Context Document: Gray Infrastructure for Stormwater Management Ecosystem Service Logic Model

Project: GEMS
http://bit.ly/NI-GEMS

Ecosystem Service Logic Models (ESLMs) are conceptual models that summarize the effects of an intervention, such as a habitat restoration project, on the ecological and social systems. Each model links changes in biophysical systems caused by an intervention to measurable socioeconomic, human well-being, and ecological outcomes. ESLMs assume that the restoration is successful and include all potentially significant outcomes for the intervention; not all outcomes will be relevant to each individual project, depending on location and environmental conditions.

The direction of an outcome (whether the restoration will have a positive or negative influence) often depends on the specific situation or is unclear due to multiple links (arrows) leading into an outcome that may have opposite effects. Thus, language like "increased" or "decreased" is not included in the models. These models are often used to consider management with or without an intervention or to compare different interventions.

This context document includes additional information about the restoration approach and details about some of the relationships in the green infrastructure for stormwater management ESLM. It also includes a list of the references used to develop the ESLM and names of experts with whom we spoke to refine the model.

Gray Infrastructure for Stormwater Management in the Gulf of Mexico

Gray infrastructure for stormwater management refers to a network of water retention and purification infrastructure (such as pipes, ditches, swales, culverts, and retention ponds) meant to slow the flow of stormwater during rain events to prevent flooding and reduce the amount of pollutants entering waterways.

Municipalities typically design stormwater management plans and integrate stormwater management systems with nearby cities when it is reasonable to do so. There is not one set method or system for designing stormwater management—they differ across municipalities within the Gulf of Mexico. Typically, decentralized infrastructure (e.g., ditches and culverts) in places like roads and on private property are installed to slow down water flow and absorb sediments and pollutants in the discharge. The water moves through a series of below- and aboveground infrastructure before being discharged into retention ponds, which are considered both green and gray infrastructure (Prudencio and Null 2018) and can control the rate of wastewater being released into waterways. Beyond providing ecosystem services as they relate to water quality (reduced flooding, sediment, pollution, etc.) retention ponds are considered to provide additional ecosystem services including carbon sequestration, increased biodiversity through habitat, enhanced recreation, and food.

Restoration projects for gray infrastructure typically do not focus on the entire stormwater management system, but rather on enhancing, repairing, removing, or installing new infrastructure in ways that will optimize the efficiency of the system and reduce the likeliness of flooding or polluting waterways during and after storm events. As such, restoration projects can

focus on the repair, addition, or removal of ditches, weirs, culverts, storm drains, and stormwater retention ponds/basins. These interventions can also restore hydrological pathways.

External Factors That Influence Restoration Success

Stormwater backflow is a Gulf-wide phenomenon where high pressure storms push seawater inland and back through stormwater infrastructure of coastal communities. This affects stormwater infrastructure, increasing flooding by overwhelming drainage systems with both fresh- and saltwater, and introducing saltwater to soil which can harm groundwater quality. These phenomena may increase overtime as climate change and sea level rise threaten severe and more frequent storms in the Gulf (Díaz et al. 2016).

Impervious surfaces include areas that do not allow stormwater to absorb into the soil. They include parking lots, roads, roofs, driveways, etc. In areas with many impervious surfaces, stormwater tends to accumulate pollution and overwhelm nearby water bodies during storm events. Areas with many impervious surfaces will have higher levels of runoff as a result.

Model Notes and Clarifications

System Wide Water Retention Capacity: Certain improvements are meant to enhance the overall ability of the system to hold on to water during storm events so that it doesn't overwhelm natural water systems and allows for some suspended solids to be removed from stormwater before it flows into water systems. These improvements tend to be focused on creating more retention ponds either in response to increased development or to affect the system's overall retention capacity. These ponds create spaces for mosquitoes to breed.

Condition of Pipes and Outfalls: Other improvements are meant to improve the conditions of pipes and outfalls where solids and other pollutants tend to build up and disrupt the movement of water throughout the system. These improvements typically remove those pollutants from the infrastructure and can affect how quickly water flows and prevent overflows and subsequent flooding.

Erosion: The placement and condition of stormwater management infrastructure can affect erosion on the coast as well as in streams. This is because infrastructure lies upstream from and adjacent to coastal habitats and carries sediment through various waters including streams and coastal areas. Erosion in freshwater streams has different outcomes than in coastal areas.

Inflow and Infiltration into Wastewater System: Though stormwater management is intended to be separate from other sources of water, stormwater can contaminate those sources during heavy storm events. Stormwater backflow (above) or uncontained stormwater runoff (Gaffield et al. 2003) can contaminate groundwater and wastewater systems.

Nutrition for Communities: This as an expected socioeconomic outcome of restoration projects can come from two sources: changes in fish and shellfish harvesting, and changes in land-based hunting on restoration areas. For this model, the source of nutrition is mainly from changes in fish and shellfish harvesting.

Experts Consulted

Dr. Chris Martinez, University of Florida

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References

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