acres, has 20 cabins, over 200 campsites, and about 19-miles of trails but no longer contains the symbolic cross that represents the landing of the colonists (FLSP, n.d.b). Over one million visitors come to the park each year to enjoy the beaches, appreciate the unique environments from the trails, and to spend a night / weekend / week tent / RV / cabin camping (DCR, 2020). It is highly attractive to residents and tourists because of the rich history and prime location so close to oceanfront Virginia Beach. People also have a lot of interest in the deep and rich history and come to learn more about the Chesapeake Indians and the first colonists.

## 1.2 Outlier

This study is being complete between June and August of 2020 in Virginia Beach, Virginia. It is important to note that this study was conducted during a global pandemic. In late 2019 through January of 2020 an infectious virus spread from Wuhan, China and is now known as a novel coronavirus, 2019-nCov (Li et al., 2020). By the 21st of January, 2020, Thailand, Japan, and Korea confirmed cases of the disease (Li et al., 2020). The International Committee on Taxonomy

of Viruses (ICTV) named the virus SARS-CoV-2 and the disease as COVID-19, which will be the name used to refer to the pandemic in this study. COVID-19 is not the only coronavirus to cause severe respiratory illness. In 2002 SARSCoV spread to over 32 countries and infected 8,422 people, causing 916 deaths worldwide (Li et al., 2020). Other CoVs have spread in the recent past, but none have reached the extreme human impact that COVID-19 has had globally. By the 13th of March 2020, there were 9,474 daily new confirmed cases of COVID-19 (Roser et al., 2020), bringing the total number of infected people on March 13th to 138.358 thousand. As of August 1st, countries have implemented different restrictions and strategies to combat the spread of the virus and a vaccine is in trial stages. However, the cumulative number of cases is 17.851 million people infected with 250.712 thousand new daily cases (JHU, 2020) (Roser et al., 2020). Data taken August 21st, 2020 has 23,464,660 confirmed cases globally with 809,591 global deaths (JHU, 2020).

In the United States, through the Center for Disease Control, there are some guidelines out in place to combat the spread of the coronavirus. However, many regulations to shut down businesses, schools, and governmental institutions occurred on a state-by-state basis. New York State was a leader in regulating the spread and many states followed suit, but not all. Governor Northam from the Commonwealth of Virginia declared a state of emergency on March 23rd and issued Executive Order 53 to close non-essential businesses, close K-12 schools, and ban gatherings of over 10 people (VDH, 2020). Since this time multiple executive orders were given to address the changing status of the coronavirus pandemic. Virginia has had 112,960 total confirmed cases with 2,467 confirmed deaths as of August 21, 2020. The study takes place in Virginia Beach where there are 5,693 total confirmed cases and 64 deaths (JHU, 2020). The U.S. Census Bureau estimates the Virginia Beach population to be 449.9 thousand people (USCensus, 2019). It is still unclear what impact COVID-19 has had on tourism in Virginia Beach.

### 1.3 The Challenge

FLSP is a major tourist attraction due to the beautiful beaches, trails through the unique habitats, and lodging. Climate change and sea level rise (SLR) pose a threat to low elevation areas like FLSP and Virginia Beach. Destruction from these events lowers the appeal for tourists and poses an economic threat to the surrounding community. The National Oceanic and Atmospheric Administration (NOAA) displayed the current relative rate of sea level at the Chesapeake Bay Bridge Tunnel, VA at +5.92 mm/year based on monthly mean sea level between 1975 to 2017 (NOAA, 2018). The United National (UN) International Panel on Climate Change (IPCC) has also conducted studies to project climate change and SLR on a time scale basis. The problem is that the rate at which these changes are occurring is known, but the speed of the change into the future is unknown. Although sea level is currently rising and is likely to continue to rise, addressing these problems through predicting time steps is dangerous. Planning for the probability of occurrence rather than the probability of occurrence for set time will save human lives and could increase the future socio-economy of Virginia Beach. SLR and climate change are likely to change the habitat communities of the park. The unique habitats found in the park so close to oceanfront Virginia Beach are a major reason for visitors to the park. FLSP is one of the most populated parks in Virginia. It is 2,888-acres and has more than one million visitors per year, compared to Pocahontas State Park containing more than 2.5 times the acreage at 7,604-acres but with a similar number of visitors VDCR (2020). FLSP plays an important socio-economic role in the Hampton Roads, particularly Virginia Beach, area. The challenge is to ensure that FLSP can maintain this important role during a time of SLR and climate change. Recommendations for this case study

will be given to FLSP in order to address this issue.

## 1.4 Methodology

This study is a continuation of two other projects completed in the Conservation Leadership Program at Old Dominion University. Combining these projects to address not only the problem of maintaining FLSP’s role for conservation under climate change, as seen in the other two papers, but the problem of maintaining the vital role of the FLSP in the local community as well. Like most other social planning problems, these problems are wicked problems (Rittel and Webber, 1973). In order to complete this study, the Case Study Template is used, similar to the previous studies. The Case Study Template has been developed as a part of a program from the Mitigation and Adaptation Research Institute (MARI) at Old Dominion University (Fig. 2). The template takes a transdisciplinary approach to real-world wicked problems with the goal to develop recommendations for a target audience how to tackle the problem and has been utilized for more than 80 case studies since its development in 2016 (Plag, 2019). The tool begins with a wicked problem, which will be explained in depth later, and uses a systems thinking analysis to determine the decision making space. Section 2 defines the goal statement of the project, which is then used in Section 3 to identify the system and create models. System fragilities (Section 4) and with the hazards that exploit these fragilities (Section 5) are analyzed from the conceptualized models and the stock-and-flow models. A spectrum of possible futures becomes clear (Section 6) from the system fragilities and hazards, allowing for unique interventions to be conceptualized in Section 7. Finally, there is a conclusion and discussion section (Section 8) where the whole system is discussed with the goal statement. A few interventions are discussed to address this wicked problem to inform recommendations (Section 9) that align with the goal statement and decision-making space (Plag, 2019). The case study of FLSP and the local community seeks to assess the impacts of hazards related to climate change, SLR, and economic challenges in the area. In order to determine the goal of case study, the decision-making space must be assessed.

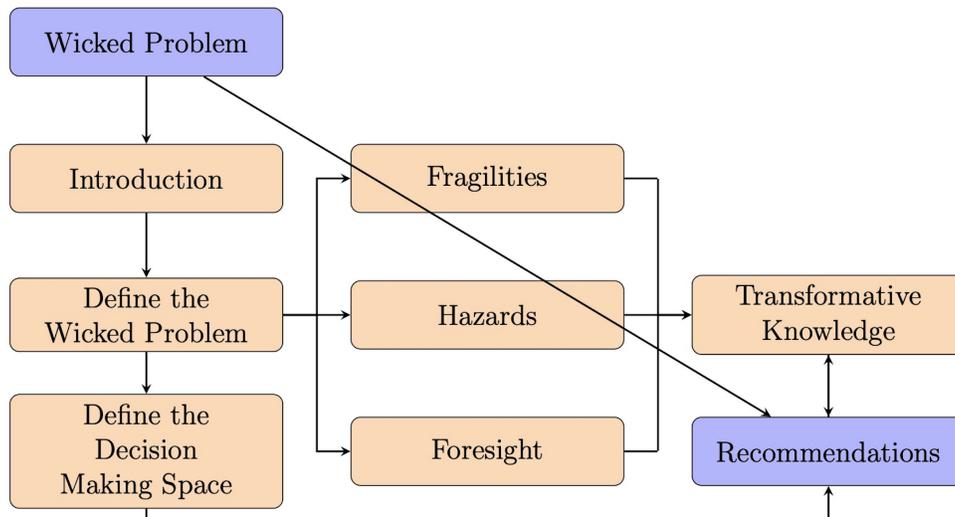


Figure 2: Mitigation and Adaptation Research Institute (MARI) Case Study Template Diagram recreated from the original version on the MARI website.

## 2 Decision Making Space

Determining the decision-making space is a crucial step to addressing wicked problems because it outlines the regulations and the goals of the decision makers. The decision-making space includes federal and state regulations and stakeholders. Stakeholders are organizations or individuals that are impacted by the decisions of the park. Some are high interest or high influence stakeholders who work directly in the park and/or influence the decision process, while other stakeholders are low interest but are impacted by the decisions. The decision-making space must be thoroughly researched to determine the desirable futures for the high interest and high influence members to shape the outcome of the wicked problem.

FLSP is a Virginia State Park managed by the Virginia Department of Conservation and Recreation (VDCR). This places the VDCR with the highest interest and highest authority of the Stakeholder diagram (Fig. 3). The VDCR is the states leading natural resource conservation agency that has a mission to protect natural habitats, parks, clean water, dams, open spaces and access to the outdoors (DCR, 2020). In comparison, FLSP’s mission is to protect the unique natural environment of this historic land on the mouth of the Chesapeake Bay, while providing outdoor recreation, environmentally educational programs, and historic preservation (Widener & Group, 2019). The mission statements of both the VDCR and FLSP play an important role in determining the goals of the recommendations of addressing the wicked problem.

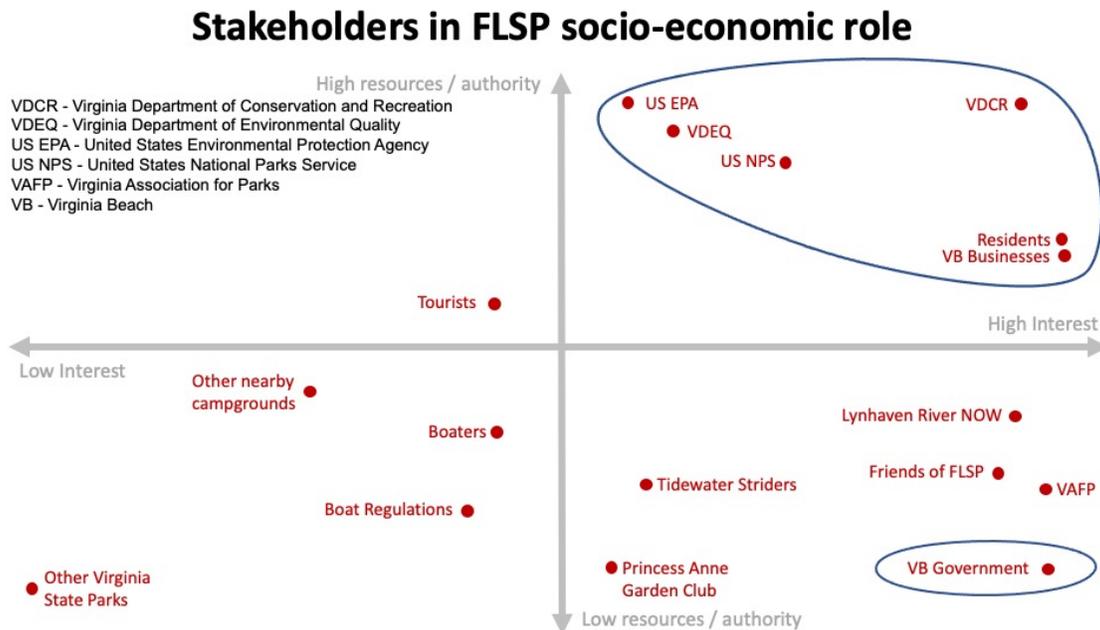


Figure 3: A map of stakeholders for FLSP was created to show how stakeholders range in interest and authority.

While FLSP is a state park under the management of the Commonwealth of Virginia, approximately 1,500 acres of the park are on the National Registry of Natural Landmarks (Kennedy, 2018), and therefore, the park must also follow the guidelines of the United States (US) National Parks Services (NPS) National Natural Landmark (NNL) program. This status places the US NPS to also be high authority and middle to high interest on the stakeholder graph (Fig. 3). NPS NNL program works to recognize the conservation of sites that contain biological and geological resources that are in good condition, are rare and diverse, and have a value in science and education. The 1,517

acres of FLSP designated as a National Natural Landmark, Seashore Natural Area, contains rare and significant natural areas. The parallel dunes found in the Seashore Natural Area are densely wooded with two distinct forest types of semitropical character and are home to an abundance of wildlife (Service, 1965). NPS NNL program cooperates with VDCR through FLSP to promote conservation of the area and an appreciation of natural heritage (Service, 2020).

FLSP is located in the City of Virginia Beach and therefore the residents, businesses, and local government must be represented in the stakeholder chart. The local government does not have any authority over the park, but the police department and the state police at the park work in coordination when necessary (Jones & Huggins, 2020). The government and community are greatly influenced by the park as well. The residents of Virginia Beach use the park for the excellent walking trails, the beaches, the boat launch, and local camping and both residents and schools utilize the educational programming. FLSP is a critical space for recreational use and educational use for the residents which put them as high interest and middle-high authority (Fig. 3). Due to the amount of use by the local people, their authority is greater than the local government and volunteer groups, even though those volunteers are likely also residents. The Virginia Beach businesses benefit from the park due to the increased amount of people using the area. Local restaurants and hotels have an increase in people due to the park's usage by both tourists and by locals (Widener & Group, 2019).

FLSP as a state park must adhere to the requirements of the Virginia Department of Environmental Quality (VDEQ). Therefore, placing the VDEQ as high resources but middle interest. They have interest in creating and enforcing requirements, but little interest in FLSP specifically. The regulations impacting the park include the Chesapeake Bay Preservation Act, or Bay Act, which is a cooperative partnership program with states located along the Bay, or have major waterways connecting to the Bay. FLSP is located on the Chesapeake Bay and must follow these regulations (DEQ, 2012). The Coastal Zone Management Program (CZMP) is another VDEQ program that involves a network of agencies working to protect coastal resources and strengthen the coastal economy (VCZMP, 2020). While FLSP does not allow for commercial use of their coastline, the park must still abide by the regulations within this program.

Similar to the VDEQ, the United State Environmental Protection Agency (US EPA) creates regulations that impact the park, having high authority. The US EPA do not look specifically at FLSP for creating or enforcing regulations and therefore their interests are middle to low (Fig. 3). The mission of the US EPA is to ensure that the US has clean air, land and water by reducing environmental risks through regulation and enforcement (USEPA, 2020). The US EPA has many regulations that include the Chesapeake Bay and FLSP must adhere to these as well. These include the Chesapeake Bay Agreements from 1983, 1987, 2000, and the Chesapeake Bay Watershed Agreement of 2014 (USEPA, 2015).

## 2.1 Participatory Modeling

Participatory Modeling is a tool used to integrate different perceptions and representation by creating a common goal and therefore a common systems model. This would allow for the stakeholders to discuss and develop resolutions for complex societal and environmental problems addressed in this case study. Participatory modeling is crucial to addressing wicked problems due to the nature of the process. Including stakeholders that are not experts or professional modelers help with the understanding of the different systems as well as the interconnections within the system. Every stakeholder has a different perspective and goals for the system. Best case, these stakeholders can be brought together, in-person or virtually, to engage in exercises and

conversations to create a collective understanding of the system and a common solution to the problem. The system can then be placed in models in the forms of games or digital modeling programs to test the solutions, informing the changes the system may occur.

In the event that a stakeholder meeting cannot be conducted, as is the case here, a role-playing exercise or thought experiment can be used. A role-playing exercise can be used when a group of people learn of the problem being address and research the perspectives of assigned stakeholders. A thought experiment was needed for this case studying to gather information about the perspectives of the decision space members. In order to determine this, the stakeholder graph was created, as explained in the decision-making section (Fig. 3), and further research was conducted. This graph shows all of the initial stakeholders based on research about FLSP and the Virginia Beach community, but the ones relevant to the study and included in the thought experiment were explained in detail above. Here is a summary of the thought experiment, determining the goals of the stakeholders:

1. FLSP: Our mission is to protect the natural environment, while providing outdoor recreation, environmentally educational programs, and historic preservation of the area (FLSP Business Plan). We have limited resources to engage in extra activities that do not align with the mission or that create more work hours or funding within the mission statement.
2. Local Residents: We love utilizing the park for recreational activities as well as the variety of educational programs. FLSP is a unique environment and our goal is to continue to use it as long as it is economical.
3. Tourists: FLSP provides us with outdoor recreational activities and contains a rich history. Many come for the campgrounds near the beach, while others come for the historic areas. Others come to visit Virginia Beach or other local cities and find it for good walking and biking trails. We want it to remain active to provide these for us, and without them we would have to find somewhere else.
4. VB Businesses: FLSP bring in tourists and is good for the shops, restaurants, and accommodations. We think that the park enhances our business and would like for it to continue to bring in people.

## 3 Wicked Problem

The decision-making space has now been analyzed and understood to show the depth of the potential decisions. With this in mind, the goal statement can be finalized, and the wicked problem can be defined. Goal Statements use the perspectives of the decision-making space to describe the desired futures, while addressing the wicked problem is to make progress towards this desired future. The goal of the study is to examine the potential interventions and to make recommendations for actions based on this assessment.

### 3.1 Goal Statement

A goal statement was created based on the perspectives of the stakeholders and the restrictions of the regulators to begin the process of defining a wicked problem. This goal statement combines the mission of the VDCR and FLSP with the goals of the local community. The mission of FLSP

is to protect nature while providing outdoor recreation and learning. The goal of the community is to enjoy a beautiful natural park while working to bring in tourists. The goal statement derived is to maintain FLSP's natural land while providing educational and recreational activities for locals and tourists in order to maintain FLSP's socio-economic role in the community. With this goal, the natural land can be changing, and the futures will allow the park to continue to provide recreation and education about the changing natural environment.

### **3.2 (Super) Wicked Problems**

Wicked Problems are societal problems rooted in the environment. These problems ask scientific questions which have contradictory knowledge, contradictory opinions, and economic burdens and require transformative knowledge to attempt to solve (Plag, 2019). Wicked Problems were first defined by Rittel & Webber (1972) as problems that fit ten specified criteria.

1. Wicked problems have no definitive formulation. There is no formula to addressing the problem of FLSP maintaining its socio-economic role in the community during a time of climate change and SLR.
2. Solutions are better or worse, not right or wrong. Due to the lack of formula, there is no final solution to wicked problems. Therefore, the recommendations cannot be right or wrong, but can only improve or degrade the problem.
3. Each employed solution to a wicked problem is a one - shot opportunity. Addressing the problem alters the range of possible futures and therefore, changes the problem. Meaning, once a recommendation is put into place, there is no going back to make different decisions.
4. Every problem is a symptom of another problem. The scientific problems rooted in societal context are interconnected and therefore cannot be separated. The climate crisis and SLR are symptoms of carbon emissions, and the problem of meeting the energy needs of humans without increasing the carbon footprint.
5. The explanation of the problem determines the solutions that are employed. The different stakeholders having differing perspectives and goals of addressing the problem. The recommendations implemented are a result of the goals of the stakeholders defining the problem.
6. The solver has no right to be wrong. FLSP and the VDCR are responsible for the recommendations implemented to address the problem.
7. There is no defined set of options and solutions. There are several options to addressing this wicked problem, the only limit is the perspectives of the stakeholders, the financial and physical limitations for the strategies implemented, and the focus of the solutions.
8. There is no immediate test for solutions. There is no way to have a testing period to see which solutions may be best for the system. The only way to know the results of a recommendation is to apply it to the system directly and observe the changes.
9. There is no stopping rule. There is no final solution to a wicked problem that makes the problem stop, there is only a new problem left in place. After recommendations are implemented and observed, the new problem can be readdressed, and new recommendations applied when necessary.

10. Every problem is essentially unique. The issues raised by SLR and climate change impact locations differently. FLSP is a park unique to the community and the role it places within southeastern Virginia is not replicated. The stakeholders of this problem and the scientific dilemma of SLR determine the recommendations and are unique to this problem.

FLSP can be characterized by all 10 criteria given by Rittel & Webber (1972) for maintaining the mission and role of FLSP under climate change and SLR and can therefore be classified as a wicked problem. Using these criteria, Levin et al. (2012) added four characteristics to define Super Wicked Problems. FLSP cannot be classified as a super-wicked problem because it does not fit all four of the characteristics below.

1. Time is running out.
2. No central authority.
3. Those seeking to solve the problem are also causing it.
4. Policies discount the future irrationally.

The wicked problem of maintaining FLSP's socio-economic role within Virginia Beach and other surrounding communities during a time of SLR and climate change cannot be taken further to be classified as a super wicked problem. While time is running out due to SLR, there is no central authority. The commonwealth of Virginia can migrate the coastal cities inland and begin preparing for SLR, but there is no central authority on global climate change. Those seeking to solve the problem are contributing to the problem but are not solely causing it. Virginian policies are discounting the future irrationally by not moving toward migration systems. This problem is a wicked problem, but cannot clearly be defined as a super wicked problem.

### 3.3 The System

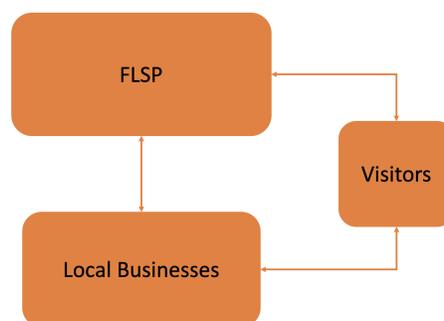


Figure 4: An initial high-level conceptual was created of the First Landing State Park and Virginia Beach community to show the three main, overarching stocks of the system addressed.

The goal statement to maintain FLSP's natural land while providing educational and recreational activities for locals and tourists in order to continue FLSP's socio-economic role in the community provides a clear image for the system. In order to achieve a complete understanding of the goal statement and the problems faced at FLSP, it is crucial to outline the system involved. The system must include crucial elements and the flows between them. Initially, the crucial

elements included FLSP, the Virginia Beach community, and the park’s visitors (Fig. 4). These elements were broken up with consideration that the people are moving from one stock to another, people are the flow unit. Fig. 5 shows the high-level stocks in orange, which include: FLSP; visitors; and local businesses. These are respectfully separated into a light peach color to show attractions and infrastructure; locals and tourists; food, transportation, accommodations, and other attractions(Fig. 5). This high level conceptual model was then changed to a stock-and-flow model by defining the flows and having a consistent unit for the system (Fig. 6).

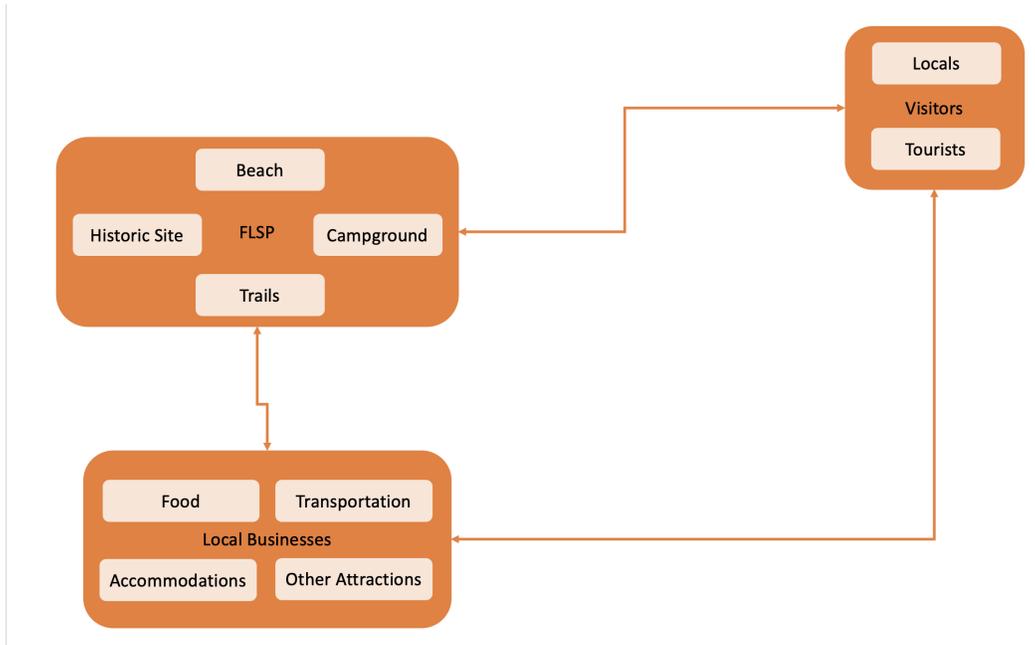


Figure 5: Aft this initial high-level conceptual was created, a second-level was added to show the internal systems withing each original stock of the First Landing State Park and Virginia Beach system.

The stock-and-flow model shows that visitors of the park flows to FLSP and to local businesses, as well as FLSP to the local businesses itself (Fig. 6). Within FLSP, there are 5 stocks representing the different parts of the park. There is the Beach and Bay; Infrastructure; Historic Sites; Campground; and Trails. The Beach and Bay area will expand into the Infrastructure or Campgrounds with sediment transport and inundation, while the Beach and Bay would be turned into Infrastructure or Campgrounds through construction. Infrastructure could become Campgrounds or Trails, and vice versa, through construction changes. While the park is a Historic Site itself, the changes in the specified historic areas would either grow or shrink based on changing construction. The unit within the park is land area. Although the system looks at the movement of people, the internal systems could have different units which include the risk associated with this issue.

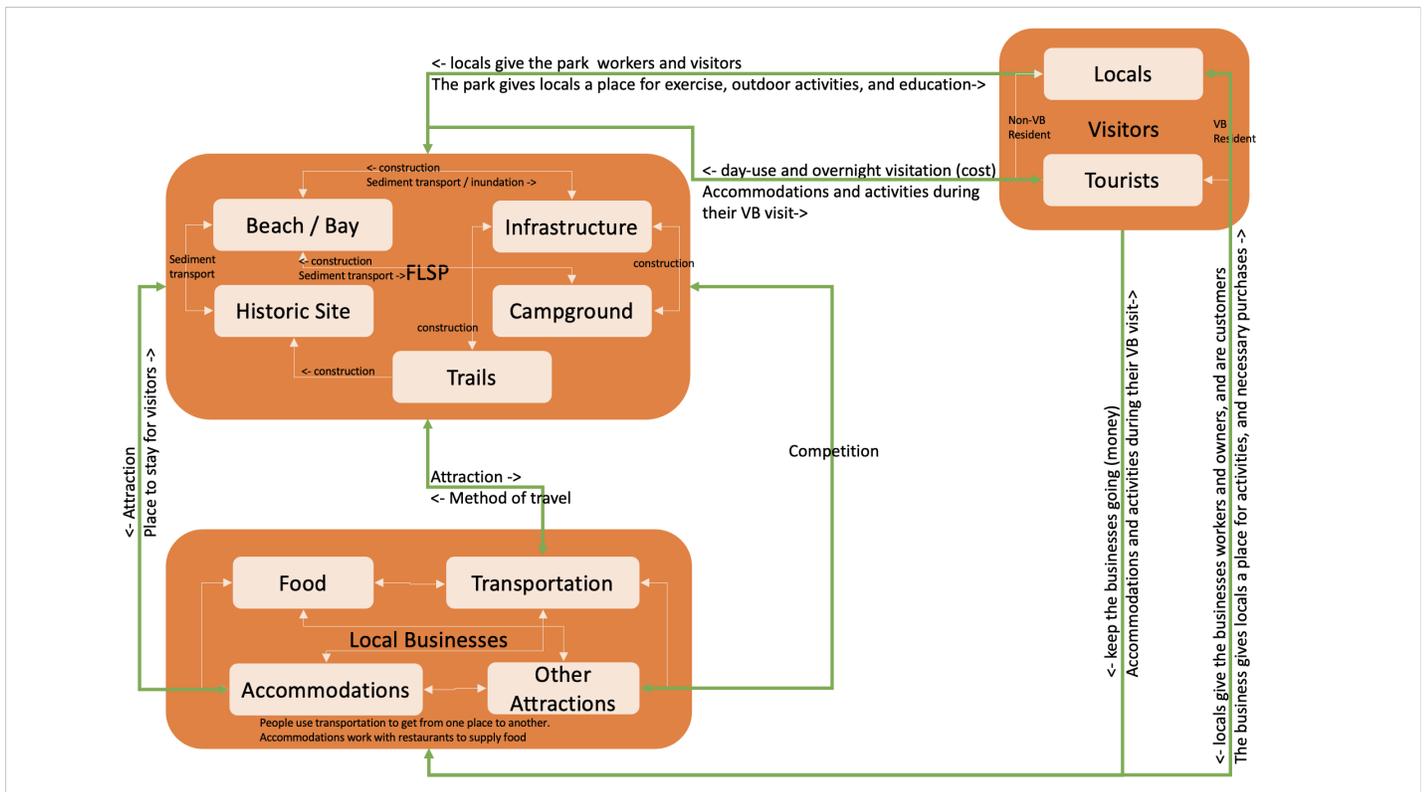


Figure 6: This is the finalized Stock-and-Flow Model of the First Landing State Park and Virginia Beach community system.

The local business contains a unit of people, and therefore money, through food, transportation, accommodations, and attractions. The local businesses need people to stay open and FLSP is a major attraction that is necessary for the tourism industry. The flow of park visitors is based on residency. Locals become visitors when changing residency to outside of southeastern Virginia and tourists can become locals when moving into the area. When looking at the flows between the three main stocks, the flows must be analyzed on a slightly smaller scale. The flow of people moves from visitors to the businesses. Visitors, both local and tourist, keep businesses going through enterprise and the businesses provide activities, accommodations, and necessities to the Visitors. It is also important to look specifically at the local interaction. They give the businesses workers and owners and are also customers, while the local businesses give the locals a place for activities and income.

## 4 System Fragilities

Fragile, as defined by Merriam-Webster (2020), is constitutionally delicate, and easily broken or destroyed. Determining the conceptual model of FLSP and the surrounding community allowed for a deep analysis of the systems fragilities and the hazards that exploit them (see Section 5). Fragilities of a system are inherently apart of the system and impact the flows, remaining when the system is stopped. Due to each part of the high-level system (FLSP, Local Businesses, and Visitors) having an internal system, or second-level, fragilities had to be determined based on both the high-level system and the second-level system visualized in the conceptual model (Fig. 5) and stock-and-flow model (Fig. 6). An initial diagram of fragilities was created based on the stocks and flows of second level parts of the system (Fig. 7).

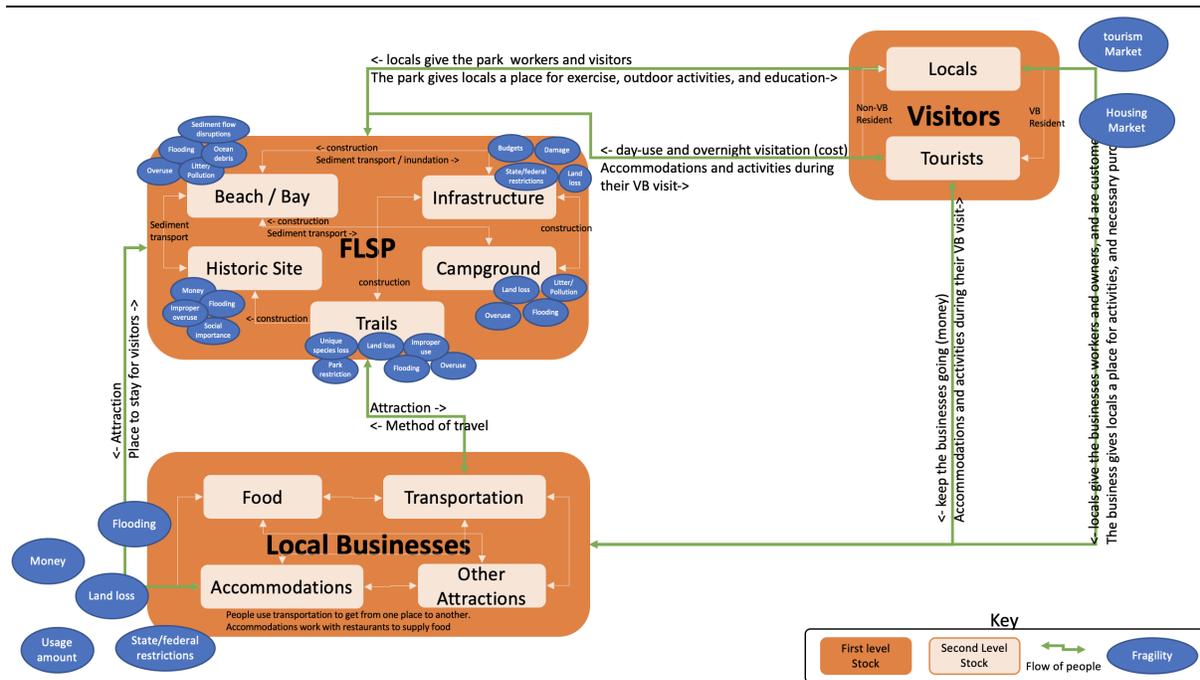


Figure 7: Stock-and-Flow model depicting the fragilities which are inherently specific to a part of the system.

The high-level stock of FLSP contains the second-level stocks of the Beach/Bay, Historic Sites, Trails, Campgrounds, and Infrastructure. Each of these second-level stocks has its own fragilities, but not all are applicable to the first-level system that the study focuses on. The high-level system is fragile to the park losing attractiveness to tourists and to residents. The second-level fragilities that are characteristics include:

- The Beach/Bay are fragile to being unclean, ocean debris, flooding, and overuse. Uncleanliness and ocean debris on the beaches and in the water make visitors unattractive to the area due to litter and pollution. While flooding and overuse can cause the natural environment to be minorly destroyed, such as brush or trees blocking the main visitor areas.
- The campgrounds are fragile to uncleanliness, usage amounts, and flooding. Similar to the Beach and Bay, litter along with debris from usage and flooding can be unattractive to visitors. Overuse can also discourage visitors because of lack of privacy or leaning towards uncleanliness.

- The historic sites are fragile to loss of social importance. If the sites are no longer relevant or important to visitors, the attractiveness of the park decreases.
- The trails are fragile to unattractiveness through fragilities of overuse, improper use, land loss, and unique species loss. The trails kept tidy and accessible are a big reason for visitation. The educational aspect of the trails through the unique species and environments is another attraction of the park to visitors. Loss of this could be detrimental.
- The park infrastructure and buildings are fragile to unattractiveness as well. Damage and uncleanliness lead to this unattractiveness.

Another high-level fragility for FLSP is that visitors could no longer be able to come to the park. Closure of the park would result in devastation for the park's ability to maintain itself, let alone what would happen to the surrounding communities. When looking at this high-level fragility, we must assess the second-level fragilities that can be characterized under this:

- The Beach / Bay areas are fragile to flooding and biological debris which are characteristics of changing park openness. If the beach is flooded then the park cannot allow visitors in. Biological hazards on the beach or in the bay can force the state to close because it is unsafe for visitor use.
- The campgrounds are fragile to land loss, flooding, and damage. If the campground does not have any land then people cannot come camping. Flooding and site damage or debris will also prevent visitor use.
- The historic sites are fragile to loss of preservation funding, land loss, increased improper usage, and flooding. If these fragilities were to be exploited the historic sites, a large part of the park, would have to close.
- The trails are fragile to land loss, flooding, and park regulations. The trails bring in large quantities of people daily, mostly local people excited for the unique recreation opportunity. Closing the trails would devastate the park's revenue and if land is inundated, temporarily flooded, or needs to close, then people cannot come.
- The park infrastructure, such as roads, visitor and maintenance buildings, and other built structures, are fragile to budget cuts, state and federal restrictions, land loss, and damage. Exploiting these fragilities would force the state to close the park, potentially for long periods of time, resulting in devastation for the park.

While it was important to look at the fragilities of the park on a deeper level, the stocks of local businesses and park visitors have more general fragilities that apply to the high-level stocks. When addressing in the high-level format, the main fragility in the local businesses is remaining open to maintaining an income. The second-level fragilities characterized under this include:

- Structural damage of any of the local businesses is a characteristic of the high-level fragility of closure and income loss. The exploitation of this second-level fragility would force a local business to close and, potentially spend money on repairs.
- Land loss can be exploited by natural and human hazards and is a clear characteristic of closure. Exploitation of the fragility of land loss would force local businesses to close down or move, exploiting the fragility of staying open and maintaining income.

- Regulations made by the local, state, and federal agencies. All local businesses are required to follow regulations, some protecting the business, and some protecting the customers. Regulations put in place that force businesses to close or limit customer interaction exploits the high-level fragility.
- Economic downfall and income loss are second-level fragilities that are directly correlated with the high-level. Businesses, especially those that are small and locally-owned, are fragile to economic downfall and income loss which are caused by a variety of different hazards.

The high-level fragility of being able to remain open and receive income is specified by the second-level fragilities listed above. These fragilities allow for harm to occur to the local businesses and have an impact on the overall system. Section 6 will go into further detail about the hazards that exploit these fragilities. The final stock of the high-level system is the visitors. This refers to FLSP visitors and includes both local residents and the tourists that travel into Virginia Beach. Both groups also have a high-level fragility of staying home. The visitors implies they travel to the park and local businesses and are fragile to not being able to by the following second-level fragilities:

- Income changes can potentially change the ability of a visitor to leave their home. Exploited by job loss or change in spending amounts can cause visitors to be uncomfortable spending money on travel, excursions, or even shopping locally.
- Changing desires can be influenced by state, national, or global health problems; societal pressures; and weather events. All of these external stressor can make people feel like they should stay home. They do not want to travel or go places because they are perceived as dangerous. This mostly applies to tourists, but is a clear characteristic of visitors being fragile to staying put.
- Physical abilities of people is another fragility that has an impact on the high-level one. People are fragile to physical health changes, such as broken bones or illnesses that prevent them from traveling.
- Restrictions set by local, state, and federal agencies typically prevent local businesses and attractions to allow people but, as seen during COVID-19, they can also prevent people from traveling, or even leaving their homes for unnecessary goods and services.

Fragilities are an inherent part of the high-level and second-level systems and can be clearly identified from the conceptual and stock-and-flow models. After analyzing all the relevant fragilities, each one was taken from the system model and used to identify the hazards that exploit these fragilities.

## 5 Hazards

Hazards are the changes to the system that lead to a degradation through the exploitation of the systems fragilities. When time is removed from the system, a hazard cannot occur. However, when time is a function of the system, hazards change the natural flows of the system, typically resulting in a degradation. External hazards cannot be prevented, but their effects on the system can be mitigated by addressing the systems fragilities. The fragilities were assessed as both high-level and second-level. While the hazards will be identified based on the event, rather than the system model.

## 5.1 Sea Level Rise and Climate Change

As seen in the previous section, FLSP and local businesses are fragile to their ability to remain open, which can be achieved through exploiting the second-level fragilities of flooding and destruction. Sea levels are currently rising and are predicted to continue (IPCC, 2007). Virginia Beach, including FLSP, is at a major risk for SLR because of the low elevation and intricate series of tidal rivers that run throughout the area. Norfolk and Virginia Beach, Virginia are currently flood areas. Just looking at 2ft flooding in Norfolk is a 100% probability of occurrence by 2030, 2050, and 2100 (ClimateCentral, 2020). If we look at flood risks increasing in height above sea level, the probability of likelihood before 2030 and 2050 decreases. Looking out to 2100, the probability of Norfolk flooding at 10ft to a very wide range of 4% to 92% (ClimateCentral, 2020). The foresight section will discuss the impacts of SLR further.

Looking to the short-term future, local businesses are more at risk of construction-caused land loss, because there are no measures that prevent construction. Whereas this is an unlikely at FLSP due to the protection of the state. Inundation causes structural damage to not only the park's many buildings, but also impacts the local businesses and homes of residents. FLSP has guest cabins and yurts; a visitors center and store; and a maintenance building. These are major attractions for the park and if damaged or destroyed would be a major problem for the park. The trails, beaches, and history make up the rest of the park's attractions and it can be assumed that if the buildings are damaged, the other infrastructure is impacted as well. The likelihood of wind, flooding, storm, and inundation occurring is increasing with climate change and SLR. Damage to local businesses due to flooding could result in another hazard of income loss due to having to closing up and potentially spending money on repairs.

## 5.2 Amount of People

FLSP is fragile to overuse, while the local businesses are fragile to under-use. The hazard that exploits usage amounts in this system is the amount of people in a given area. More people that use the facilities incorrectly will cause damage to the trails, beaches, campgrounds, etc.. The probability of overuse occurring at the state park is great with each year due to increased amount of tourism. COVID-19 has also resulted in more local people wanting to get outdoors and find educational, active places to recreate. This increased the park's visitors as of August 2020 compared to the years before (Jennifer Huggins, word of mouth). It is unknown at this time how the post-COVID-19 community will be able to use the park. While an increase in people at the park is hazardous, the decrease in people in local businesses is hazardous. Local businesses need people in stores and using their merchandise in order to stay in business. A lack of use will result in loss of businesses. COVID-19 resulted in a large decline in visitors to local businesses. Businesses were mandated to close for many weeks and when finally able to re-open, there were and are many restrictions on the amount of people inside and out. Although most businesses were able to re-open at partial capacity, the amount of people coming into Virginia Beach was lower and the future tourism industry outcomes are unknown.

Virginia Beach is at risk of uncleanliness due to the fragility and exploitation through the amount of people and lack of societal pressure to avoid littering and pollution. FLSP, as well as the local businesses, are negatively impacted by litter and pollution because it changes the perception of the visitors on the area. If the area is unclean, visitors will chose to go to a different location. Unfortunately, it is the visitors that typically cause the hazard of litter and pollution. Therefore, the probability of the hazard occurring is relatively high. The hazard here is the amount

of people because people are the reason for littering.

### **5.3 Economic Downfall**

Local, state, national, and global economies are hazardous to FLSP, local businesses, and visitors, but the hazards impact different fragilities. FLSP is fragile to budgeting restrictions. They apply and receive money from the VDCR and therefore, are dependent on the Virginia economy. Much, but not all, of the park's budget comes from taxpayers. This means that FLSP also has a hazard of low population to pay taxes. Local businesses are dependent on the local economy in order to keep the businesses going. The local economy, when strong, encourages people to go out and spend their money in the community. When the economy is weak, people are less probable to spend. State, national, and even global economies impacts the tourism industry. With weaker economies tourists are less likely to travel, and therefore less likely to come to Virginia Beach. Less tourists leads to less money in the community and local businesses. This then increases the risk of community decline and further tourist decline.

### **5.4 Government Restrictions**

Government restrictions are hazards that are associated with this system. Local, state, and federal restrictions determine not only the rules and regulations of FLSP, but also the rules and regulations of local businesses and people. Virginia state makes rules for the park based on biological needs of the unique community. If there is overuse of certain areas; are areas in need of protection; or are ongoing studies, the state is able to make regulations to block that part of the park to visitors in order to protect the land or species. The state and federal agencies are also able to make rules and regulations for the amount of people allowed in the park, and the guidelines necessary for park use. This is seen during COVID-19. Local businesses are also subject to rules and regulations made by local, state, and federal agencies to ensure the safety of visitors. People, either residents or tourists, must also abide by the rules and regulations set.

### **5.5 Social Pressure**

Finally, the fragility of changing desires impacts the flow of people from home to the local businesses and FLSP. Weather, changing health and health risks, changing physical abilities, and economic loss are all hazards that exploit this risk. Some have been addressed above, but weather and health changes impact the desire for people to travel. If there are weather or health warnings not only in Virginia Beach, but also in nearby areas or states, people are less likely to travel than if the weather is nice and there are no health risks. Currently, there is a global pandemic, although the data is not complete. COVID-19, which has greatly influenced tourism, has slowed incoming tourists to local businesses and FLSP, but has increased the amount of locals. The construction of barriers or addition of sand to beaches exploits the fragility of the beach and bay changes to sediment flux. The beaches are also vulnerable to losing societal interest through ocean debris by way of marine pollution or biological events. Recently, there has been more biological events that cause bay waters to smell or be dangerous to people. These include extreme algal blooms, jellyfish blooms, or decaying marine flora pushing into the beaches (WAVY, 2020). These hazards can be dangerous to people and can deter visitors from enjoying the park.

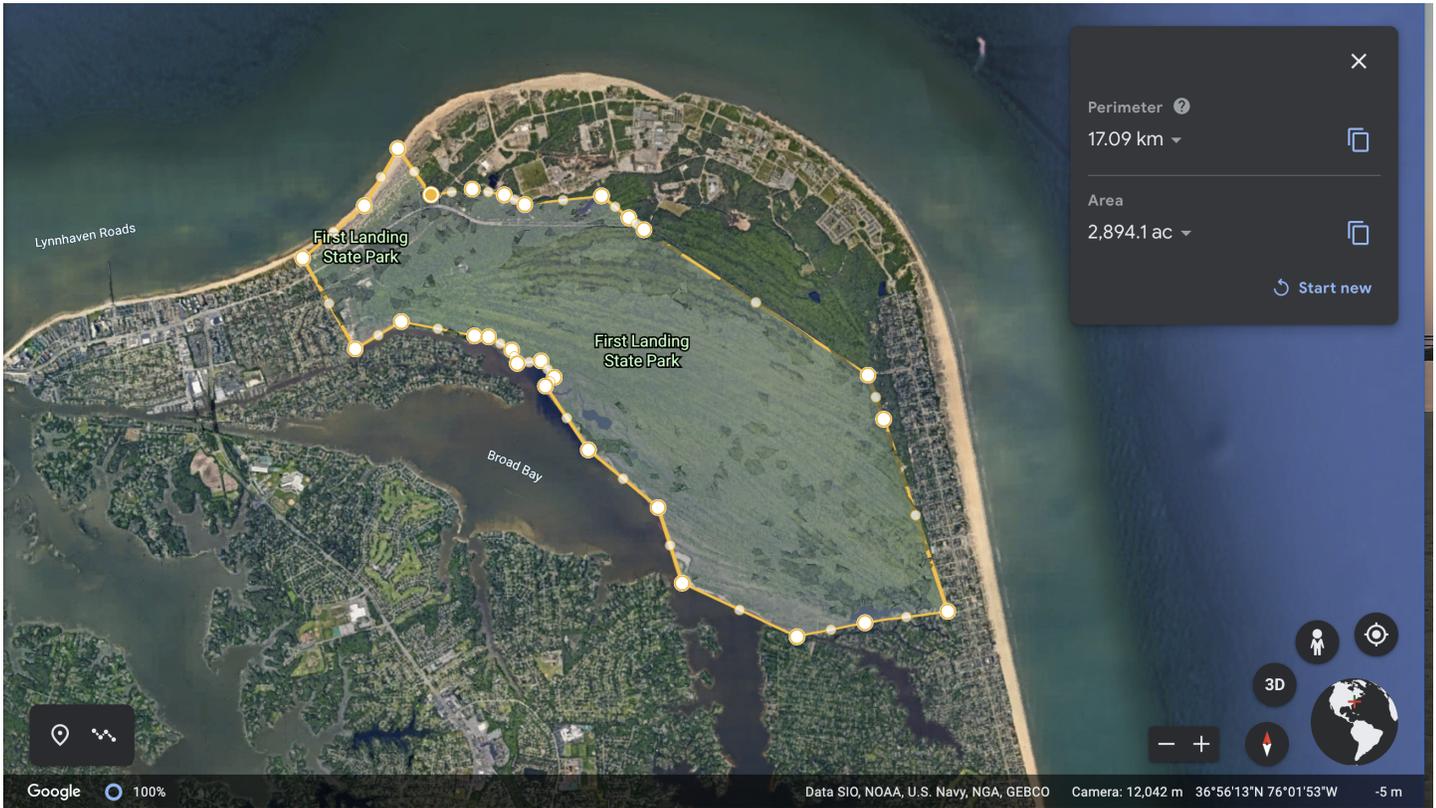


Figure 8: Satellite image of First Landing State Park showing an estimate of the acres at current sea level (GoogleEarth, 2020a).

## 6 Foresight

Foresight helps to identify future developments by considering the hazards and the threats of the system and gathers insight through the scenarios developed. The insight is then used by decision makers and stakeholders to further progress in the decision-making process by gathering information for interventions. FLSP and the Virginia Beach communities face their own spectrum of possible futures. In this section, we discuss the possible futures of this system under two main scenarios; SLR and Economic downfall.

### 6.1 SLR and climate change

As sea level rises, land will become submerged, and storms will have an impact further inland. NOAA’s SLR Viewer tool (NOAA, 2020a) was used to view how sea level would cover the land at different sea level heights. The tool uses elevation changes to predict mean high tide line at different interval sea level changes. FLSP is fragile to inundation caused by the hazard of SLR. At current sea level, the park contains 2,888-acres and is a strong member of the Virginia Beach community (Fig. 8). Increased sea height to 4 feet above current sea level will have great impacts (Fig. 9). More than 9 miles of the total 19 miles worth of trails will be impacted. Approximately 7 miles will be completely submerged by mean high tidewater, while about 3 miles will be submerged during extreme high tide events.

At 4 feet SLR (Fig. 10), Virginia Beach community become inundated from North Bay

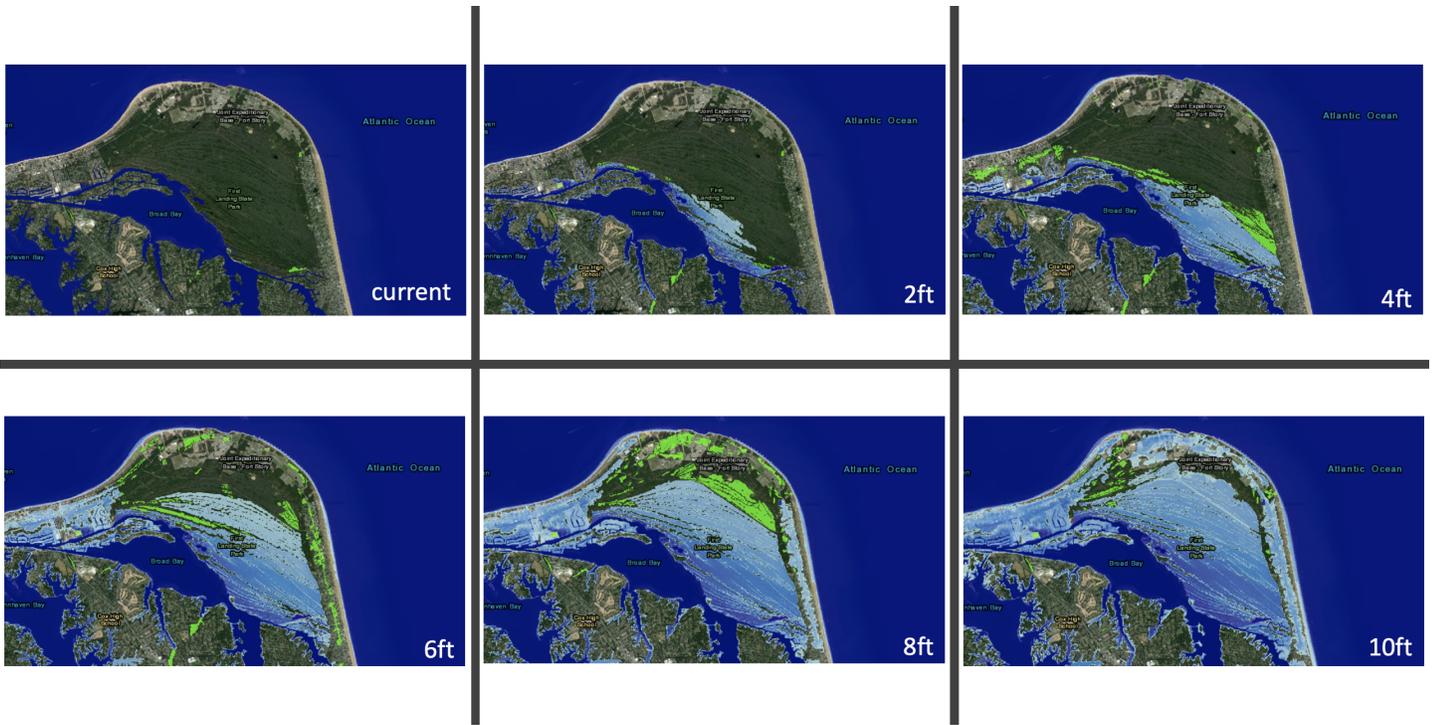


Figure 9: NOAA varying SLR of First Landing State Park (NOAA, 2020b).

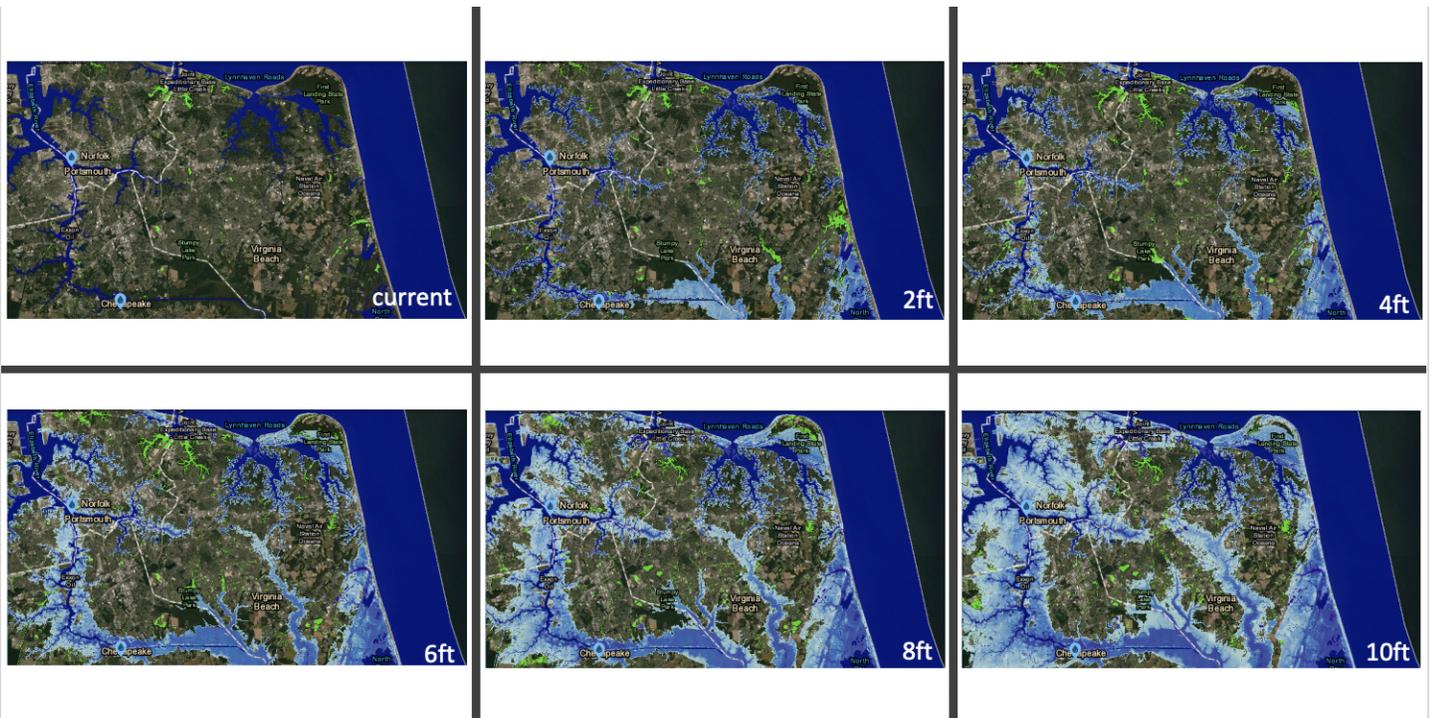


Figure 10: NOAA varying SLR of Virginia Beach, Chesapeake, Norfolk, and other communities (NOAA, 2020b).

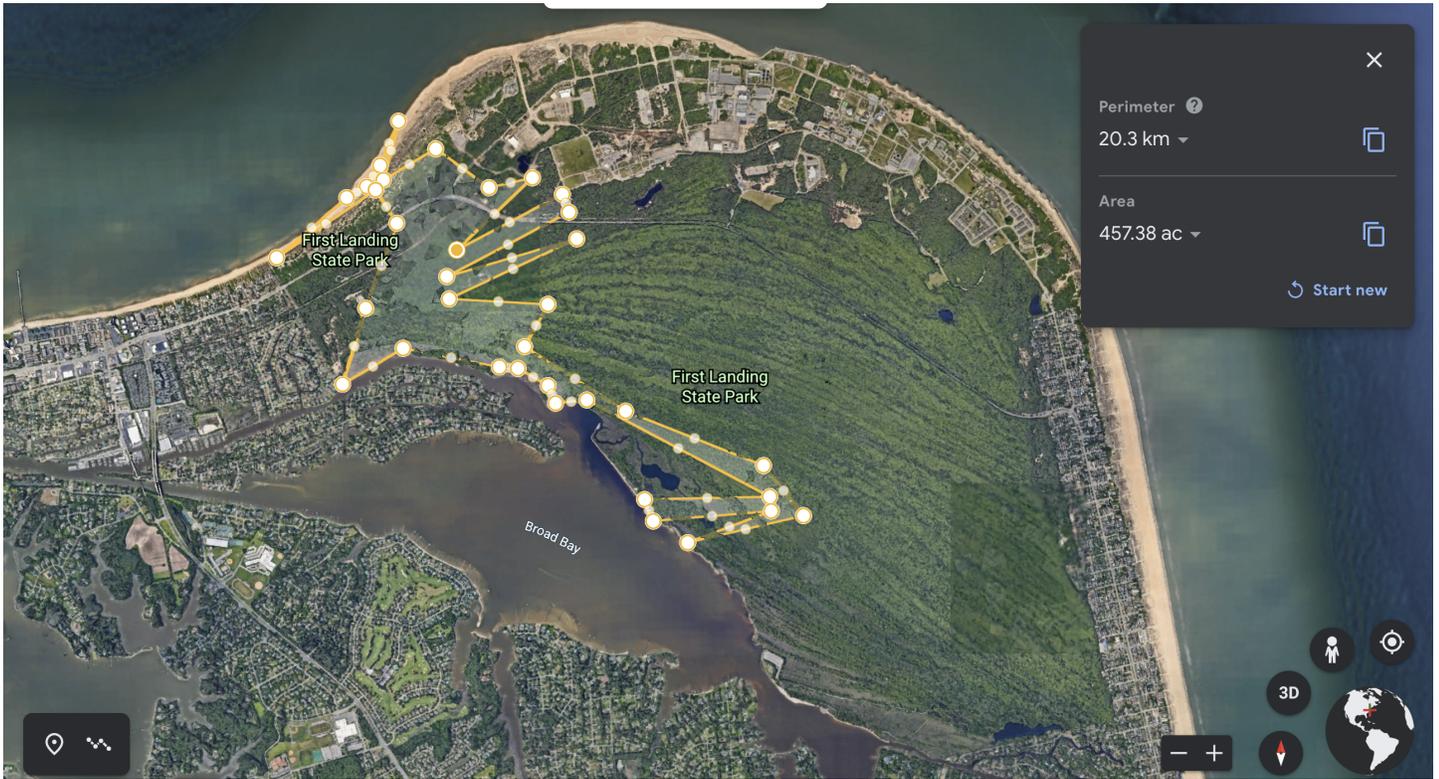


Figure 11: Google Earth extrapolation of Area in First Landing State Park after 10ft of SLR as seen from NOAA (GoogleEarth, 2020b).

flooding north to northwest. At high mean tide the land up to 1 mile inland from North Bay will be flooded and during major high tide events, this could increase up to 2 miles inland. The North Landing river will also expand from 0.25 miles across between Pungo Ferry Rd and W Landing Road to 0.5 miles or more. The expansion of this river will also result in a greater sediment flux and increased erosion. During storm surge and flooding events, the river could expand even greater. At current sea level, the Lynhaven River connects to the North Landing River through a small creek (Fig. 10). At the 4 feet increase in mean sea level, these two rivers will be clearly connected on the western side of the Naval Air Station at Oceana (NOAA, 2020a).

At 10 ft FLSP will go from the current 2,888-acre area (GoogleEarth, 2020a) of land down to 500 or less according to the maps from NOAA SLR Viewer (Fig. 9) and Google Earth (Fig. 11) (NOAA, 2020b) (GoogleEarth, 2020b). All of the trails will be inundated and mostly unable to be utilized. The campground area will also be inundated, except the area closest to the road and to Fort Story. The cabins, visitor center, and maintenance buildings will also be inundated. These once populated areas will be available only to small boats, no longer on foot. The unique marshes, dunes, and forests will no longer exist and the attraction to the land will be lost.

Virginia Beach, Norfolk, Chesapeake, and other local cities are not able to escape the effects of rising seas either (Fig. 10). At 10 feet above current high tide, Norfolk is completely inundated, there is only small areas above the new sea level that are not flooded, but are now islands. These small islands will be only accessible by boat and likely to be inundated by storms surges or high flood events. Portsmouth is also inundated, leaving Chesapeake and Virginia Beach to be disconnected from the rest of Virginia (NOAA, 2020a). There are areas of land not flooded, but this leaves islands disconnected (Fig. 10) by saltwater rivers and would be extremely fragile to

storms. Virginia Beach is no longer a thriving tourist destination as the beach front businesses and attractions are under the tide level. The new coast lines are full of debris and are not sandy beaches, but old properties or grasslands. Eventually, this will turn into beaches with building debris, but will still not be desirable to tourists.

## **6.2 Economic Stability:**

Section 5, Hazards, talked about the various hazards that exploit this system. Not only do SLR and climate change create a many futures, but economic status also creates a spectrum. Local, state, federal, and global economies impact the ability for FLSP to maintain its socio-economic role. State economy is growing, people are feeling comfortable with their personal finances and are wanting to travel. Local businesses are booming, there is a consistent influx of people traveling from Northern and Western Virginia providing growth for Virginia Beach. Colleges and universities are in session, bringing out-of-state students local. The influx of money to businesses and the communities allows them to stay updated and clean, providing for more tourists to have the desire to visit. FLSP provides a much needed space for recreational activities. The high-use park is able to request more state money for repairs and growth. The growth of FLSP is related to the growth of Virginia Beach. More people coming in for the history, beaches, trails, and camping means more people wander out into the city to look for food, or accommodations, or other attractions. The money spent in the community increases the well-being of business owners and the community as a whole. As the community grows, there are more businesses that pay taxes and will potentially increase the park fund, allowing FLSP to expand even more. Federal and global economic growth is also correlated with the growth of the state and local economies. Globally, or even nationally, economic standing relates to the desires of people to travel. If there is stability world wide, then the economy locally increases as well. People travel from different countries to come to FLSP, mainly from Canada, but with global economic growth other nations too.

Due to the current nature of economy, the US economic standing is directly correlated to state economies. Natural hazard-caused disasters and other state-based disasters can cause burdens to state economies. However, global or national recessions also describe local and state standings for the purposes of this study. Given this, a foresight where local, state, national, and global economies are in recession is negative to the tourism industry, and therefore negative to Virginia Beach and FLSP. People are not traveling on regular vacations, but are staying home and saving money or spending it in their own communities. Health hazards, such as COVID-19 or other dangerous viruses, push people to stay home or stay outdoors. FLSP has lower visitors from outside of the community, but an increase locally at first. Restaurants and retailers are closed and their owners can no longer provide for themselves or their families. Eventually, many of these must close their doors permanently. The community becomes desolate as more shops, businesses, and restaurants close and residents leave the area. The tourists, when later are able to travel, do not want to visit Virginia Beach because it is unclean, sad, and has limited attractions. As the economy declines and residents move away, FLSP loses local visitors as well and cannot sustain itself. The VDCR struggles to maintain, not only FLSP, but the others that relied on the revenue from FLSP as well. The foresight outlined in this section describes futures of the FLSP and Virginia Beach system that are positive and negative. Interventions will use this foresight to discuss various changes that can be made to attempt to address the undesirable futures.

## 7 Interventions

Sections 3, 4, 5, and 6 have outlined the system and the drastic changes to the system that are likely to occur in the future. The changes to the systems of FLSP and the Virginia Beach community will move the system closer to their tipping points. These have been identified in Section 4, the fragilities, Section 5, hazards, and Section 6, foresight. The changes are currently in progress and will continue unpredictably. Therefore, it is important to assess multiple interventions that can either delay the rates of change or change various societal influences on the systems. Maintaining the socio-economic importance of FLSP during a time of SLR involves unique interventions to keep the system resilient. This assessment reviewed various interventions from natural, to virtual outreach, to economic initiatives in order to assist in the recommendations process.

### 7.1 Interventions Addressing Sea Level Rise

FLSP is an important tourist attraction due to the unique ecosystems as well as the various beaches, camping, and trails that provide excellent outdoor recreation. As seen in foresight, SLR will inundate these features from the bayside of the park. Potential natural interventions include adding sediment to the beaches, building natural dikes, and increasing vegetation and marshland. Bringing in sediments to build up the beaches of the bayside of the terrain would delay to impacts of SLR. Increasing the elevation of this particular area, which is seen to be inundated first in the foresight, would help slow the inundation. It would take longer for the sea level to increase above the added beach sediments. Unfortunately, this method would also greatly impact the unique ecosystems by covering them up and potential inviting invasive species to the park. Expanding marshes and vegetation would also slow the erosion of the inland-most areas, first inundated by SLR. However, there are no solutions that would stop SLR and therefore, interventions that attempt to do this would be short-term.

### 7.2 Interventions Addressing Societal Pressures

It has been made very clear during the pandemic of COVID-19 that businesses, schools, and governmental organizations must be able to work online. Many people found themselves out of date and worse off because they could not easily switch to a virtual world. FLSP has a website where basic information about the park is placed, but it does not nearly show everything one wants to know about the area. A virtual intervention would include the VDCR updating the already existing virtual platform to include more information and park videos on the parks page. This would increase the desire for people to visit the park compared to the current content. There is not any use of Facebook, Instagram, Twitter, or any other social media by FLSP itself. The VDCR is responsible for all virtual content for all of the parks which makes the information impersonal and out-dated. Another intervention would be for the VDCR to allow a person from the park's staff to post events, health and safety information, and fun activities or facts about the park on a regular basis. This would incline more people to either participate virtually with the park, potentially increasing revenue, or increase in-person participation by bringing in more people. While this intervention is a good step to increasing park use, the social media currently in-use poses a problem.

According to the Social Dilemma Documentary, social media is a tool used to group like-minded people together. The algorithm is designed to show content and advertisements related to the content a user searches for (Orlowski et al., 2020). This pushes people deeper into whatever they

are searching for, rather than showing contrasting content. The danger of this mindset is that there is no facilitation of conversation from different viewpoints. While Twitter, Facebook, and Instagram are main platforms (Statisa, 2019) used by companies and entities for promotion, but none have successfully created a new environment where discussion is the main purpose. FLSP could work with others to create a virtual platform where there could be a space for a facilitation of knowledge sharing. There could be videos of features of the park that include unique species, the unique environments, the history, and more. This space should be able to host people who want to 'go' to the park without being there in person and should be able to facilitate discussion between experts of the park and the people trying to learn and participate in the park. This virtual intervention could also have a membership fee for some of the content or costs for virtual programming which would maintain revenue flow during off seasons or when people cannot travel.

### **7.3 Interventions Addressing Economic Issues**

Currently FLSP is located in the city of Virginia Beach, but there is not a lot of interaction between the two. There is a clear economic benefit for the local businesses from FLSP (Widener & Group, 2019) and a benefit for FLSP to be in Virginia Beach. If the park, the businesses, and the local government were to work more hand-in-hand and provide more transportation of activities and events between the two, there could be a stronger economic relationship. Building programs that work more effectively with VB and its residents will ensure longer term incentive for the residents to engage with FLSP. Investing in the community is a key factor here.

Another engagement is to increase funding from VDCR to FLSP in order to increase cleanliness, keep the park updated, and limit costs to residents. FLSP brings in a large sum of the total park revenue for Virginia. While they receive a larger amount in return, FLSP is still partially responsible for the survival of other parks. If other, smaller parks, were to engage with virtual platforms and marketing techniques, their revenue could increase. This would lower the need for FLSP carry many of the others. While these interventions would change the direction of possible futures of FLSP and the Virginia Beach community, the recommendations must be focused on the goal statement created by the stakeholders.

## **8 Discussion and Conclusions**

### **8.1 FLSP History**

FLSP is located on the southeastern coast of Virginia, in the United States along the Chesapeake Bay. The park is part of an larger system with the Virginia Beach community. The system is rapidly changing due to increase exposure to hazards that threaten the ability of FLSP to maintain it's socio-economic role in Virginia Beach. Ensuring the system remains resilient to the changes facing it is crucial. The past 11,000 years have remained relatively stable, meaning the natural changes made to the system have happened very slowly on a geological scale. However, no the environment is largely changing due to anthropogenic climate change and SLR. The system of Virginia Beach and FLSP includes an economic balance that is fragile to societal changes threatening the park and community as well, potentially changing the system permanently.

## **8.2 The System and the Goal**

The multiple models created, including the two conceptual models and the stock-and-flow model, have clearly outlined how the systems are interconnected. There are various stakeholders involved to formulate the common goal statement, inform the desired futures, interventions, and, therefore, recommendations. FLSP and VDCR are the main stakeholders being addressed due to the ownership of the park and their ability to make influential decisions. The goal is restated here to show the importance of this statement on the recommendations: to maintain FLSP's natural land while providing educational and recreational activities for locals and tourists in order to maintain FLSP's socio-economic role in the community. The members of the decision-space are able to implement interventions which have a potentially large impact on the community. The common goal statement and participatory though experiment are crucial for the outcome of the study, but it is equally important that the stakeholders are aware of the system fragilities and associated hazards discussed, including things such as economic loss and physical destruction. Some of the hazards addressed include SLR and economic recessions.

## **8.3 The Spectrum of Futures**

A spectrum of possible futures was then analyzed based on the fragilities hazards discussing two main scenarios. SLR is a threat that will happen, despite an unknown time line. FLSP and Virginia Beach will become inundated from the sea which will ruin the tourist industry that allows for the community to thrive. Economic growth and economic recessions are futures that greatly varying from desirable to undesirable. These possible futures show that changes need to be made in order to avoid the undesirable through interventions. These were explored to potentially increase the likelihood of maintaining FLSP socio-economic role.

## **8.4 The Interventions**

The interventions reviewed in this study included implications that could delay the effects of SLR and those that could increase the economy of both the park and or Virginia Beach. Natural interventions to increase elevation of the park's most vulnerable areas could slow inundation but would also go against the park's desire to maintain the natural environment. Virtual Interventions explore the need for an increasing presence virtually and the ways in which this could increase socio-economy of the park. Further economic interventions discussed increasing the relationship between FLSP and Virginia Beach to increase the chance to having a supportive environment.

## 9 Recommendations

FLSP is an integral part of the Virginia Beach community. It provides the area with educational and natural activities for both residents and tourists and therefore provides a socio-economic benefit to Virginia Beach. FLSP contains 2,888-acres that is capable of bringing in over one million visitors a year. Containing 1.5 miles of beaches located on the mouth of the Chesapeake Bay, the park also houses unique features including back dunes, tidal marshes, swamps, and a maritime forest community. The land is considered the northernmost limit for semi-tropical species and the southernmost limit for temperate species. This unique environment, coupled with the many trails running through it, the campgrounds and cabins, and the rich history allows for FLSP to have socio-economic importance in the community. FLSP is run the VDCR which is the main stakeholder addressed here. Other stakeholders are the Virginia Beach businesses, government, and local residents, as well as regulatory agencies including US EPA, VDEQ, and US NSP. The goal of these stakeholders is to maintain FLSP's natural land while providing educational and recreational activities for locals and tourists in order to maintain FLSP's socio-economic role in the community.

FLSP and Virginia Beach Virginia are low in elevation and located at the confluence of the Atlantic Ocean and the Chesapeake Bay. This leaves the area fragile to flooding exploited by SLR and storms. The socio-economic standing of the park within the community also allows for fragilities based on economic stability and societal pressures which can be exploited by recessions and health hazards, respectively. The study examined the fragilities and hazards in detail to create a spectrum of possible futures that were outline in the foresight. Interventions were then explored to make changes to the system in order to avoid the undesirable futures.

The goal of the recommendations is to assess the interventions under considerations of the stakeholders and decision makers, as well as the system, in order to recommend the most beneficial interventions to the area to achieve the goal. The goal statement for this project was to maintain FLSP's natural land while providing educational and recreational activities for locals and tourists in order to maintain FLSP's socio-economic role in the community. The recommendations seek to maintain the parks natural education and recreation area while working to lower the risk of economic loss. The recommendations will be addressed to the VDCR and FLSP staff members.

### 9.1 Addressing Sea Level Rise

- Recognizing that:
  - Sea level rise is a continuous threat to the area
  - The missions of the VDCR and FLSP are to maintain natural environments for educational and recreational activities
  - The park and local region has a limited lifespan
- Acknowledging that:
  - FLSP is only one of the many state parks and is not the sole focus of VDCR, but provides a major revenue source for the state park system
  - Virginia Beach has many small businesses and other tourist attractions to encourage community growth, but that FLSP is one of the largest outdoor recreational locations

- The southern end of the park is the most likely to be affected by sea level rise first, as it is at the lowest elevation in the park area
- The southeastern end of Virginia Beach is also likely to be affected by sea level rise first, as it is at the lowest elevation in the area and closest to the ocean inlets.
- It is recommended that the Virginia Department of Conservation and Recreation and First Landing State Park:
  - Allow the natural inundation to occur
  - Use this natural process as an educational experience and encourage tourists to come and learn about the changing environment
  - As a part of the history, beaches have been migrating forever and can be included in the discussion when talking about the colonist’s landing site. Showing images of the beach changes could be a good display

## 9.2 Addressing Societal Pressures

- Recognizing that:
  - Technology today allows for virtual spaces to be semi-equivalent to in-person needs
  - Global pandemics, such as COVID-19, and other global societal pressures are major hazards for today’s society
  - Tourism is fragile to the emotions of people traveling
- Acknowledging that:
  - FLSP and Virginia Beach are fragile to these implications
  - FLSP and Virginia Beach are interconnected provide one-another with necessary economic importance
  - Virtual Spaces are not utilized enough to support FLSP or Virginia Beach local businesses
- It is recommended that the Virginia Department of Conservation and Recreation and First Landing State Park:
  - The VDCR update the already existing virtual platform to include more information and park videos on the parks page.
  - Another intervention would be for the VDCR to allow a person from the park’s staff to post events, health and safety information, and fun activities or facts about the park on a regular basis on Twitter, Instagram, and other current social media applications
  - FLSP could work with others to create a virtual platform where there could be a space for a facilitation of knowledge sharing. This space should be able to host people who want to ‘go’ to the park without being there in person and should be able to facilitate discussion between experts of the park and the people trying to learn and participate in the park.

### 9.3 Economic Interventions

- Recognizing that:
  - SLR and climate change can cause physical destruction
  - Societal pressures lead to people being unable to travel and therefore lead to economic loss
  - Businesses and governmental agencies are fragile to budgeting and economic changes
- Acknowledging that:
  - FLSP is fragile to revenue loss caused by physical destruction, societal desires, and governmental restrictions changing the amount of people able to come to the park
  - Local businesses are fragile to these changes in revenue as well
  - FLSP and local businesses are interconnected and are important economically to one-another
- It is recommended that the Virginia Department of Conservation and Recreation and First Landing State Park:
  - The park, the businesses, and the local government work to build programs that work more effectively with Virginia Beach and its residents will ensure longer term incentive for the residents to engage with FLSP. This can be done by having some local restaurants host booths on the park property to sell food. Some businesses selling local merchandise could also host booths. The park could also provide more transportation between oceanfront and the park to increase tourists flow around the area
  - Another engagement is to increase funding from VDCR to FLSP in order to increase cleanliness, keep the park updated, and limit costs to residents.
  - Take the virtual intervention of creating a new virtual space and include a membership fee for some of the content or costs for virtual programming. This would maintain revenue flow during off seasons or when people cannot travel.

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