



# Protecting Delaware's Natural Heritage:

## Tools for Biodiversity Conservation

### *Executive Summary*





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*Executive Summary*  
*Protecting Delaware's Natural Heritage:*  
*Tools for Biodiversity Conservation*

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# Executive Summary

Biological diversity  
is the “variety of life  
and its processes.”

Source: The Keystone Center. 1991. *Keystone Dialogue  
on Biological Diversity on Federal Lands.*

## INTRODUCTION

Delaware was once a land of mature hardwood forests, coastal marshes, and freshwater swamps. Its lands and waters provided rich and productive habitat for a myriad of songbirds, waterfowl, fish, reptiles, amphibians, and native plants. Forested ecosystems supported wildlife and maintained the diversity of Delaware’s rivers, streams, and wetlands. Delaware’s prosperity was built on its biological diversity. Yet, as the state’s early inhabitants took advantage of the land’s natural riches to build an economic future, they were simultaneously compromising the base of that diversity. If Delaware citizens hope to provide future generations with healthy populations of plants, animals, and a diverse array of native ecosystems, action must be taken now to protect and restore the state’s natural heritage.

Biological diversity is the “variety of life and its processes.” It includes “the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.”<sup>1</sup> Concern for biological diversity (or “biodiversity”) requires the conservation and restoration of many types of landscapes, native plant and animal species, and the protection of healthy and diverse genetic stocks within species. In order to protect Delaware’s biodiversity, the state’s plants, animals, and ecosystems must be conserved and restored on public and private lands.

Delaware’s biological diversity provides the state and its inhabitants with numerous economic, social, and environmental benefits. These benefits include: the jobs and income generated by the forest and fisheries industries that are dependent on healthy forests and aquatic habitat; abundant recreational opportunities, such as hunting, fishing, wildlife observation, and photography, provided by healthy populations of native species and ecosystems; and a variety of ecosystem services, such as photosynthesis, water purification, and flood control, that are supported by diverse, sustainable ecosystems.<sup>2</sup> The social, spiritual, and moral responsibility to maintain ecosystems and their associated complements of species also motivate Delawareans to protect the environment for future generations.<sup>3</sup>

State laws, policies, and institutions profoundly affect the sources of biodiversity loss. This Executive Summary, and its more detailed companion, *Protecting Delaware’s Natural Heritage: Tools for Conservation*, focus on how the state’s legal, policy, and management tools can be improved and used to ensure that Delaware’s future includes a vibrant economy, high quality of life, and rich biological resources.

## THE LOSS OF BIOLOGICAL DIVERSITY IN DELAWARE

It is believed that Delaware has lost a higher percentage of its native plant species than any other state in the nation.<sup>4</sup> An estimated 41 percent of the state's plant species are rare or uncommon and are in need of protection. Delaware's native plants are under severe threat primarily due to the direct loss of the state's wetland and forest habitat.<sup>5</sup>

Delaware has also identified 236 animal species of conservation concern. These include 6 mammals, 17 fish, 11 amphibians, 20 reptiles, 21 butterflies, and 59 species of dragonflies or damselflies.<sup>6</sup> In addition, 93 species of Delaware birds are in trouble.<sup>7</sup> And 25 species of native birds, reptiles, insects, and mussels have not been identified in the state for over 15 years.<sup>8</sup>

Habitat destruction and degradation – caused by activities such as agriculture, road-building, residential and commercial development, and logging, as well as the introduction of exotic species – are the primary causes of biological diversity loss. Over 95 percent of the species listed under the Endangered Species Act in the United States are threatened, at least in part, by habitat loss or alteration, while exotic species have contributed to the decline of 42 percent of federally listed species.<sup>9</sup>

The loss of biological diversity in aquatic ecosystems has been caused by physical habitat alteration, the introduction of exotic species, chemical pollution, hybridization, and over-harvesting.<sup>10</sup> Approximately 62 percent of the state's rivers and streams currently cannot effectively support fish and wildlife, and 79 percent of the rivers and streams are not suitable for swimming.<sup>11</sup>

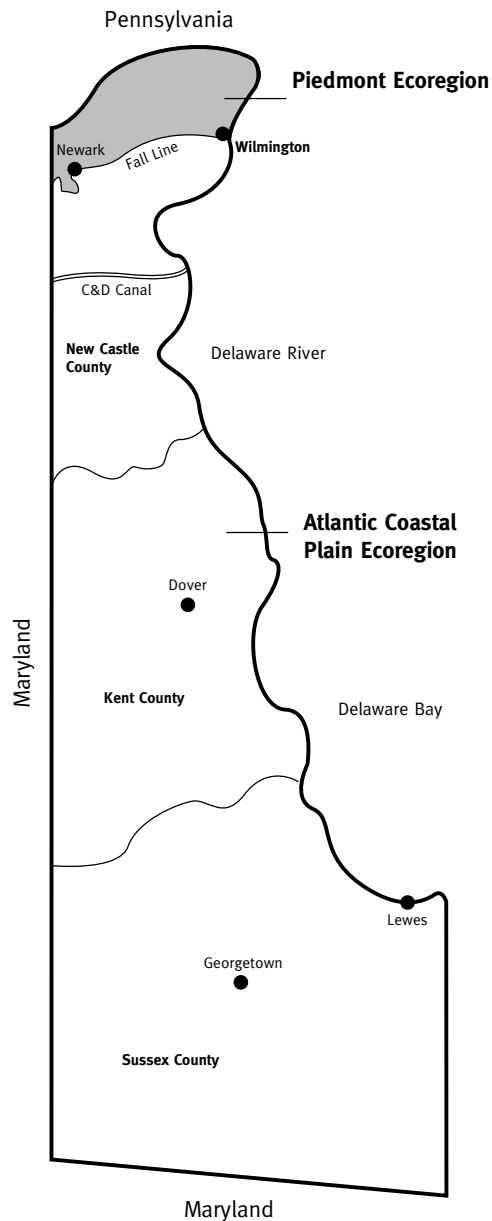
Nationally, other severe threats to ecosystems include resource exploitation, fire suppression, recreation (primarily the use of off-road vehicles), and the introduction of environmental toxins.<sup>12</sup> Historically, over-hunting and over-fishing have contributed to the decimation of specific groups of species.<sup>13</sup> Not surprisingly, many of these threats have also been identified as the primary forces that have affected and continue to affect the loss of biological diversity in Delaware. The most serious threats to biological diversity in Delaware include:

### Habitat Loss and Fragmentation

Habitat loss and fragmentation have been caused by a variety of human activities. Delaware's lands and waters have been converted for agricultural use and industrial, residential, and commercial development.

Although 31 percent of Delaware is forested,<sup>14</sup> rapid urbanization is threatening the state's diverse forest resources. Between 1984 and 1992, nearly 35,000 acres of

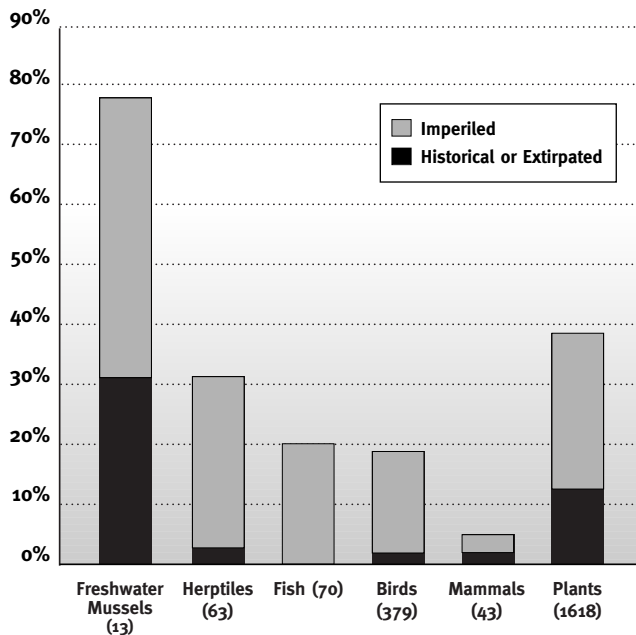
## Delaware's Ecoregions



Source: Fleming, Lorraine M. 1978. Delaware's Outstanding Natural Areas and Their Preservation. Delaware Nature Education Society: Hockessin, DE.

the state's forests were lost to urbanization.<sup>15</sup> About 75 percent of the forests in the state's Piedmont region have been cleared for development, agriculture, and pastureland.<sup>16</sup> It is a telling sign that 41 percent of Delaware's forest-dependent birds are either rare or extirpated.<sup>17</sup> Although the state's forestland has begun to recover, very few, if any, old growth forests remain. Forest fragmentation and selective

**Table 1:  
Delaware Species at Risk**



Source: Courtesy DNHP

logging have taken a particularly hefty toll on those migratory and forest interior breeding birds that require large contiguous blocks of forested habitat. These include the whip-poor-will, black-and-white warbler, cerulean warbler, hooded warbler, and American redstart.<sup>18</sup>

By the mid-1980s, Delaware had lost about 54 percent of its original wetland acreage. The majority of these wetlands were lost to stream channelization and ditching, as well as direct conversion to agriculture and urban development.<sup>19</sup> Agricultural drainage and channelization were responsible for about 82 percent of the freshwater wetland losses.<sup>20</sup>

Habitat fragmentation is the process whereby large continuous areas of habitat are reduced in size and separated into discrete parcels. When habitat is destroyed, a patchwork of habitat fragments is left behind. The fragments are often isolated from one another by a highly modified landscape. While fragmentation often results from a dramatic reduction in the area of the original habitat, it also occurs when habitat is divided by roads, railroads, drainage ditches, dams, power lines, fences, or other barriers to the free movement and migration of plant and animal species.<sup>21</sup>

Most of Delaware’s remaining ecosystems – the forests, marshes, and forested swamps – have been highly fragmented. Much of this is due to land use changes resulting from the growth and distribution of human populations. Between 1984 and 1992, the state’s population grew by about 14 percent, while the percentage of developed land

increased by 50 percent.<sup>22</sup> This rate and pattern of growth and habitat fragmentation has placed Delaware’s ecosystems at high risk.<sup>23</sup>

### Habitat Degradation

Short of the direct destruction of native habitat, the degradation of aquatic and terrestrial habitat can significantly diminish natural biological diversity.

Delaware’s water resources are vital for maintaining healthy populations of native aquatic and terrestrial species. Modification of natural stream channels and drainage patterns affects terrestrial ecosystems as well as aquatic habitat.

Agricultural drainage practices are a primary cause of aquatic alteration in the state. These practices greatly affect water flow and have significant effects on water quality, as well as the terrestrial environment. When riparian wetlands and stream channels are disturbed, flow rates from adjacent agricultural and residential lands increase, thereby increasing non-point source pollution loadings and degrading water quality.<sup>24</sup> Ditching can also lower shallow groundwater tables, drain adjacent wetlands,<sup>25</sup> and impact downstream aquatic ecosystems, even if these areas them-

“The extensive fragmentation of habitats that ensues with agricultural and urban-suburban development inevitably reduces both plant and animal diversity. For example, fragments may be so narrow that they are entirely edge, thereby diminishing or eliminating all species requiring forest interior.”

Source: Hess, G. K., R. L. West, M. V. Barnhill III, and L. M. Fleming. 1999. *Birds of Delaware*. Univ. of Pittsburgh Press: Pittsburgh, PA. p. 10.

selves are not ditched.<sup>26</sup> The resulting aquatic communities, wetlands, and riparian areas are less biologically diverse and therefore are more susceptible to pollution, disease, and genetic impoverishment.

Because agricultural drainage ditches are often cleared of vegetation and other debris to facilitate the flow of water and future ditch maintenance, riparian zones (forested



areas along streams and rivers that flood occasionally) have also been severely degraded. Removal of riparian vegetation results in reduced shading of in-stream habitat, altered hydrologic conditions, and increased siltation, and decreases the filtration of water as it flows from uplands into the aquatic environment.

The elimination or minimization of natural patterns of disturbance also can cause severe habitat degradation. Flooding is one such ecological process. Although ditching of natural rivers and streams has helped to alleviate the threat of flooding from severe storm events, this practice has also disrupted normal stream morphology and natural patterns of nutrient exchange, debris clearance, stormwater attenuation, and other functions provided by the interaction of rivers with their surrounding riparian areas. Species dependent on riparian areas rely on annual flood cycles that deposit nutrients in floodplains, clear obstructions in streams, and create diversity within stream habitats.

## “Cumulative impacts to non-tidal wetlands are more subtle but equally important to consider as human threats.”

Source: DNREC. September 1997. “Delaware’s Non-tidal Wetlands Comprehensive Conservation and Management Plan.” Division of Water Resources, DNREC. p. 49.

Harvesting, extractive activities, and development can result in unnecessary habitat degradation. These activities and the direct input of pollutants from point sources, non-point sources, and atmospheric deposition can severely degrade the aquatic and terrestrial environment. Chemical contamination of habitat can directly kill plants and animals, affect reproductive and survival rates, and cause birth defects. Most non-point source pollution in Delaware stems from sedimentation and erosion due to urbanization and nutrient loading caused by agricultural activities. Sedimentation and erosion are harmful to water quality because the sediments themselves cloud water clarity and are detrimental to aquatic wildlife, and also because the sediments bring with them nutrients and toxins that disturb the natural chemical and biological balance of waterways.

### **Exotic species**

Introduced, or “exotic,” species are plants and animals that have evolved in different regions of the world and have been intentionally transported by humans for use as culti-

vated plants and game fish, or introduced inadvertently by ships and vehicles. The majority of exotic species do not become established in their new environments. Yet, because exotics are transplanted to areas where their natural predators do not exist, they may have a substantial advantage over native species. Those exotic species that do establish themselves can greatly influence the composition of native species through competition for resources, direct predation, or alteration of the existing habitat such that indigenous species can no longer survive.<sup>27</sup>

Exotic species in Delaware – both plants and animals – have disrupted natural communities across the state. It is estimated that 543 species and varieties of non-native vascular plants have become established in the state. Non-native species now represent 25 percent of the state’s known flora.<sup>28</sup>

Many of Delaware’s exotic invasive plant species were originally planted for wildlife and decorative uses. Multiflora rose, autumn olive, and oriental bittersweet, some of the state’s most tenacious exotics, were originally planted for game food and cover. These are known to have “proliferated and aggressively displaced native plants.”<sup>29</sup>

Non-native species, such as mile-a-minute weed, kudzu, autumn olive, tree-of-heaven, Japanese honeysuckle, and multiflora rose “pose a very serious threat to forest growth, productivity, and native forest species.”<sup>30</sup> Of the 115 tree species found within the state, only 60 are native species.<sup>31</sup>

## “Native species represent the natural vegetative communities of our landscape and are critical in maintaining the biological diversity and natural heritage of our State.”

Source: Division of Parks and Recreation. “Native Plants Policy.” Division of Parks and Recreation, DNREC: Dover, DE.

### **THE CONNECTION BETWEEN BIODIVERSITY AND LAND USE**

Rapid growth – especially the suburban growth that has occurred in Delaware – has a profound affect on biological diversity. While poorly planned growth leads to the direct loss of farmland and forestland, it also fragments and degrades remaining forests and wetlands. Once fragmented



The practical goal of biological diversity conservation is to maintain “viable populations and natural distributions of native species and communities in the regional landscape.”

Source: O’Connell, Michael A. and Reed F. Noss. 1992. “Private Land Management for Biodiversity Conservation.” *Environmental Management*. 16(4): pp. 435-450.

and disturbed, vegetated communities become more susceptible to degradation by the establishment of invasive exotic species.

One of the reasons for such a disproportionately large loss of the state’s forests, wetlands, and agricultural land is the sprawling character of Delaware’s growth. This growth has been made possible by the cumulative effects of many state transportation and infrastructure decisions. Traditionally, increasing automobile use and traffic has been accommodated by the development of more roads and highways. The resulting network of roadways has enabled sprawling growth to penetrate virtually every corner of Delaware, making the protection of the state’s natural heritage that much more difficult.

How people and institutions develop and manage the land will determine the ultimate success or failure of biological diversity conservation in Delaware.<sup>32</sup> Effective conservation must occur at two levels – on individual parcels of land and on a regional basis. By focusing on an individual parcel of land or segment of a stream, decisions can be made that affect species success on that parcel or segment. At the same time, a regional perspective is important because many species depend upon large areas, and because the cumulative impact of human activities across separately owned tracts of land can promote the success – or cause the failure – of conservation efforts.

## FUNDAMENTALS OF BIOLOGICAL DIVERSITY CONSERVATION

The goal of biological diversity conservation is to “maintain in a healthy state both the species and the ecological processes historically native to a natural landscape.”<sup>33</sup> Conservation biologists seek to achieve this goal in the context of a rapidly rising “human population that has fragmented, simplified, homogenized, and destroyed

many ecosystems.”<sup>34</sup> Biodiversity conservation focuses on the importance of functioning ecological systems that support native plants and animals. It is not enough simply to conserve particular species or particular parcels of land in isolation.

In order to maximize conservation efforts, it is important to understand some basic ecological principles – principles that can be applied in the field when making decisions about the use and acquisition of land, siting of facilities, harvesting practices, and other economic activities.

***Maintain the viability of individual species represented in an ecosystem.*** Although the long-term goal of conservation efforts is to establish and maintain conditions where critical ecosystem and evolutionary processes can function, such efforts must seek to ensure that individual species populations remain viable.<sup>35</sup> To ensure the survival of individual species, population levels must remain large enough to protect against extinction from random natural events (floods, fires, droughts), and genetic diversity must be maintained to ensure that species are able to adapt to changing environmental conditions.<sup>36</sup>

***Favor native plants and animals and avoid the use of non-native species.*** Native plants and animals have great intrinsic value, as they represent the natural conditions once found in an ecosystem. Non-native, or exotic species, can severely disrupt the natural conditions and species composition in an area.

***Conserve and protect intact mature stages of habitat.*** Mature forests and wetlands are essential for the conservation of native wildlife that does not survive well in disturbed landscapes.<sup>37</sup> For example, in Delaware, birds such as the cerulean warbler, brown-headed nuthatch, and red-headed woodpecker require mature forests for their breeding habitat.<sup>38</sup>

***Focus conservation and restoration efforts on larger habitat areas.*** Larger habitats are better than smaller areas at ensuring the survival of species. Smaller populations are more vulnerable to extinction due to environmental fluctuations, demographic variation, inbreeding, and reduced gene pools.<sup>39</sup> Large habitat areas are also important for interior forest species because they reduce the influence of edge effects.<sup>40</sup>

“To keep every cog and wheel is the first precaution of intelligent tinkering.”

Source: Leopold, Aldo. 1949. *A Sand County Almanac*. Reprinted 1966. Oxford University Press, Inc.: New York.



**Minimize the distance between protected habitats and promote and maintain habitat linkages.** The distance between suitable habitats and the nature of the habitat between areas exchanging populations will influence the persistence of species.<sup>41</sup> Habitats in close proximity to one another are better than widely separated habitats. For example, amphibian species richness has been shown to decrease across the landscape as wetlands become more isolated.<sup>42</sup> Since connected habitats are better than isolated habitats, maintaining linkages between fragments may be at least as important to maintaining biological diversity as increasing the size of the fragments.<sup>43</sup>

**Protect buffer areas surrounding sensitive ecosystem types.** Creating buffer zones around sensitive areas can help to protect species that depend upon adjacent lands, especially when surrounding land uses are incompatible with conservation objectives.<sup>44</sup> Several studies have documented the necessity of establishing buffers surrounding specific habitat types, such as emergent and forested wetlands.<sup>45</sup>

**Allow natural patterns of disturbance to continue, or at least manage the landscape to emulate natural patterns.** Periodic disturbances, such as storms, floods, and fires, play an important role in maintaining patches in various stages and in maintaining the plants and animals that co-evolved under the influence of these natural processes.<sup>46</sup> For example, allowing seasonal flooding where consistent with other land management objectives can be beneficial to local biological diversity.

**Minimize human introduction of nutrients, chemicals, and pollutants.** Introduced compounds can directly impair biological diversity by killing terrestrial and aquatic species. These substances can cause reduced reproductive and survival rates, disrupt the species composition of an area, and cause birth defects. For example, the input of large amounts of sediment and associated agricultural chemicals in Delaware's rivers and streams has caused a drastic decline in aquatic diversity.

**Improve existing habitat or restore degraded areas to offset the impacts of development.** If uses of lands and waters are likely to lead to the loss of biological diversity, compensation through restoration measures within the same landscape can be an appropriate measure to replace lost habitat

functions. However, impacts to natural systems should first be avoided or minimized as much as possible. When mitigation is used to offset habitat loss, it is critically important to monitor mitigation sites to ensure that the desired ecosystem functions are being achieved.

**Manage on the regional or landscape level wherever possible.** Planning on a regional or landscape scale can provide habitat for species that require large areas of relatively undisturbed land, highly specialized species, and species that may be rare regionally but common locally. The abundance of many different suitable habitat patches over the larger landscape can help to improve species' chances of survival.<sup>47</sup>

**Maintain adaptive management strategies.** Over the course of human land use in Delaware, management approaches have been adopted to address specific natural resource goals – water control, agricultural and forestry production, wildlife enhancement, mosquito control. Over time, we have come to recognize that many of these traditional management practices may lead to unintended consequences, or more commonly, unforeseen cumulative impacts. As a result, it is essential that effects of management practices are monitored continually and evaluated to ensure that they are not harming regional, statewide, landscape, or ecosystem conservation goals. Human management tools must remain adaptive to changing environmental conditions,<sup>48</sup> scientific findings, and improved understanding about regional cumulative effects.

## WHY A COMPREHENSIVE STATEWIDE STRATEGY?

To comprehensively protect and restore its natural heritage, Delaware needs a strategy that will address short-comings in existing tools, improve coordination between state agencies and other groups, integrate disparate on-going projects, and support future public and private initiatives.

A comprehensive statewide strategy would lead to the development of a plan around which public agencies and private interests could rally to guide biodiversity conservation and restoration in Delaware. Such a strategy would build on current successes and identify urgent needs. More importantly, it would weave a web connecting projects and programs, legal tools, biological inventory and assessment tools, and people. A comprehensive strategy is the best vehicle for local groups, individuals, and government to unite their efforts. It would place seemingly small, incremental improvements in biological diversity conservation within a broad vision for Delaware.

Delaware has the technical and practical capacity needed to prepare a successful strategy. Its state, federal, and local agencies, conservation organizations, and universities have a wealth of technical expertise, a dedication to protecting the state's environment, and the desire to see Delaware's biological diversity conserved and restored in a comprehensive manner.

## DEFINING THE FOCUS FOR A DELAWARE STRATEGY

If biological diversity is ever to be meaningfully conserved and restored, it must be integrated into the fabric of state laws, policies, and institutions.<sup>49</sup> Most of the land management practices and individual decisions that contribute to habitat loss and fragmentation, habitat degradation, and exotic species invasions are profoundly affected by state laws, regulations, and policies.

There are many opportunities for Delaware agencies, organizations, local governments, corporations, and citizens to develop a statewide strategy that will address these effects. Recommendations at the end of this Executive Summary and in the companion publication, *Protecting Delaware's Natural Heritage: Tools for Conservation*, offer practical suggestions for how existing laws, policies, and practices can be used or altered to better protect Delaware's biological diversity. Many of these recommendations also suggest new tools that Delaware should consider implementing to ensure that its remaining biodiversity is protected and restored. A coordinated strategy can

help interested parties in the state determine which tools are appropriate for Delaware's future.

## NECESSARY COMPONENTS OF A DELAWARE STRATEGY

If a state biodiversity strategy is to make significant inroads into biodiversity conservation and move beyond planning to on-the-ground implementation, several elements are necessary.

**Address private as well as public land management issues.** Many existing state biodiversity plans have been developed to guide land acquisition and management practices on state-owned lands. Not all of the lands under public ownership are managed with biodiversity conservation and restoration as a priority.<sup>50</sup> But, even if Delaware succeeds in managing all of its state and federal lands with an eye toward biological diversity, the activities on only a fraction of the land base will be addressed. Because the vast majority of Delaware's land base is privately owned, private lands are also a critical part of the puzzle. A focus on private lands is essential if biological diversity is to be meaningfully protected and restored.

**Ensure broad-based involvement.** Early on in the process, include a significant number of appropriate interest groups. For biodiversity strategies to significantly alter detrimental practices on private as well as public lands, a broad coalition of Delaware agencies and organizations whose decisions affect biological diversity must be brought to the table.

**Foster leadership at high levels early in the process.** Broad involvement and strong leadership are essential to helping insulate biodiversity initiatives from political upheavals, as well as bureaucratic and corporate intransigence. Support from partners in the business community, non-profit organizations, and commodity interests can provide state environmental, agricultural, transportation, and development agencies with the encouragement necessary to withstand political change and overcome bureaucratic obstacles.

**Define goals clearly.** It is worthwhile to spend time up front to educate the public, define goals clearly, and restate them often. Misunderstandings and intentional misinformation about the goals of state biodiversity initiatives can create concerns over private property rights that may pose unnecessary obstacles to broadly supported and even voluntary efforts. Any strategy for biodiversity conservation also must be closely tied to efforts to direct growth in a manner that supports Delaware's economic, human, and natural capital.



**Focus biodiversity initiatives more broadly than on the development of an acquisition strategy.** Land acquisition alone cannot stem the loss of biodiversity. Even with Delaware's strong public land acquisition programs, it is highly unlikely that there will ever be sufficient funds to acquire the acreage necessary to protect and restore all species and ecosystems of interest and concern. Furthermore, even if such acquisition were possible, such an approach could unnecessarily constrain many productive activities that are compatible with healthy ecosystems.

**Develop a unified biodiversity assessment and provide biological data to local, state, and private decision-makers in an appropriate format.** Delaware has many sources of scientific data that land managers draw upon in their decision-making. These tools could be used to develop a model for identifying and prioritizing areas suitable for conservation and restoration, as well as acquisition. However, it is critical that biological data be provided to policy-makers at the state and local levels in a format that they can interpret and use. If existing science-based biodiversity assessment programs are not providing information in an appropriate format to those whose decisions affect biodiversity, valuable data will fail to have significant on-the-ground effects.

**Seek science-based solutions that are win-wins for private landowners and the resource.**

Landowners must be presented with an array of options and incentives for protecting and restoring biodiversity on their land. These should include opportunities such as cost-share programs, technical assistance and training, tax incentives for placing sensitive habitat in conservation easements, the ability to sell development rights, and other non-regulatory programs. Delaware agencies and organizations should work together to help inform landowners about the variety of opportunities available to them. These groups should also work with landowners to help them identify the options most appropriate to meet their needs.

**Develop a biodiversity conservation strategy that specifically addresses the effects of existing laws, regulations, and policies on biological diversity.**

Since many of the sources of biodiversity loss result from decisions made at the state and local level, Delaware must begin addressing the

direct and indirect ways the state's laws, policies, and institutions create incentives that promote biodiversity loss.

## KEY POLICY RECOMMENDATIONS

Below are a number of key policy recommendations taken from the companion publication, *Protecting Delaware's Natural Heritage: Tools for Biodiversity Conservation*. These recommendations identify ways biodiversity conservation and restoration can be enhanced through reinterpreting existing laws, fine-tuning management practices, working cooperatively to promote innovative tax incentive and voluntary cost-share programs already available in the state, or adopting new laws. Which of these challenges Delaware chooses to embrace is for its dedicated citizens, legislators, business leaders, and natural resource professionals to decide. The chapter references at the end of each recommendation identify where the background material supporting the recommendation can be found.

1. Delaware should exercise its authority to deny infrastructure and development funding for projects that



“Environmental conservation requires both sustained governmental action and an individual land ethic. The two are mutually necessary and reinforcing. The goal of public policy should be wise multiple-use land management, which effectively correlates biodiversity conservation with economic land-use, including agriculture, forestry, recreation and other land uses.”

Source: Vaughn, Gerald F. February 1999. “The Land Economics of Aldo Leopold.” *Land Economics*. 75(1): 156-159.

are inconsistent with state development policies, including development outside of designated growth areas. The Quality of Life Act should be modified to require (rather than merely allow) the state to deny funding for infrastructure projects whenever a proposed action is inconsistent with state development policies. (Ch. 3)

2. Amend existing county comprehensive plans to ensure that they are consistent with the state’s development priorities. State designated growth and preservation areas are required by law to be reflected in comprehensive plans at the county level. Require counties to develop zoning maps that are in accord with their comprehensive plans. Areas designated as growth and preservation areas in the county comprehensive plans should be reflected as such in the zoning maps. (Ch. 3)
3. The Department of Natural Resources and Environmental Control should move quickly to meet its legal obligations under the Land Protection Act by providing counties with detailed maps of State Resource Areas (SRAs). Based on these maps, all three Delaware counties should comply with the Land Protection Act by adopting overlay zoning ordinances and environmental design standards to protect SRAs. (Ch. 3 & Ch. 5)
4. Enhance the effectiveness of the state Endangered Species Act. Revise the Act to include a prohibition on the taking of listed species, a requirement for listing of species, a requirement for consultation with the Department of Natural Resources and Environmental Control on actions that may impair habitat or species viability, a requirement for recovery plan development, and a provision for critical habitat designation. Extend protection to Delaware plants that are endangered, threatened, and species of concern either by including plants in the legal definition of “species” or by enacting a separate plant protection law. Also, revise the Act to extend protections to threatened species and species of concern in the state. (Ch. 4)
5. Regularly update the list of “rare” species that are afforded protection under the state’s freshwater fishing and hunting regulations. (Ch. 4)
6. Amend the state tidal wetlands law to provide protection for buffer areas adjacent to tidal wetlands. The law should also be amended to require local governments to adopt the appropriate tools to protect critical wetlands and buffers. (Ch. 4)
7. Enact a non-tidal wetland law to provide sufficient protection for habitats and waters of the state not sufficiently protected by the federal §404 program. Secure sufficient appropriations for effective administration of the law. (Ch. 4)
8. Adopt water quality criteria specific to wetlands. Adopt and implement regulations guiding Delaware’s §401 program for approving, conditioning, or denying federal §404 wetland permits. (Ch. 4)
9. Amend Delaware’s subaqueous lands law to eliminate the requirement of navigability. (Ch. 4)
10. Improve nutrient management practices in the animal industry through the adoption of appropriately stringent nutrient management regulations, such as time-of-year restrictions on manure spreading. Develop a nutrient applicator license or certification program. (Ch. 4)
11. Eliminate exemptions for agricultural practices that are detrimental to water quality and biological resources, and provide appropriate incentives for improving existing conditions. Repeal agricultural exemptions in the

- Erosion and Sediment Control law and encourage the U.S. Environmental Protection Agency to reconsider its determination that waterways in basins of less than 800 acres are considered ditches. This would remove the exemption of ditching activities from environmental review and permitting requirements under the federal Clean Water Act, state tidal wetland law, and other state laws. Adopt regulatory and cost-share incentive programs to encourage the construction and maintenance of buffers and habitat corridors along drainage ditches. (Ch. 4)
12. The Delaware Department of Agriculture Forest Service should develop rules and regulations to implement its new authority to require landowners to submit notification to the agency prior to commencing planned silvicultural activities. The agency should make development of forest management plans mandatory under the notification process, develop a notification and management plan review process to ensure that landowners seeking approval for a planned harvest include in their plans appropriate conservation provisions, and reserve the right to approve, condition, or deny proposed harvests if appropriate conservation measures are not included in harvest or management plans. (Ch. 4)
  13. Require strict implementation of wetland mitigation policies, ensuring that rigorous alternatives analysis is conducted. If mitigation banks are utilized to compensate for permitted losses, banks should support functioning wetlands prior to the withdrawal of credits, success criteria should take biological diversity into account, and long-term management responsibility should be secured. Similar standards should be developed for other compensatory mitigation approaches, including on-site mitigation. Commission a study to review the permit and ecological success of existing compensatory mitigation projects. (Ch. 4)
  14. Secure a stable annual source of funding for the Open Space Program and the Agricultural Lands Preservation Program. (Ch. 5)
  15. Revise the Land Protection Act to create a matching grant program within the Open Space Program. Matching funds could be allocated to local governments and conservation organizations to acquire open space in areas consistent with the state's conservation goals. (Ch. 5)
  16. Revise the scoring system of the Agricultural Lands Preservation Act to give increased weight to wetlands, forests, areas in close proximity to open space, wind-breaks, bufferstrips, and other natural amenities on agricultural lands. (Ch. 5)
  17. Amend the Agricultural Preservation Program to provide greater incentives to district landowners to engage in environmentally beneficial practices. Provide enrolled landowners with tax credits for implementing agricultural conservation management plans. The Delaware Department of Agriculture, U.S. Department of Agriculture, and U.S. Fish and Wildlife Service should coordinate to give additional preference to landowners enrolled in Agricultural Preservation Districts to encourage them to apply for cost-share funding through existing Farm Bill and wildlife enhancement programs. (Ch. 5)
  18. Within the Division of Fish and Wildlife, consolidate the Non-game Program and Delaware Natural Heritage Program in a Wildlife Diversity Program. Establish the Wildlife Diversity Program at the section level or integrate it into the division in such a manner as to ensure that it receives attention equal to that of the wildlife and fisheries sections. Secure a stable source of funding for the program and use donated tax check-off funds for restoration and research activities. (Ch. 6)
  19. Develop a statewide biodiversity inventory and assessment methodology – drawing from existing sources of biological data, such as the Delaware Natural Heritage Program and Gap Analysis Project – to identify biologically critical areas for targeting incentive programs, management resources, acquisition funding, cost-share programs, long-range planning, and restoration activities. Provide this biological information to Delaware's land management, economic development, transportation agencies, local governments, and conservation organizations in a format that can help guide on-the-ground decision-making. (Ch. 6)
  20. Develop management plans for each of Delaware's public land holdings that address biodiversity conservation and restoration goals. Require regular updates to reflect new trends in wildlife and recreational use, include regular updates on exotic species, ensure that each agency's constituents are being served, and ensure that management activities reflect current scientific understanding and do not adversely affect species diversity. (Ch. 6)



21. Amend Delaware's Farmland Assessment Act to allow lands managed for conservation purposes to be eligible for property assessment at current use, as are lands that sell agricultural, horticultural, or forestry products. (Ch. 7)
22. The U.S. Department of Agriculture's Natural Resources Conservation Service, Delaware Department of Natural Resources and Environmental Control, Delaware Department of Agriculture, and other state and local natural resource agencies should coordinate efforts to promote voluntary private land conservation programs that benefit biodiversity. (Ch. 7)

## CONCLUSION

There is ample authority for, and interest in, the development of a statewide strategy to protect and restore biological diversity in Delaware. Delaware must look to its future by developing a statewide strategy that acknowledges that biodiversity is the common heritage and responsibility of all the state's citizens. Now is the time to define whether or not Delaware's future will reflect the biological abundance that once characterized the state and that continues to draw people from around the world.

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