



*Sector 1:*

# **Environment & Natural Systems**



## *Background*

Maryland's environment and natural systems are a vital asset for the State and include watersheds, coastal areas, streams, lakes, wetlands, forests, essential habitat, and protected lands. These systems face urgent threats from climate change, natural hazards, and encroachment, among other factors. Through conservation, restoration, and the spread of nature-based solutions, Maryland can not only protect its natural resources, but harness the benefits of these ecosystems like reduced hazard risks.

Environment and Natural Systems was chosen as one of the five sectors in this strategy based on a review of plans from Maryland and other states. Protecting Maryland's landscapes strengthens the distinct character of its regions, from the Chesapeake Bay all the way to Western Maryland's forests, while building resilience locally.

## *Definitions*

**Definition of the Sector:** Restoring and protecting Maryland's environment and natural ecosystems to enhance ecosystem services in the face of environmental change and help communities harness benefits such as risk reduction, carbon sequestration, cleaner air and water, health, recreation, ecotourism, habitat diversity, and natural resource conservation.

Maryland's natural resources play a critical role in lessening the impacts of natural hazards and climate change, while building overall community and ecological resilience.

**Definition of Hazard:** The Department of Homeland Security defines a hazard as "A source or cause of harm or difficulty".<sup>1</sup> This term is often used to capture **acute shocks** such as hurricanes or cyberattacks.

**Definition of Stressor:** Stressors are chronic challenges that harm communities on blue-sky days and can make hazards more severe. This term is used to capture **ongoing or structural challenges** like persistent poverty or sea level rise.

*Note that while this strategy distinguishes between hazards and stressors for the purpose of discussion, the two are deeply linked and interconnected.*

## *Hazards*

Maryland's environment and natural systems are on the front lines of natural hazards such as flooding, drought, and extreme temperatures. The hazards highlighted in this section are the ones most frequently identified by stakeholders through surveys, interviews, and workgroup discussions. The following pages will capture top examples of hazard impacts, but the list contained therein is not exhaustive.



## Flooding

- Maryland is projected to face a 50% increase in inland flooding by 2050 due to intensified heavy rainfall.<sup>2</sup> Rapid downpours, especially when stormwater systems are overwhelmed, result in flash flooding and severe soil erosion.
- Flooding intensifies stormwater runoff in Maryland, washing sediments into the Chesapeake Bay and its tributaries. These sediment surges cloud the water, block sunlight, and drive die-offs of submerged aquatic vegetation (SAV), which dropped to 36,794 acres in 2024 - less than half the state's 79,800-acre restoration goal.<sup>3</sup>



## Extreme Temperature

- Temperatures in Maryland's streams, rivers, and the Chesapeake Bay have been increasing over the past 30 years, reducing available oxygen in the water and causing ecosystems to shift.<sup>4</sup> The Bay is especially vulnerable since many species are already at the edge of their temperature range. Eelgrass, an underwater grass that dominates much of the lower Bay and provides critical habitat for fish, crabs, and other species, is expected to decline as waters warm. Unlike other species, it cannot simply shift northward, since it requires the saltier waters found in the southern Bay.
- During the colder winter of 2017–2018, 6.37% of Maryland's blue crabs died from overwinter mortality, compared to only 0.36% during the warmer winter of 2019–2020.<sup>5</sup>
- Invasive species such as the Chesapeake Channa, which tolerate a wide range of temperatures, salinity levels, and oxygen conditions, further threaten ecosystems by preying on native fish, crustaceans, and amphibians. Land-based invasives like kudzu and ticks can also thrive at higher temperatures and disrupt ecosystems.
- On the flipside, green space can reduce the effects of extreme heat. Trees, parks, green roofs, and other natural features can cool down neighborhoods and lessen the heat island effect.<sup>6</sup>



## Tropical Systems & Severe Storms

- Between 2007 and 2016, nearly 30% of Maryland's rainstorms would have ranked among the top 1% of storm intensity had they occurred in the 1950s, reflecting the increase in atmospheric water vapor.<sup>2</sup>
- Heavy rainfall, such as that seen in 2018, reduces the salinity of the Chesapeake Bay and makes it harder for oysters to spawn and reduces their ability to filter contaminants out of the water.<sup>5</sup>



## Drought

- USDA has designated 18 of Maryland's 24 local jurisdictions as primary natural disaster areas for drought.<sup>7</sup>
- Extended dry spells deplete soil moisture, threaten forest health, reduce agricultural yields, and endanger public health.<sup>8</sup> Water shortages from drought lower streamflows and decrease groundwater levels, diminishing agricultural production, freshwater availability, and fish populations.<sup>9</sup>
- Drought increases the risk of wildfires, especially in forested areas already stressed by pests and disease. The Maryland Forest Service annually responds to an average of 123 wildfires, burning more than 1,780 acres of forest, brush, and grasses.<sup>10</sup> Local fire departments respond to over 5,000 wildfire incidents annually.

## The Wonders of Wetlands

Wetlands are transitional areas between land and water, where soil is saturated or covered by water at least part of the time.<sup>11</sup> They take many forms, including marshes, swamps, bogs, and wet prairies.

- Wetlands play a critical role in reducing flood risks. During storms, they store water and filter out sediment much like a sponge, with just one acre capable of holding up to 1.5 million gallons of floodwater.<sup>12</sup> This ability to capture and slow down water translates into real economic value.
- Studies show that every square kilometer of wetland provides roughly \$1.8 million in storm protection annually (approximately \$7,300 per acre per year).<sup>13</sup>
- Wetlands also act as natural barriers against waves. A strip only 15 feet wide can cut incoming wave energy by 50 percent, reducing the damage communities face from coastal storms.<sup>14</sup>

## Long-term Stressors

In addition to the hazards described above, Maryland's environment and natural systems face a variety of ongoing stressors. Some of these include:



### Coastal Erosion & Saltwater Intrusion

Maryland's 7,700 miles of shoreline make it one of the most vulnerable states to the effects of coastal erosion.<sup>15</sup> Over the past century, the state has experienced more than a foot of sea level rise, leading to marsh loss, vegetation decline, and widespread saltwater intrusion.<sup>16</sup> Since the 1980s, approximately 25,600 acres of forests and 3,500 acres of farmland have been converted to tidal marsh.<sup>17</sup>

Dorchester and Somerset Counties face the greatest impacts, with the highest share of farmland affected by salinization while also ranking among the five counties with the highest poverty rates in Maryland.<sup>18</sup>

#### Did You Know?

Over 84,300 acres of Maryland's forests have been impacted by saltwater intrusion, resulting in "ghost forests," areas of standing dead trees where live trees are mostly absent.<sup>19,20</sup>



### Pollution & Runoff

When drought is followed by extreme rainfall, nutrient runoff intensifies because dry soils cannot effectively absorb applied fertilizers.<sup>21</sup> This leads to excess nitrogen and phosphorus entering waterways through topsoil erosion and flooding in urban, residential, and agricultural areas, which are the two leading sources of pollution in the Chesapeake Bay.

Nutrient pollution fuels harmful algal blooms, depletes oxygen in rivers and streams (including drinking water sources), and creates dead zones where aquatic life cannot survive.<sup>22</sup> Agriculture contributes an estimated 38% of the Bay's nitrogen, 45% of its phosphorus, and 60% of its sediment loads.<sup>23</sup> Maryland has been a leader in reducing these numbers. Since 2018, Maryland has been implementing its Phase 3 Watershed Implementation Plan (WIP), consistent with the Chesapeake Bay Total Maximum Daily Load (TMDL) to reduce nutrient and sediment loads to the Bay.<sup>24</sup>

#### Did You Know?

Roughly 42% of farms in the Chesapeake Bay watershed are devoted to livestock and poultry production. Addressing excess manure nutrients by moving them off these farms and applying them in areas where they can be managed safely and productively is expected to cost between \$18 million and \$30 million each year.<sup>23</sup>



### Development & Economic Pressures

Impervious land covers, including pavement, roofs, and highly compacted soils, diminish the landscape's ability to absorb stormwater, mitigate hazards (e.g. flash floods), and support biodiversity.<sup>25</sup>

Wetlands once covered 7% of Maryland's landscape, but now, over 2.8 million acres of wetlands have been converted to development or drained for agricultural use.

Western Maryland has lost over 8,600 acres of forests that were formerly contiguous, leading to habitat fragmentation.

#### Did You Know?

An acre of wetlands can store between 1 and 1.5 million gallons of floodwater, acting like a natural sponge that significantly reduces runoff and downstream flooding.<sup>26</sup>

### Existing State Efforts

In response to these hazards and stressors, Maryland has taken the following actions thus far:



### NextGen Adaptation Plan

The NextGen Adaptation Plan, led by the Maryland Commission on Climate Change, serves as the state's strategic framework for preparing for the impacts of climate change.<sup>27</sup> This plan outlines proactive measures to reduce risk and enhance resilience across sectors, with a strong emphasis on equity, environmental justice, and climate-smart infrastructure.

Key priorities include addressing flooding, extreme heat, sea level rise, and other hazards through coordinated, data-driven, and locally informed strategies.



### Whole Watershed Restoration Fund

The Whole Watershed Restoration Fund, established through the Whole Watershed Act (SB 969/HB 1165) and administered by the Maryland Department of Natural Resources (DNR), in coordination with a multi-department State Management Team, supports a more collaborative, science-based approach to watershed restoration.<sup>28,29</sup>

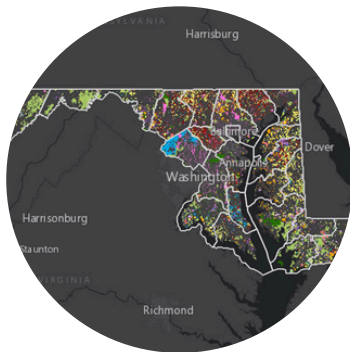
Utilizing existing state resources, the Fund supports integrated, community-driven projects that improve water quality, restore ecosystems, and strengthen resilience to climate change. This initiative emphasizes innovative, nature-based solutions and prioritizes investment in underserved communities through equitable, capacity-building efforts.



### 5 Million Trees for Maryland

Maryland's tree planting initiative, launched in 2021, aims to plant and maintain five million native trees by 2031, and over one and a half million are already in the ground - about 30% of the way there.<sup>30</sup> Beyond planting at scale, the program uses advanced monitoring tools to track survival rates and maximize long-term benefits for people and the environment.

A key focus of the effort is equity. More than 57,000 trees have been planted in urban and historically underserved neighborhoods, where they provide shade, improve air quality, and create greener, healthier community spaces. These plantings not only address environmental disparities but also help build neighborhood pride and resilience.



### Maryland the Beautiful Act

The Maryland the Beautiful Act of 2023 set ambitious land conservation goals: protecting 30 percent of the state's land by 2030 and 40 percent by 2040.<sup>31</sup> As of February 2024, more than 1.85 million acres have been conserved with the State six years ahead of schedule.<sup>32</sup> This progress reflects the combined efforts of state and local governments, nonprofit land trusts, and federal agencies.

State agencies are now focused on strategies to reach the 40 percent target, which will require conserving an additional 600,000 acres of land.<sup>33</sup>



### Critical Area Commission

In Maryland, the Critical Area includes all land within 1,000 feet of Maryland's tidal waters and tidal wetlands. The Critical Area Commission consists of 29 Governor-appointed members that represent a broad set of interests and expertise.

Among other responsibilities, the CAC reviews and approves projects on State-owned land in the Critical Area and also reviews and approves state or local actions that result in major developments on private lands or those owned by local jurisdictions.<sup>34</sup> In 2024, the CAC's program was amended to incorporate climate change and environmental justice.<sup>35</sup>

### Challenges & Needs

To appropriately respond to the hazards present in this sector, the following issues should be addressed:

#### Private Landownership of Shoreline and Forests

Implementing nature-based climate strategies, such as living shorelines, forest buffers, and restored wetlands, is complicated by patterns of land ownership.<sup>36</sup> Approximately 85 percent of Maryland's shoreline and 76 percent of Maryland's forests are privately owned, meaning that large-scale implementation depends heavily on individual landowner participation. Overcoming funding and knowledge gap challenges may require more flexible financing models, expanded technical assistance, and stronger public-private collaboration to encourage nature-based resilience investments on private land.

*Potential Tool Available:* The Maryland Department of Natural Resources (DNR) Shoreline Erosion Loan Program provides loans to homeowners, community groups, nonprofits, and counties to design and construct living shorelines.<sup>37</sup> With flexible repayment terms, minimal upfront costs, and county support, the program helps protect property and restore natural shorelines.

#### Valuing Natural Systems in Decision Making

Natural systems are often undervalued in land-use decisions and infrastructure planning, as policies and professional practices have historically prioritized "grey" infrastructure like roads, pipes, and seawalls.

Green infrastructure and nature-based solutions are newer concepts, and the science of quantifying their co-benefits is still evolving. As a result, the resilience value of wetlands, forests, or living shorelines, such as reducing flood risks, cooling urban areas, and buffering storm surge, is frequently underestimated. This can lead capital investment decisions to prioritize short-term development over long-term conservation and restoration, even when natural systems could provide critical protections for Marylanders.

Maryland was the first state to prioritize living shorelines as the first form of coastal defense to consider when protecting shorelines.<sup>38</sup> By continuing to improve how we measure and communicate these benefits, and by integrating valuation tools into local and state planning processes, Maryland can better incorporate cost-effective nature-based strategies into future investments and deliver stronger, more sustainable resilience outcomes.

***Establishing Value with an “Eco-Price”:*** Ecosystem services are the many ways nature supports people, from clean air and water to healthy soils and wildlife habitat. The idea of an “eco-price” captures the value of these benefits by comparing the dollars invested in protecting or restoring them (or the costs society avoids when they are maintained) with the improvements in ecosystem health.<sup>39</sup> In Maryland, the Department of Natural Resources estimates that natural lands provide seven major services: air quality improvement, carbon storage, nitrogen reduction, surface water protection, groundwater recharge, habitat for wildlife, and flood control/stormwater management. Together, these benefits are worth about \$8 billion each year to Maryland residents.

**\*\* End of Sector Analysis \*\***



## Watershed Initiatives

To strengthen stormwater resilience, the Maryland Department of the Environment (MDE) will identify and analyze flooding locations across the state to better understand their causes, impacts, and potential solutions.<sup>40</sup> By combining national flood data with local information on floodplains, stormwater infrastructure, and management requirements, MDE will coordinate with local jurisdictions to address data gaps and guide watershed studies. These studies are critical for helping communities move beyond reactive flood response and toward proactive planning. They pinpoint where projects will have the greatest impact, reduce repetitive losses, and ensure that limited resources are directed to the highest risk areas.

With \$2.4 million in federal Flood Mitigation Assistance (FMA) grants, MDE is launching a suite of watershed initiatives, including:

- **Risk Identification (2025):** Analyze and prioritize Maryland watersheds most vulnerable to flooding.
- **Digital Watershed Study Guide (2026):** Develop a step-by-step guide for conducting watershed studies, including modeling best practices and community engagement.
- **Pilot Studies (2027):** Fund three pilot watershed studies and create a replicable framework for other Maryland communities to use in local planning efforts.

Together, these efforts will give leaders the evidence to guide investments and policies while equipping communities with tools to protect homes, businesses, and critical facilities - laying the groundwork for long-term resilience across Maryland.

# Goals & Recommendations

## *Environment & Natural Systems*



### **GOAL 1 - Prioritize resilience as a criteria for conservation & restoration investments.**

#### **Recommendation 1.1**

Develop methodology and case studies quantifying the costs and benefits, including ecosystem service value, of nature-based practices that increase resilience of human and natural systems.

**Owner:** DNR

**Timeline:** 2-3 years

**Funding:** \$100k+ for a study

**Focus Area:** Robust Economy & Job Creation

#### **Why This Matters:**

- While nature-based practices provide an array of ecosystem benefits, including hazard risk reduction, those benefits can be difficult to quantify and are not always incorporated into cost-benefit analyses.<sup>41</sup>
- DNR already quantifies many of the ecosystem benefits associated with restoration, but could expand its resilience benefit calculations to consider inland flooding, heat reduction, and more. This could be used to inform investments.

#### **Recommendation 1.2**

Include quantified resilience benefits as criteria for investment across relevant conservation and restoration programs.

**Owner:** DNR

**Timeline:** 5 years

**Funding:** TBD

**Focus Area:** Robust Economy & Job Creation

#### **Why This Matters:**

- Once DNR has a more complete understanding of the resilience benefits of conservation and restoration approaches, this information can be used to drive decision making.
- When evaluating potential projects, DNR could evaluate resilience benefit as one of the criteria for selection.

### **GOAL 2 - Improve resilience data collection, governance, coordination, access, and usability for local governments and state agencies.**

#### **Recommendation 2.1**

Identify data needs which may support local governments and the State of Maryland in advancing resilience.

**Owner:** MDP

**Timeline:** 2 years

**Funding:** Funding secured - General Funds

**Focus Area:** Justice & Equity



### Why This Matters:

- During the stakeholder engagement process, the Maryland Office of Resilience repeatedly heard that local governments lack data to develop resilience projects, such as downscaled climate projections or basic mapping capabilities. These needs vary by community and region.
- Because MDP has regional planning staff, the Department is well-poised to identify local data needs that can be addressed at a later date.
- This is the first step, and once the data needs have been identified, MDEM will help coordinate across agencies to fill data needs.

## GOAL 3 - Identify innovative approaches and structures to increase nature-based solutions, by working with private property owners and nongovernmental funders.

### Recommendation 3.1

Improve the accessibility of the living shoreline loan program to increase implementation by private property owners.

**Owner:** DNR

**Timeline:** 2 years

**Funding:** No additional funding needed

**Focus Area:** Justice & Equity

### Why This Matters:

- More than 80% of Maryland's shoreline is privately owned, making collaboration between government and private landowners essential.<sup>42</sup>
- DNR administers the Shoreline Erosion Loan Program, offering no-interest loans to finance living shorelines on public, private, and community owned lands.<sup>37</sup> These projects not only protect against shoreline erosion but also reduce hazard risks.
- One option for improving utilization of this program is by updating its formula to reduce the financial burden for property owners.

### Recommendation 3.2

Develop 100 Coastal Resilience Management Plans to help private landowners plan for and adapt to sea level rise.

**Owner:** DNR

**Timeline:** 5 years

**Funding:** Climate Pollution Reduction Grant (CPRG) Funding Secured

**Focus Area:** Robust Economy & Job Creation

### Why This Matters:

- Sea level rise will dramatically change Maryland's landscape, especially on the lower eastern shore.<sup>17</sup>
- Through proactive planning, Maryland can help private landowners prepare for the impacts of sea level rise on their financial, social, and environmental systems.
- DNR has received funding through an EPA Climate Pollution Reduction Grant to advance marsh restoration, tidal connectivity, living shorelines and marsh migration corridor resilience by creating 100 Coastal Resilience Management Plans, which will support this goal.<sup>43</sup>



### Recommendation 3.3

Make nature-based solutions a mainstream and accessible resilience practice for private property owners.

Owner: DNR

Timeline: 10 years

Funding: TBD

#### Why This Matters:

- Successful implementation of Recommendations 3.1 and 3.2 will help make nature-based solutions both mainstream and accessible.
- Nature-based solutions can be highly effective for reducing flood risk, providing storm protection, and minimizing erosion.<sup>44</sup>
- For instance, wetlands act like sponges, absorbing and slowly releasing water that would otherwise cause flooding.<sup>45</sup> Living shorelines can have a similar impact, breaking up wave energy and reducing storm damages.<sup>46</sup>
- But a variety of barriers prevent greater uptake of nature-based solutions.<sup>47</sup> By updating policy, engaging community members in planning, and continuing education efforts, DNR can make this practice mainstream and help draw down Maryland's hazard risk.

### Recommendation 3.4

Share information, best practices, and lessons learned in enhancing resilience through public-private-philanthropic partnerships and non-traditional financing structures.

Owner: MDEM/MOR

Timeline: 5 years

Funding: No additional funding needed

Focus Area: Robust Economy & Job Creation

#### Why This Matters:

- To help ensure the spread of high-quality resilience projects, Maryland should explore innovative financing structures that can bring in private dollars.
- This could include partnering with MDE and DNR to explore ways to leverage Maryland's Conservation Finance Act for resilience outcomes using pay-for-success contracting methods.

**\*\* End of Sector Recommendations \*\***

## **Predictive Climate Change Modeling**

Maryland's resilience planning depends on accurate, accessible climate projections, yet current data and modeling efforts are spread across agencies, universities, and research institutions. While these efforts provide valuable insights, they vary in scope, methodology, and geographic resolution, creating challenges for decision-makers trying to prioritize conservation, restoration, and infrastructure investments.

A systematic review of what already exists is needed to identify overlaps, inconsistencies, and critical gaps. A coordinated statewide framework would make climate data more consistent, actionable, and integrated with ecological and land-use trends. This approach would reduce duplication, fill gaps, and ensure resilience planning and investments are guided by reliable science.

## **Innovative Financing Mechanism for Nature-Based Solutions**

One of the persistent challenges in advancing nature-based solutions is financing. Unlike traditional infrastructure, these projects rarely generate direct revenue streams to repay private investments. This raises an open question for Maryland: What innovative approaches can be used to bring in private financing for resilience projects? Maryland already uses a mix of funding strategies for climate work, but expanding these tools could strengthen long-term investment in resilience.<sup>48</sup>

Several models could provide a path forward. Resilience Bonds, for example, a sub-set of green bonds, raise capital specifically for climate-resilient investment.<sup>49</sup> Environmental Impact Bonds go a step further by tying investor returns to measurable environmental or climate outcomes, broadening access to Environmental, Social, and Governance (ESG) focused capital while promoting transparency and accountability.<sup>50</sup> Green Revenue Bonds provide another option by financing projects through revenue generated by the project itself, rather than tax dollars, thereby preserving the state's general borrowing capacity.<sup>48</sup>

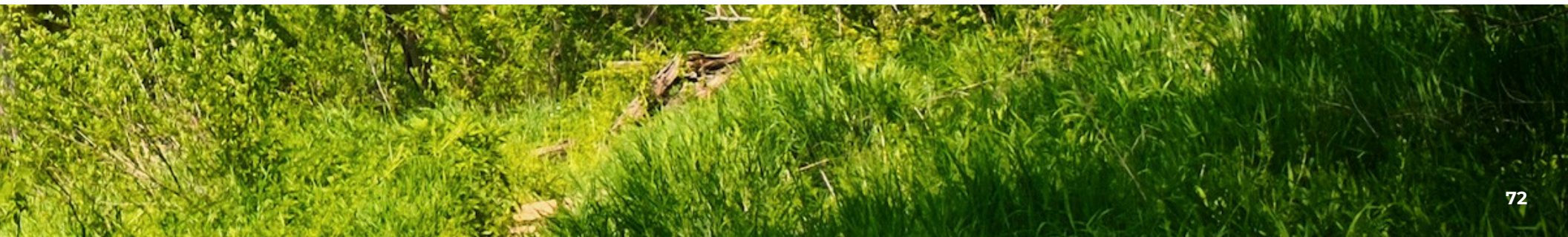
Beyond individual instruments, Maryland could also consider developing a State Resilience Finance Plan, as other states have done, to estimate long-term resilience costs, identify available funding sources, and prioritize the highest-return investments. Ultimately, investments in nature-based solutions can pay dividends, by reducing future damages from disasters.

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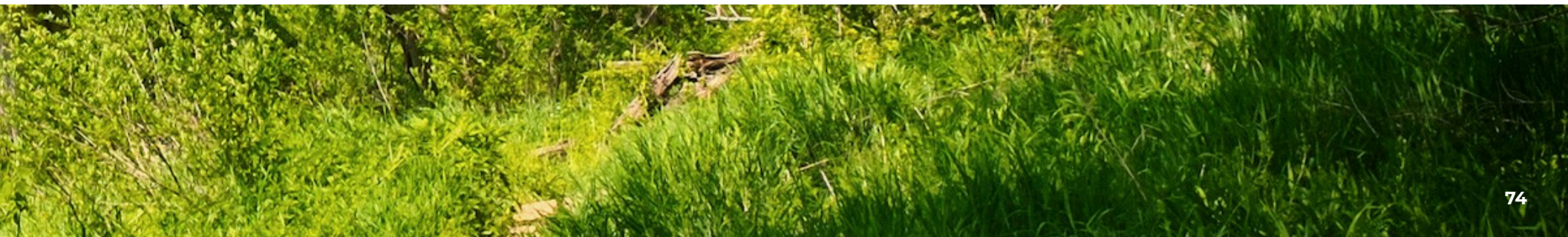
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