Murderkill Integrated Sustainability Tactics
(MIST)

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Mission Statement

The goal of MIST is to safeguard the health and vitality of the Murderkill Watershed. This will be achieved by reducing nutrients levels and shoaling which contribute to habitat degradation. Ideally, federal funding and plan implementation will be completed by 2045. Through engaging stakeholders and the community as a whole we hope to ensure long term resiliency in the Murderkill watershed.

Background

The Murderkill River Watershed is situated in southeastern Kent County, Delaware, encompassing an area of 106 square miles (**Figure 1**). Stretching approximately 20 miles from its source near Felton to its convergence with the Delaware Bay at Bowers Beach, the Murderkill River involves a tidal lower section extending to the Rt. 113 Bridge at Frederica. The river's attention grabbing name has Dutch origins, as Moeder is the Dutch word for mother, and Kille is the Dutch word for river, meaning the "Mother River". The waterway is also used as a navigable waterway for its lower 10 miles according to the US Army Corps of Engineers. Numerous tributaries, including Browns Branch, Double Run, and Hudson Branch, feed into the river. There are several lakes and ponds along the watershed as well such as McColley Pond and Killens Pond. Municipalities within the watershed include Bowers Beach, Felton, Frederica, Harrington, and Viola.

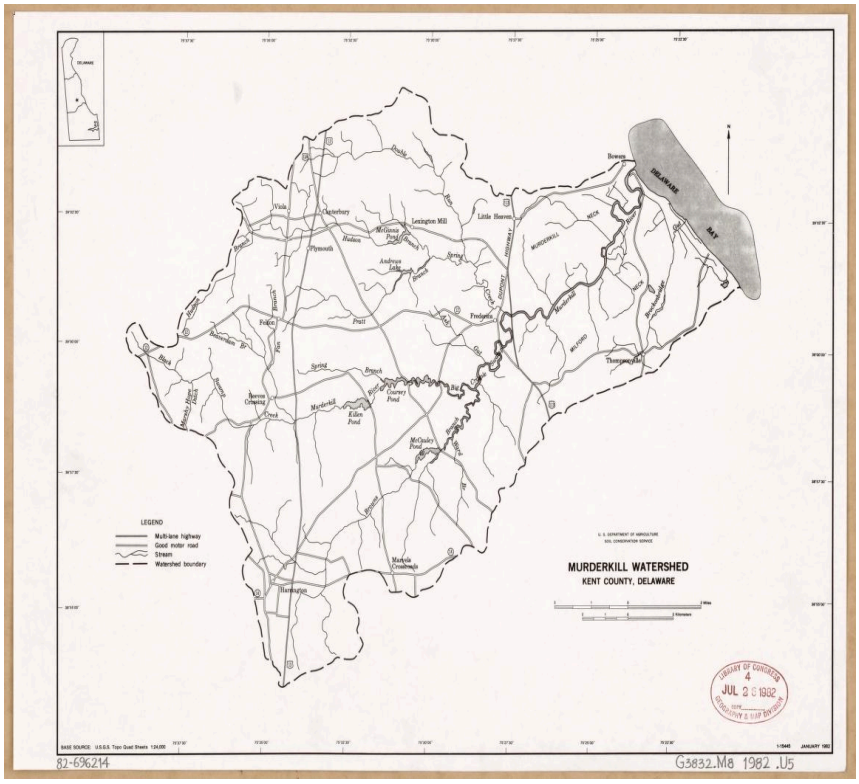

Figure 1: Map of Murderkill Watershed

Land Use

In 2007, the land use in the Murderkill watershed was predominantly agricultural (56%), followed by urban/built-up areas (16%), forests (11%), wetlands (17%), and water bodies (2%). Compared to 1997 data, there has been a decrease of 4% in agricultural land to accommodate a 3.7% increase in urban areas. There has also been a decrease in undisturbed forest land and protected wetlands since 1997. The distribution of land use in Murderkill Watershed is depicted in **Figure 2**.

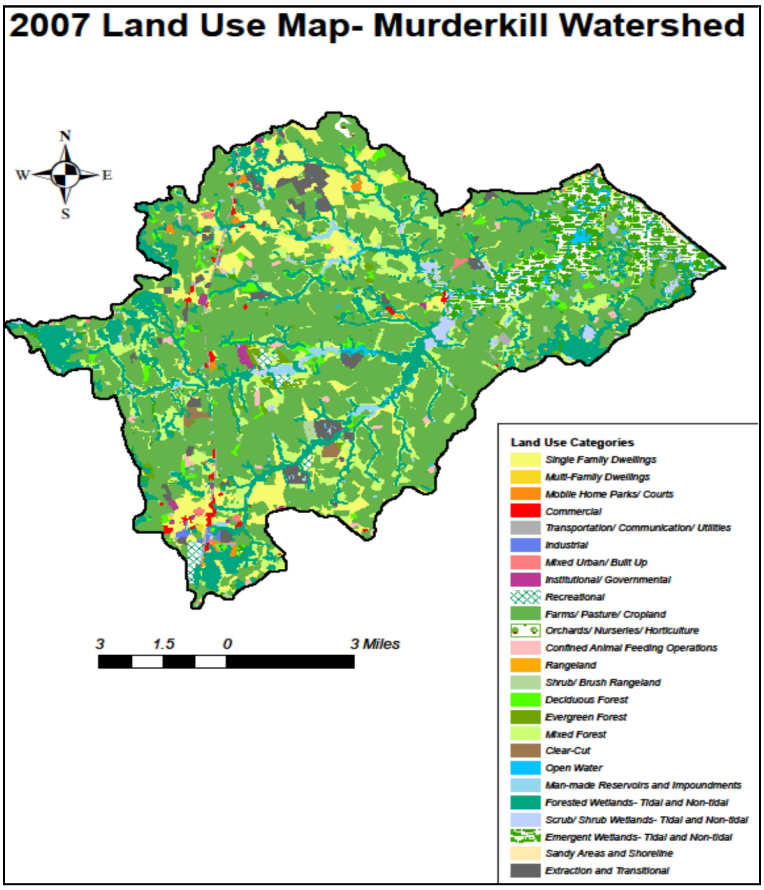

Figure 2: Land Use Map of Murderkill Watershed

Policies and Mandates

In December 2012, a “Pollution Control Strategy” was drafted for the Murderkill Tributary Action Team. The document set guidance on utilizing nutrient reducing Best Management Practices (BMPs) at point sources, and pollution control strategies at non point sources to achieve predetermined Total Maximum Daily Loads (TMDLs) for the Murderkill River. With 55% of the watershed’s land being used for agricultural purposes, steps such as requiring Nutrient Management Plans (NMPs) and additional measures concerning Concentrated Animal Feeding Operations (CAFOs) were taken by the state in November 2011. In addition to these 2011 guidelines, stormwater BMPs became a requirement on any new chicken houses or other

agricultural structural practices within the watershed. Finally, in June 2019, DNREC and the FDA introduced a red dye formerly known as "Rhodamine WT" to the river to gain a better understanding of what would occur in the event that the nearby wastewater treatment plant in Fredrica experienced a spill. The plant is the second largest in Delaware, and processed 14 million gallons of water per day (14 MGD) at the time of the study.

Summary of Problems and Causes

Problem	*Description*	*Causes*
Shoaling	Shoaling can lead to navigation hazards and increased risks of vessel grounding, along with exacerbating coastal erosion and loss of valuable beachfront property. Altered sediment transport patterns can disrupt coastal ecosystems, affecting marine habitats and biodiversity.	Shoaling occurs when ocean waves encounter shallower water near the coastline, causing them to slow down and increase in height. This phenomenon is primarily driven by the interaction between waves and the ocean floor, as well as changes in water depth along the coast.
Increase in Nutrients	Excess nutrients in a watershed can lead to eutrophication of water bodies, causing algal blooms, oxygen depletion, and the decline of aquatic ecosystems. Nutrient runoff can contribute to the contamination of drinking water sources, posing health risks to humans and wildlife.	Nutrient over-enrichment in a watershed can result from agricultural runoff containing fertilizers and animal waste, urban runoff carrying pollutants from lawns, roads, and wastewater treatment plants, and industrial discharges.
Habitat Degradation	Habitat degradation in a watershed can lead to the loss of biodiversity, and reduced water quality which impacts both aquatic and terrestrial species and diminishes the overall resilience of the watershed ecosystem.	Habitat degradation in watersheds often results from human activities such as deforestation, urbanization, agricultural expansion, and infrastructure development. These activities lead to habitat loss, fragmentation, and pollution, disrupting natural ecosystems and diminishing the capacity of watersheds to support diverse plant and animal communities.

Problem & Goal One

Shoaling

Shoaling is a major factor that has shaped the coastline of the Murderkill watershed. Shoaling is primarily caused by the interaction between ocean waves and the seabed as waves approach the coastline. As waves enter shallow water, their motion is influenced by the decreasing depth, causing them to slow down and increase in height. This phenomenon is a result of wave refraction, which occurs when waves change direction due to variations in water depth. Additionally, as waves approach the shoreline, they encounter frictional resistance from the seabed, further amplifying their height and leading to shoaling. Other factors such as coastal topography, underwater terrain, and tidal fluctuations also play a role in shaping the extent and severity of shoaling in a particular area.

Some of the effects of shoaling include that it leads to a submerged build up of sediment and makes it difficult to navigate around them. This can lead to restricted access as the inlet channel reduces in width and depth, especially for larger vessels. Shoaling also creates a more turbulent environment especially during tidal changes and storms. This poses a safety risk to both commercial and recreational boaters using the inlet. The murderkill watershed plays a crucial role in the natural sediment transport process and shoaling can throw it off balance. This can lead to harm along the shoreline and neighboring ecosystems.

Goal One

Creating a consistent dredging and beach nourishment schedule would be the most reliable way to remove the sediment build up. Proper maintenance of the existing jetties will help control the movement of sediment and slow down the shoaling process. Planting vegetative stabilization along the shoreline would help prevent sediments from entering the inlet and support the health of the ecosystem.

Problem & Goal Two

Increase in Nutrients

Intensive water quality monitoring has found that multiple tributaries and ponds in Murderkill Watershed are impaired due to low dissolved oxygen and high nutrient levels. This presents dangers to aquatic life, as oxygen depletion has led to anoxic and eutrophic environments that result in the degradation of aquatic habitats. Nutrient over-enrichment, particularly nitrogen and phosphorus, has exacerbated the issue leading to frequent phytoplankton blooms, decreased water clarity, and altered species composition. Both point and nonpoint sources are responsible for the discharge of oxygen-consuming pollutants and nutrient runoff. Concentrations of nitrogen

and phosphorus in the Murderkill River exceed state targets, with maximum levels reaching alarming levels, posing significant threats to the watershed's ecological balance and overall health.

The primary causes of nutrient over-enrichment in a watershed arise from various human activities such as agricultural practices, urbanization, and industrial processes. Agricultural runoff laden with fertilizers and animal waste carries excess nutrients such as nitrogen and phosphorus into water bodies, fueled by intensive farming methods and improper soil management. Urbanization exacerbates the issue through stormwater runoff, which transports pollutants from lawns, roads, and sewage systems into rivers and lakes. These cumulative inputs disrupt natural nutrient balances, leading to eutrophication, algal blooms, oxygen depletion, and overall degradation of water quality and aquatic ecosystems within the watershed.

Goal Two

One of the best ways to limit excess nutrient-enrichment is to decrease application of fertilizers and pesticides that may runoff into the waters. It is also important to strengthen buffer regulations to allow room for wetlands to move landward with sea level rise. By planting a natural buffer along waterways, native plants can thrive while filtering through stormwater and intercepting nutrients that may otherwise accumulate in rivers and streams.

Problem & Goal Three

Habitat Degradation

Murderkill is home to many different types of species including bass, toadfish, seabass, and perch. These fish are a large part of the recreational fishing that occurs in this region and the habitat degradation reduces this. In this region most of the wetlands are being degraded due to a number of factors. Some of these factors include invasive species that are coming into this ecosystem, filling, and ditching that is occurring in the region and development in the nearby locations. These different factors are leading to the wetlands shrinking in size as well as an increase in pollution and unmonitored species becoming an explosive population. All of these factors lead to the degradation of this river.

Habitat degradation in watersheds can have far-reaching consequences on both aquatic and terrestrial ecosystems. Loss of vegetative cover due to deforestation and urbanization can lead to increased soil erosion, sedimentation of water bodies, and altered hydrological patterns. Fragmentation of habitats disrupts wildlife movement and can lead to isolation of populations, reducing genetic diversity and resilience to environmental changes. Furthermore, degraded habitats are less able to provide essential ecosystem services such as for various species, ultimately impacting human well-being and biodiversity conservation efforts.

Goal Three

Some ways that would be most effective in helping to counteract this degradation includes trying to reduce impervious surfaces near the shore as well as controlling the spread of invasive species. Another option is to help create regulations that will allow the river to return to its true size and not overcrowd and populate the species that inhabit this region.

Recommendations

To combat issues caused by shoaling, our recommendation includes:

- Working with the US Army Corps of Engineers to create a dredging and beach nourishment plan
- Repair existing jetties
- Planting indigenous vegetation stabilization along the shoreline

To combat issues caused by increase in nutrients, our recommendation includes:

- Decrease application of pesticides in the area surrounding the Murderkill watershed
- Increase and implement buffer regulations

To combat issues causing habitat degradation, our recommendation includes:

- Creating and implementing policies/regulations that prevent overcrowding of indigenous species
- Reducing impervious surfaces near the shoreline
- Control the spread of invasive species using mechanical and chemical control methods

Conclusion

In summary, addressing the environmental challenges of shoaling, nutrient increase, and habitat degradation in the Murder Kill watershed requires a multifaceted approach. By refining our methods and adapting to the changing environment, we can work towards the restoration of this ecosystem to its original state of health. Implementation of erosion control measures, adoption of best management practices, habitat restoration efforts, and ongoing monitoring are essential to our plan. Through collective action and dedication, we can work towards a future where the Murder Kill thrives once again.

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