



# STORMWATER RUNOFF AND LAKES

Keeping Our Lakes Clean and Healthy  
*in a Changing Regional Climate*





# HYDROLOGIC CYCLE

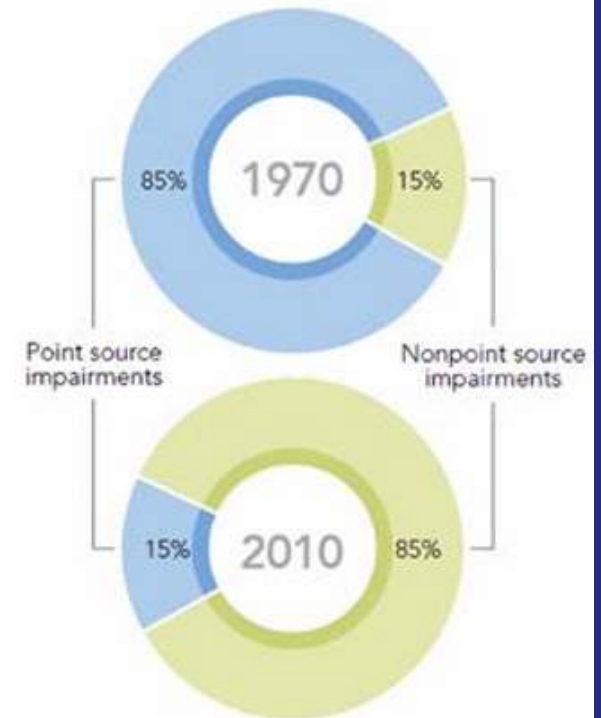


## National Issue

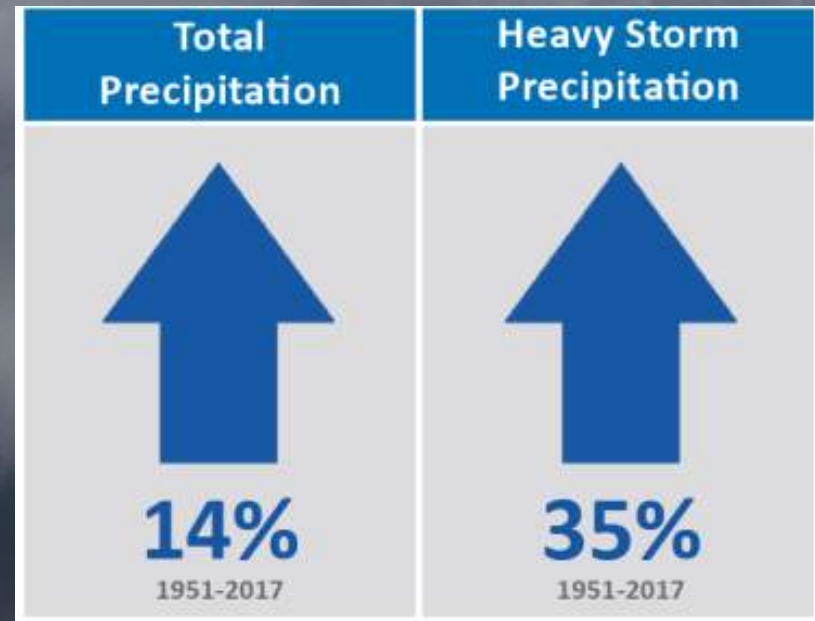
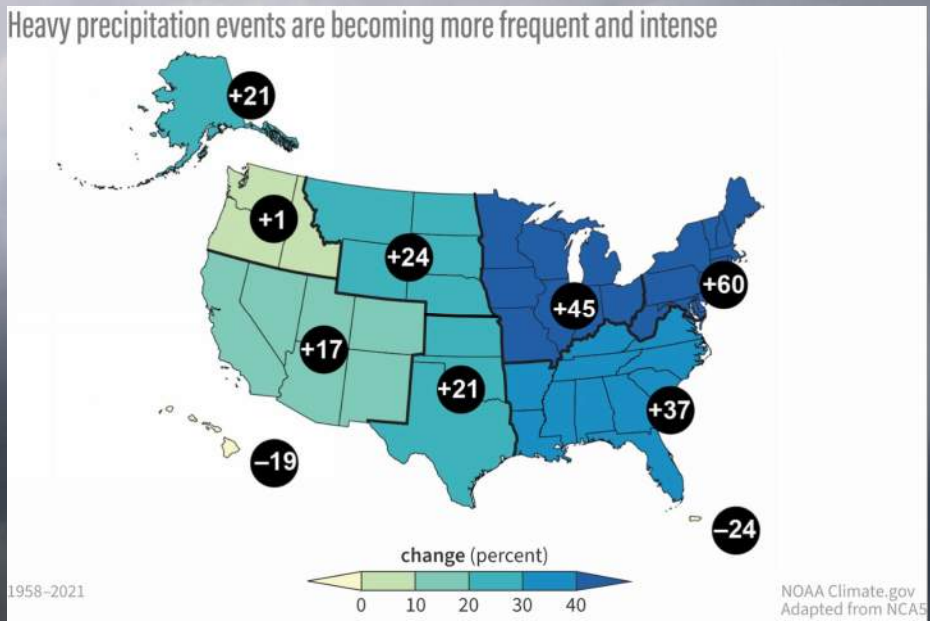
“Stormwater is the only growing source of water pollution in many watersheds throughout North America. Urbanization and climate change exacerbate stormwater pollution, and, today, more than half the world’s population lives in cities.”

“To put this issue in the context of environmental effect, in 1970, 85% of water quality impairments were associated with point-source pollution. The remaining 15% came from nonpoint sources such as agricultural and urban stormwater. Today, after significant advancements in wastewater treatment, these values have flipped — 85% of impairments now stem from nonpoint and urban stormwater discharges.”

*Rainfall to Results: The Future of Stormwater*  
Water Environment Federation, 2015



# Extreme Precipitation Events



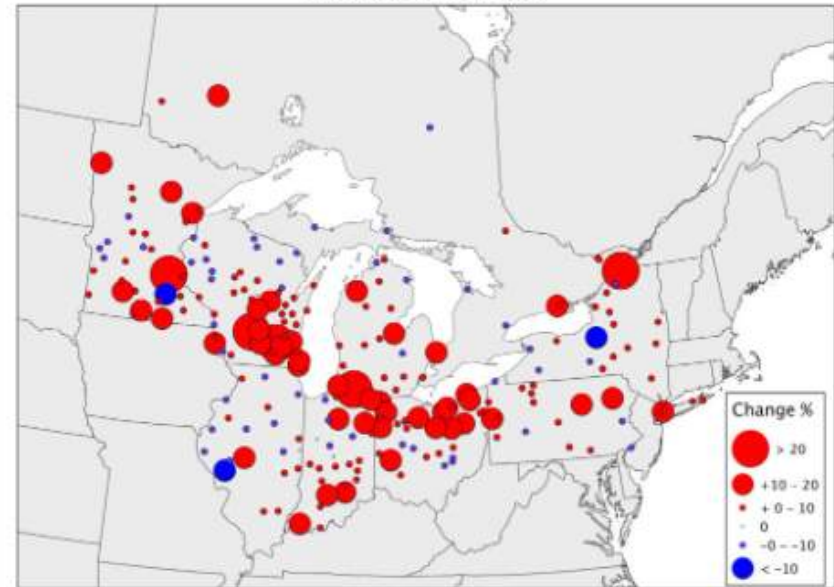
Michigan Data Courtesy of GLISA 2019

## Changes in the Heaviest 1% of Daily Precipitation Events from 1951-1980 to 1981-2010 in the Great Lakes Region

Change in Intensity of 1% Heaviest Storm (%)	5.1
Change in Number of 1% Heaviest Storm Days (%)	23.6
Change in Amount Falling in 1% Heaviest Storms (%)	24.5

Regional analysis of extreme precipitation. Values are based on observations from 230 U.S. and Canadian GHCN stations across the Great Lakes region.

Observed Changes (%) in the Intensity of the 1% Heaviest Precipitation Days (1951-1980 vs. 1981-2010)



Change in intensity of the heaviest 1% of daily precipitation events for GLISA quality-controlled GHCN-Daily stations in the Great Lakes region.

# Impacts from Storm Sewers and Open Drains



- Lawn/Driveway Runoff
  - Fertilizers
  - Pet and Avian Waste
  - Pesticides
  - Household Chemicals
  - Salt
- Streets
  - Sediment
  - Oils and Greases
  - Cleaners/Detergents
  - Increased Water Temperature
  - Salt
- Outfalls
  - Soil Erosion Sediment
  - All the Above

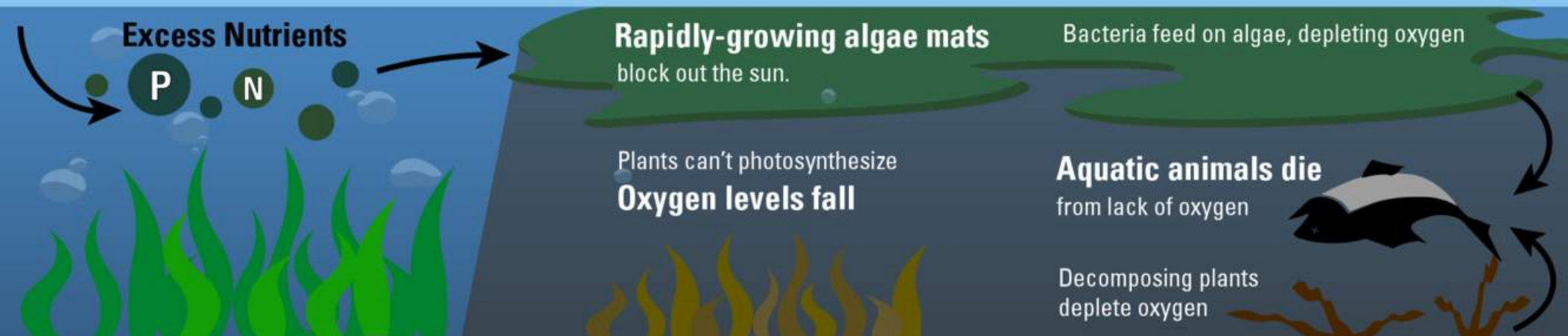
An aerial photograph showing a massive, swirling green algal bloom in a body of water. The bloom is a vibrant, bright green color and has a complex, swirling pattern that resembles a large-scale eddy or a series of smaller vortices. The surrounding water is a darker, more uniform green. The text "HARMFUL ALGAL BLOOMS" is overlaid in white, bold, sans-serif capital letters on the left side of the image.

# HARMFUL ALGAL BLOOMS

# Fertilizers and Nutrients

- Plant and Algal Growth
- Blocks Sunlight
- Decreases Oxygen

## Nutrient Pollution







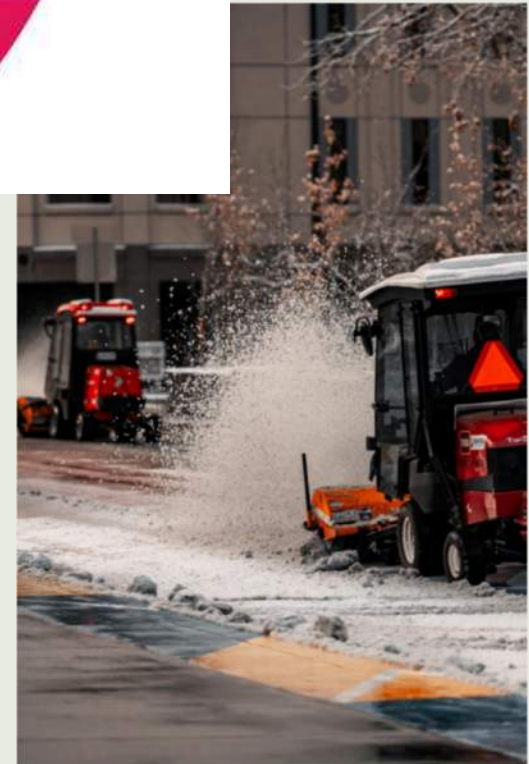
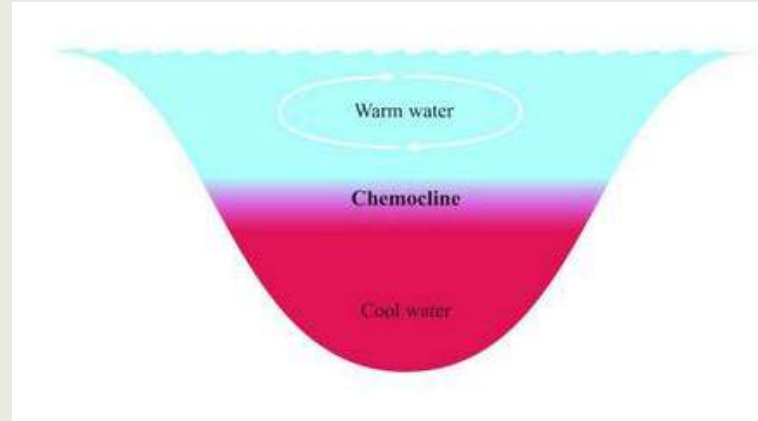
## Pet and Avian Waste

- *E. coli*
- Nutrients

## Household Chemicals

- *E. coli*
- Cleaners/Detergents
- Pesticides
- Oil and Grease





# Chlorides

- Habitat/Biodiversity Decreases
- Water Temperature
- Very Transmissible/Soluble
- Increases Available Phosphorus
- Decreased Oxygen



# Sediment

- Habitat
- Blocks Sunlight
- *E. coli*
- Build up

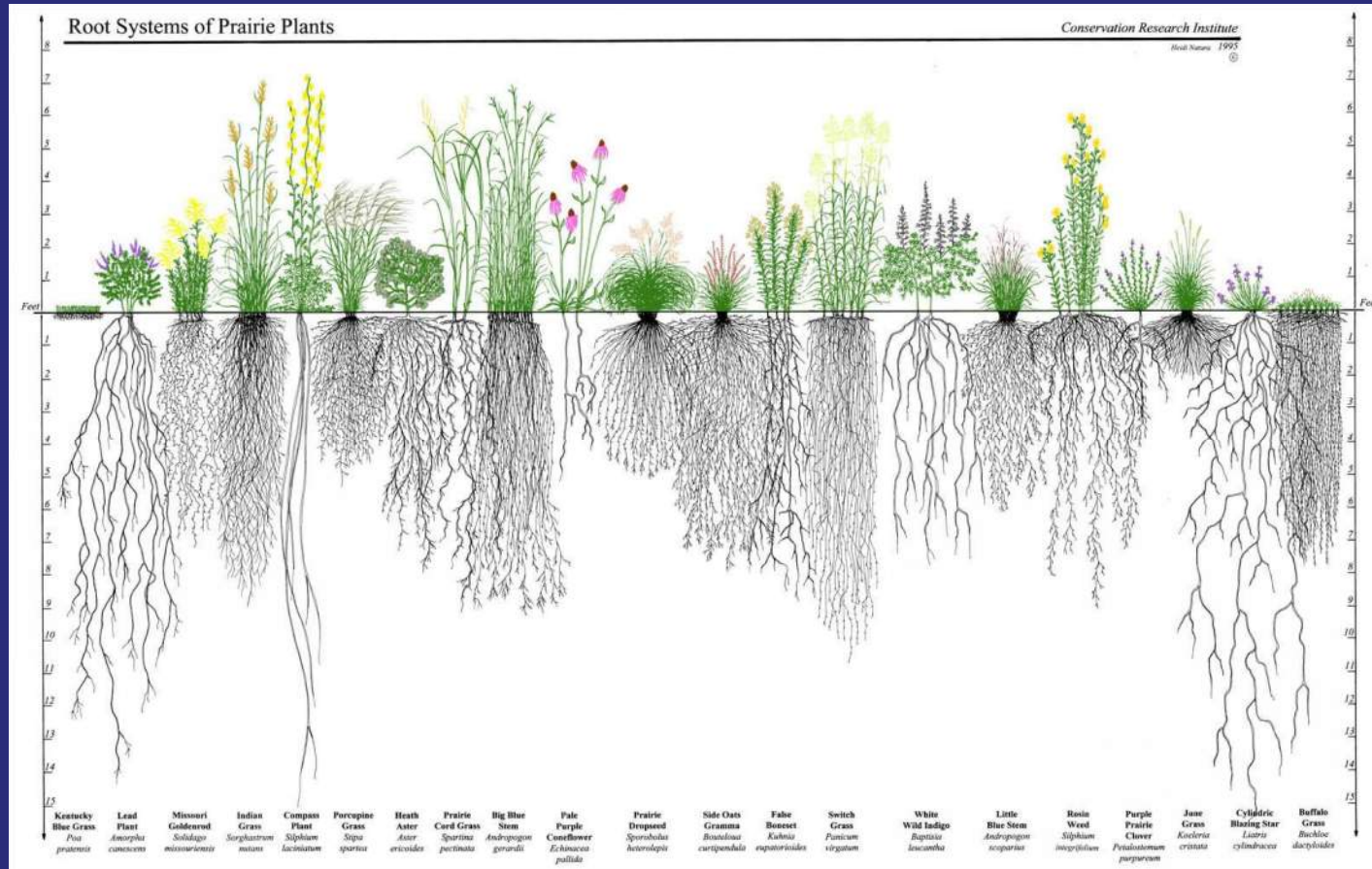
# Increased Water Temperature

- Plant and Algal Growth
- Loss of Habitat/Loss of Native Species





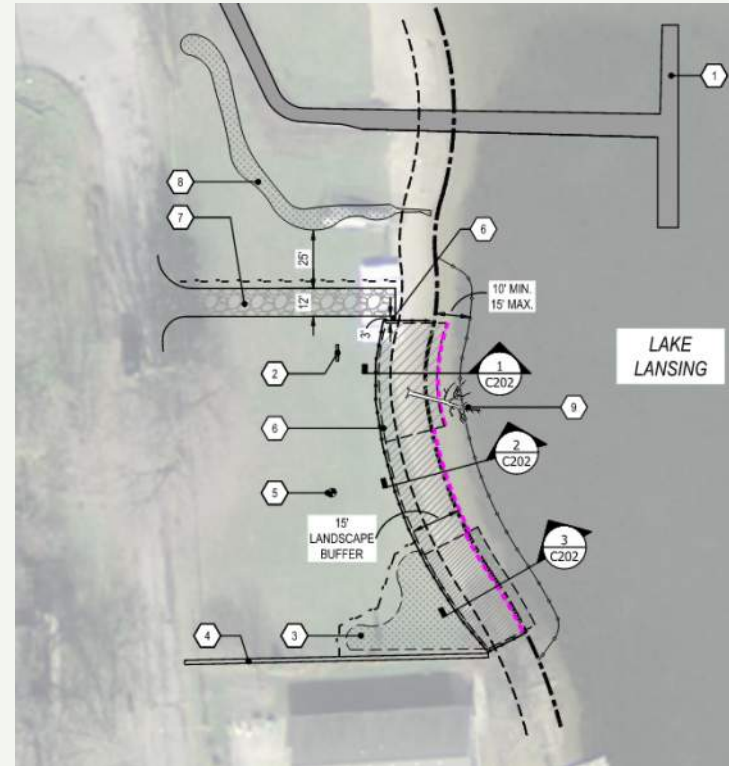
# NATURE-BASED SOLUTIONS

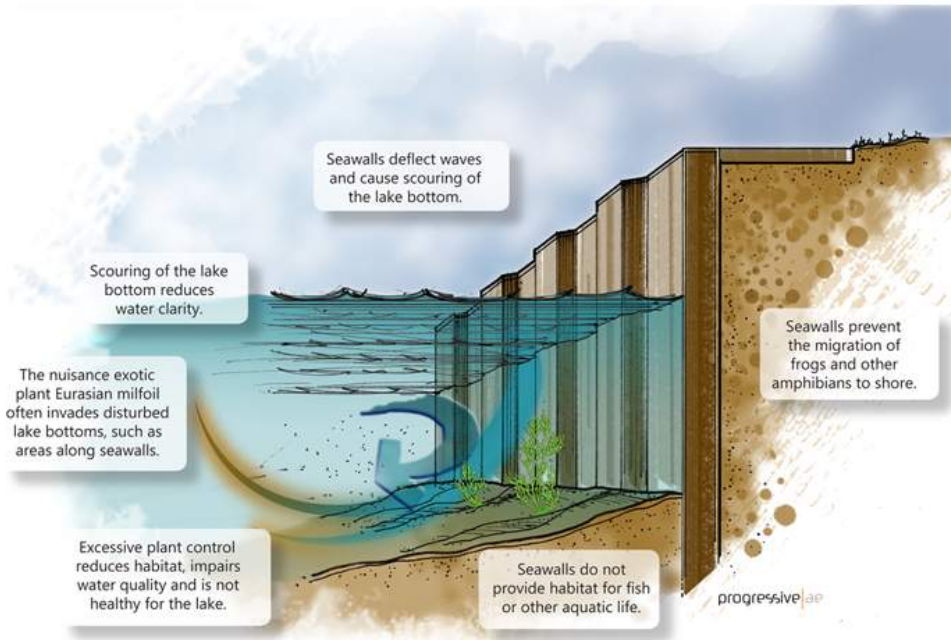


# Rain Gardens and Bioswales



# Natural Shorelines and Filter Strips





# Hardened Shorelines

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**Your shoreland can be maintained to provide beach and boat access for you while maintaining habitat for fish and wildlife.**

Don't dump into storm drains; pollutants may be piped directly to the lake.

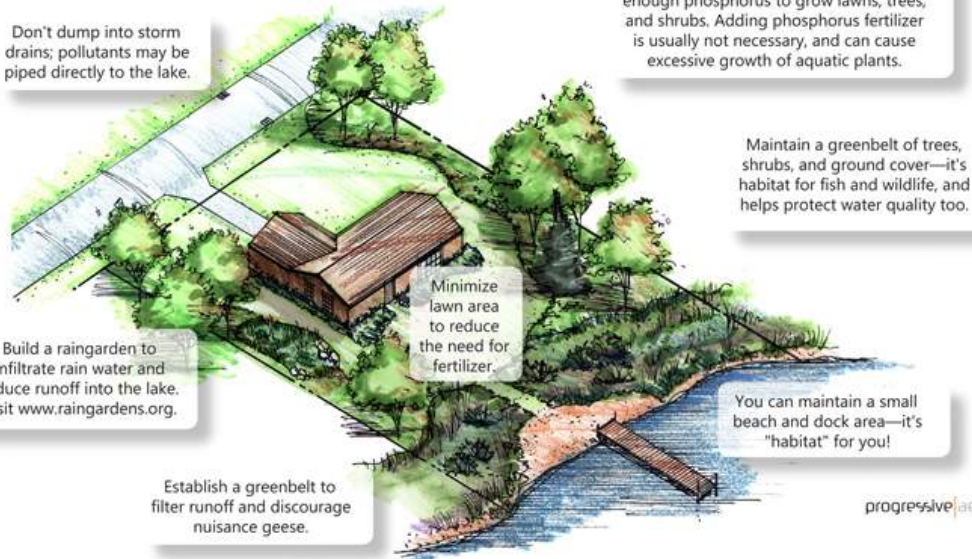
Most lakeside soils have more than enough phosphorus to grow lawns, trees, and shrubs. Adding phosphorus fertilizer is usually not necessary, and can cause excessive growth of aquatic plants.

Maintain a greenbelt of trees, shrubs, and ground cover—it's habitat for fish and wildlife, and helps protect water quality too.

Minimize lawn area to reduce the need for fertilizer.

You can maintain a small beach and dock area—it's "habitat" for you!

Establish a greenbelt to filter runoff and discourage nuisance geese.



**Aquatic plants are part of a healthy lake. They produce oxygen, provide food and habitat for fish, and help to stabilize shoreline and bottom sediments.**

Insects and other invertebrates live on or near aquatic plants, and become food for fish, birds, amphibians and other wildlife.

Plants and algae are the base of the food chain. Lakes with a healthy fishery have a moderate density of aquatic plants.

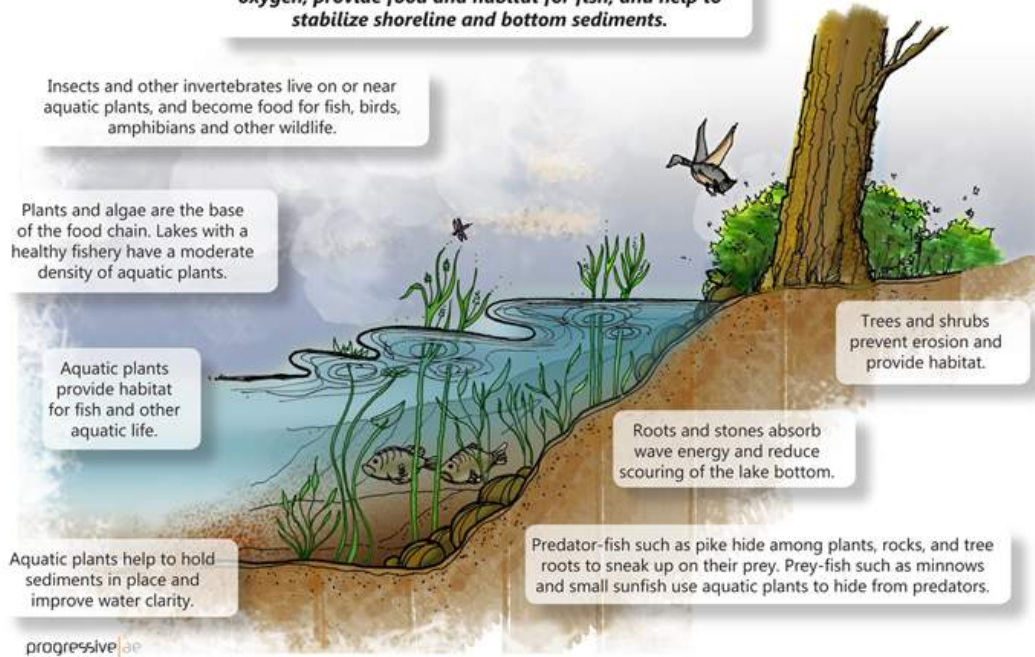
Aquatic plants provide habitat for fish and other aquatic life.

Aquatic plants help to hold sediments in place and improve water clarity.

Roots and stones absorb wave energy and reduce scouring of the lake bottom.

Trees and shrubs prevent erosion and provide habitat.

Predator-fish such as pike hide among plants, rocks, and tree roots to sneak up on their prey. Prey-fish such as minnows and small sunfish use aquatic plants to hide from predators.



# Natural Shorelines



# Daylighting Outfalls and Buffer Strips



# Permeable Pavement



## Leaching Catch Basins

# Mechanical Filters

- Floatables
- Solids
- Hydrocarbons



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The background features a complex, abstract geometric pattern composed of various shapes such as squares, triangles, circles, and rounded rectangles. These shapes are arranged in a way that creates a sense of depth and movement, with some elements appearing to overlap or recede. The color palette is limited to a range of muted green tones, from light sage to a slightly darker, more saturated green, set against a plain white background.

# THANK YOU

We welcome your feedback,  
insights and inquiries.



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