Executive Summary

Lake Allen, located on the North Tract of the Patuxent Research Refuge in Laurel, Maryland is currently experiencing an overgrowth of the aquatic plant spatterdock. Aquatic plants are a crucial element for the ecological stability of lakes and ponds, but overgrowth can cause adverse reactions. Overgrowth occurs when 25% or more of surface water is covered. This can cause negative impacts for aquatic life while also interfering with recreational activities such as swimming, boating, and fishing. The goal of this report is to identify external hazards that could be causing the overgrowth of spatterdock in Lake Allen, identify vulnerabilities that exist within the system, look at possible futures, reference key stakeholders, discuss options for mitigation and adaptation, then present a long-term recommendation based off relevant findings.

Findings

1. *External Hazards*

Rouge Harbor Branch is the main stream that feeds Lake Allen. Tributary to Rouge Harbor is the Midway Branch and Franklin Branch. Both streams have been listed as impaired by sediments, phosphorus, and nitrogen and are primarily located in Fort Meade with just a portion of the Midway Branch extending through to Anne Arundel Country. Increases in impervious surfaces due to ongoing development projects in Fort Meade and irrigation of the historic golf course has likely contributed to decreasing depth and increasing nutrient inputs to Lake Allen. Agricultural practices outside of Fort Meade in Anne Arundel Country have likely been a key contributor as well. Rainfall enhances these hazards due to surface water runoff. The overgrowth of spatterdock in Lake Allen is largely attributed to increasing nutrient deposits and decreasing depth.

2. *Vulnerabilities*

Two main vulnerabilities have been identified within the system of Lake Allen, a nutrient level threshold and depth. A nutrient level threshold exists within Lake Allen and when it is crossed, rapid transitions can occur such as the overgrowth of aquatic plants and algae. Decreasing depth provides optimal conditions for the production of photosynthesis, thereby increasing the output of aquatic plants and algae.

3. *Possible Futures*

Two possible future scenarios for Lake Allen were evaluated, a business as usual scenario and a mitigation scenario. A business as usual scenario will likely transition Lake Allen into a freshwater marsh faster than natural lake succession due to increased sediment and nutrient deposits. A mitigation scenario could help to promote balance between human related activity and ecological functionality. Balance could be achieved through best management practices that help alleviate impact from external hazards such as urban development, soil erosion, and nutrient pollution.

4. *Key Stakeholders*

The mayor of Anne Arundel County, the Maryland Department of Environment, the Commander-of-Chief for Fort Meade, scientists, and the Patuxent refuge manager are key stakeholders that could heavily impact the future of Lake Allen. The Maryland Department of Environment issues total maximum daily loads for water bodies throughout their jurisdiction to help meet water quality standards that support the water bodies intended use and furthermore, the intended use of the Chesapeake Bay. Fort Meade has been issued permits for the total maximum daily load that can be received by the Midway Branch and Franklin Branch on their behalf. The manager of the Patuxent Research Refuge could benefit from maintaining contact with up to date information regarding the status of permit loads from point and non-point sources in surrounding areas. Furthermore, enhanced collaboration with scientists could help further research and establish total maximum daily load limits for Lake Allen which can then be passed on to the Maryland Department of Environment. Enhanced collaboration with Fort Meade could ensure implementation of total maximum daily load limits and best management practices. Ultimately, the refuge manager decides what happens to Lake Allen within refuge boundaries.

5. *Options*

To help alleviate impact from external hazards resulting in increased nutrient and sediment deposits to Lake Allen, four options were listed. These options include

- Enhancing collaboration with Fort Meade and scientists
  Enhancing collaboration could help establish and implement best management practices and total maximum daily load limits that could decrease nutrient and sediment pollutants to Lake Allen. However, without proper analysis, these practices may not prove to be effective against worst-case urban development and precipitation scenarios.
- Environmental dredging
  Dredging could help the system find immediate relief from decreasing depth and increasing nutrient deposits. It is important to note however, that dredging can also activate pollutants
- Flushing the system of Lake Allen
  This may help to promote more flow between bodies of water, while also exposing chosen areas of Lake Allen to air which would ultimately promote the degradation of spatterdock. However, this option could cause adverse impacts to the Little Patuxent River.
- Introducing a solar panel aerator
  A solar panel aerator could help promote circulation and water quality within the system of Lake Allen. However, to date, there is no actual research proving that aerators reduce aquatic vegetation.

6. *A Long-Term Sustainable Recommendation*

Fischbach et al. (2015) conducted a study that concluded the current total maximum daily load permits issued by the USEPA and the bay watershed jurisdictions are not likely to be met under future worst-case urban development and precipitation scenarios. Given that best management practices falter, the Patuxent Research Refuge may want to consider letting Lake Allen serve as a retention pond to the U.S. Army until an ecological transition occurs within the system. Under this plan, recreational activities could still be carried out in Lake Allen until a limiting factor is reached. Furthermore, the refuge may benefit from extending and promoting recreational activities in different lakes throughout the refuge.