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SECTION 24 - WAP CHALLENGES AND OPPORTUNITIES: STABLE FUNDING FOR WILDLIFE MANAGEMENT

24.1 BACKGROUND

Throughout their histories, both the Pennsylvania Fish and Boat Commission and Pennsylvania Game Commission have relied almost solely upon hunting and angling revenues to support species management and habitat protection/enhancement activities. With hunters and anglers as their direct-paying constituents, the Commissions historically have focused much of their management attention toward 85 species of game animals and sport fish, although many non-game species benefited both directly and indirectly from this approach. The commissions, however, are responsible for the management and protection of both game and non-game species, and, unfortunately, directed management for the state's more than 400 species of non-game mammals, birds, fish, reptiles, and amphibians has been limited. This is largely the result of funding and manpower deficiencies, not an unwillingness to manage all species. Both agencies historically have expressed concern about their inability to direct management attention to all fish and wildlife.

Limited license-based resources prevent the commissions from fully meeting their mandates to manage all fish and wildlife species for the benefit of present and future generations. In spite of extremely limited budgets and staffing, the commissions' Diversity Sections have worked determinedly and diligently to moderate species' declines, restore species when feasible, and protect habitat to the extent that the commissions are able.

Many activities conducted by the commissions benefit both game and non-game species. Such activities in the Fish & Boat Commission include water pollution investigations, levying fines for water-quality violations and fish kills, wetland encroachment enforcement, and the long-term monitoring of water quality. Game Commission activities that benefit non-game species include land acquisition, habitat management practices on state game lands and some private lands, landowner/conservationist outreach programs, and coordinated species-specific projects with conservation partners. In addition, both commissions engage in law enforcement to protect threatened and endangered species, provide education programs that discuss issues affecting non-game as well as game species, and relay information on non-game species in *Pennsylvania Game News* and the *Pennsylvania Angler & Boater*. Nevertheless, more work is needed to adequately manage non-game species. The comprehensive, proactive management efforts required to reverse or halt declines among non-game species are beyond the current staffing and financial capabilities of the commissions.

Since 1982, direct agency expenditures on non-game management have been augmented by the Wild Resource Conservation Fund, which funds research, conservation, and education efforts relating to native plants and non-game fish and wildlife. The Fund, now renamed the

Wild Resource Conservation Program (WRCP), is supported by voluntary contributions derived from a state income tax check-off and sale of specialized license plates, as well as annual funding from the Pennsylvania Department of Conservation and Natural Resources (DCNR), where WRCP is headquartered. However, even with assistance from WRCP, Pennsylvania has always been substantially short of the financial support it needs to implement comprehensive management efforts.

Federal appropriations through the Wildlife Conservation and Recreation Program (WCRP) and State Wildlife Grants program (SWG) have provided much-needed annual funding for the conservation of species of concern. Yet, because of increasing threats on these resources, more funding is needed to address the dynamic environment. With inadequate funding as an overriding constraint, several challenges confront the commissions as they attempt to balance public demands with resource management needs. These challenges fall into four general categories: 1) resource management issues (covered in Sections 10-23 of the WAP), 2) demand for recreation, 3) education needs, and 4) coordination. These issues must be addressed as the commissions position themselves to meet the increasing resource management challenges of the future, while responding to the changing demands of Pennsylvanians for recreation and education opportunities.

24.2 RESOURCE MANAGEMENT ISSUES

To some extent, a lack of basic ecological information prevents the implementation of comprehensive management efforts. Basic inventory data, which indicates where species occur, is available for most non-game mammals, birds, and fish. However, monitoring data, which reveals population trends over time, is practically non-existent for these species. For less conspicuous groups like reptiles, amphibians, and invertebrates, managers are lacking both inventory and monitoring data. Although there are several inventory and monitoring efforts being conducted across the state, these efforts are largely uncoordinated and may or may not be providing information on high-priority species and habitats. To date, there is neither a standardized protocol for assessing the status of non-game species and habitats, nor a prioritization of which species and habitats are most in need of such efforts (though a prioritization process has begun with the development of the Conservation Priority Tiers presented in this WAP).

Because non-game species are so numerous and diverse, management efforts will be most effective if conducted at the habitat level. State lands should include representation of Pennsylvania's most unique habitats and protect critically important habitats of rare and declining species and of common species that act as keystone species in communities. The Game Commission has been instrumental in acquiring wetlands that serve as critical habitats for both game and non-game species. By identifying high-value habitats at the landscape scale, resource managers stand the best chance of assuring long-term protection of the greatest number of plant and animal species.

Privately-owned land constitutes nearly 80 percent of Pennsylvania's land mass, yet the commissions lack a statewide coordinated program to provide technical assistance to private landowners to conserve fish, wildlife, and habitats on private property. The Pennsylvania Natural Diversity Inventory has identified more than 50 sites that are in critical need of protection that fall outside of state managed lands. Clearly, Pennsylvania cannot rely solely on public lands to maintain sustainable populations of fish and wildlife. Private landowners must be encouraged to conserve fish, wildlife, and habitats through a combination of incentives and education. Development of the Game Commission's Private Lands Assistance Program (with the use of SWG funding) has begun the process of providing coordinated outreach to interested landowners.

24.3 DEMAND FOR RECREATION

There is a growing need to manage the Commonwealth's recreation resources. Recreation facilities and public lands are increasingly subjected to competing recreational uses and incompatible land uses within and around their borders. Maintaining the environmental integrity of natural areas and facility maintenance continue to be major concerns of Pennsylvania's conservation agencies. In addition, the plight of public lands is compounded further by the increased posting of private property, which likely is forcing more recreationists to use state-owned lands.

Recreational demands upon fish, wildlife, native plants, and their habitats are accelerating. New technology and new types of recreation equipment have brought about increased recreational demands and have increased physical pressure on Pennsylvania's public lands. In addition to "traditional" uses of state recreation areas, such as camping, hiking, hunting, and fishing, a host of new recreation activities are becoming increasingly popular.

With increased usage comes increased demand for established campsites, restroom facilities, road access, maintained trails, and other recreational amenities. One of the challenges for recreation planners will be to balance the demand for developed recreation sites, such as modern campgrounds and cabins, picnic areas, bike paths, boating facilities, and wildlife viewing areas, with the demand for dispersed recreation opportunities such as hiking, backpacking, and cross-country skiing that depend upon a certain amount of solitude and natural-appearing forests and waterways.

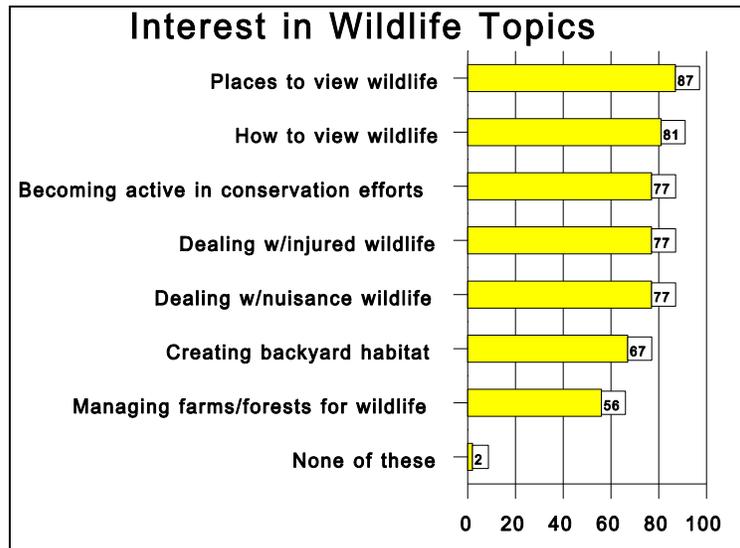
The trend toward increased recreational use of public lands also is an opportunity. More people involved in outdoor recreation means that more people will become interested in resource management issues, if education opportunities are provided along with recreation opportunities. Increased participation in outdoors recreation may set the stage for natural resource agencies to reach a larger audience for education efforts than ever before, if recreational development is strategically targeted and education programs are presented as part of the recreation experience.

24.4 EDUCATION NEEDS

While the Commissions make use of Project WILD and KARE (Keystone Aquatic Resource Education) to educate school age children throughout Pennsylvania, adult education efforts are directed primarily at the hunter/angler/boater constituency. There is growing evidence, however, that many other adult audiences are interested in learning about fish and wildlife. In a joint Commission survey conducted in summer 1996, 95 percent of respondents agreed that educating the public about Pennsylvania’s fish and wildlife is an important responsibility of the Commissions, and 90 percent agreed that providing education programs in urban areas is an important responsibility. In a recent Opinion Needs Survey conducted by the Department of Conservation and Natural Resources, respondents expressed more interest in environmental education programs than in any other type of recreation programming.

Sportsmen and sportswomen apparently agree that the Game Commission should expand educational programming. In a recent survey of hunters, 70 percent of those polled agreed that the Pennsylvania Game Commission should offer additional education facilities and nature centers and 70 percent agreed that the Commission should increase wildlife research and education in urban areas (Responsive Management 1996).

The commissions have an opportunity to reach out to new audiences with their education efforts by developing educational programs that focus on the interests and activities of non-traditional audiences. Non-consumptive wildlife recreationists outnumber hunters and anglers by two to one. In Pennsylvania’s female population, different rates of participation are even more pronounced. In 1991, six percent of Pennsylvania females fished and two percent hunted, while 44 percent participated in non-consumptive outdoor recreation, such as feeding, viewing, and photographing wildlife.



Creation and delivery of education programs that encourage people to become involved in either consumptive or non-consumptive recreation would serve to increase public recognition and support for the commissions. Survey findings indicate that as people participate in outdoor and wildlife-associated recreation (both consumptive and non-

consumptive) their knowledge of the commissions increases along with their approval ratings of agency performance.

When developing informational materials for new audiences, it is important to know which topics interest the target audience. Fortunately, there are many areas of common interest between consumptive and non-consumptive users. When asked about areas of interest in a recent Commission survey, hunters and anglers ranked topics very similarly to non-consumptive users, indicating that educational programs developed on these topics would have broad appeal among both traditional and nontraditional audiences (Responsive Management 1996).

24.5 COORDINATION

Comprehensive fish and wildlife conservation requires the unending support and continued cooperation of public and private organizations and residents throughout the Commonwealth to be successful. Human and capital resources must be combined, coordinated, and increased to achieve success in conserving fish and wildlife populations and their habitats. Stakeholders in this process include decision-makers, land managers, scientists, private landowners, and conservation organizations across the Commonwealth, who, collectively, have the ability to meet the WAP's ambitious goals for fish and wildlife conservation. The power of conservation lies in the synergy that builds when diverse, committed partners work together toward a common goal.

This Strategy is a blueprint for fish and wildlife conservation and, as such, is not intended to replace existing or developing conservation plans at the local, regional, or state level. In fact, there are several complementary planning efforts underway that should assist in the implementation of statewide conservation action. Such plans as the Pennsylvania Biodiversity Blueprint, The Nature Conservancy's ecoregional planning process, Department of Conservation and Natural Resources Forest Resource Management Plan and the HGIS -Tier 2 planning effort, as well as individual organizations' strategic plans, all have a role to play in conserving Pennsylvania's invaluable fish and wildlife resources. The conservation and management strategies required for several hundred species are far too complex and varied across the Commonwealth to be treated in just one plan. Further, implementation – that critical step in the process where a plan becomes an on-the-ground conservation action – must take place at state, regional, county, and local levels. To be most effective, however, such actions should be guided by an overall strategy; this type of statewide guidance is what the WAP is designed to provide.

It is recognized that once statewide guidance has been finalized, it will be up to regional and local conservation partners to identify priority species and habitats that fall within their jurisdiction, set goals and objectives for their organization's involvement, identify local issues and opportunities, and develop strategies for implementing local conservation actions.

It is anticipated that the content of partners' plans may not be in full synchrony with the content of this WAP; that is a natural consequence of working at different scales and in different operating environments. It will be important over the next few years to resolve differences and arrive at better conservation objectives at all scales and for all fish and wildlife species.

24.6 FUNDING FOR WILDLIFE MANAGEMENT

Although more than four million Pennsylvanians participate in wildlife viewing, feeding, and photography, there is no direct mechanism whereby non-consumptive users can support the Commissions' management efforts. Unlike the case with hunters and anglers, a direct user pay/user benefit relationship between the commissions and non-consumptive recreationists is lacking. At the same time, the number of hunters and anglers in Pennsylvania is declining because of a variety of factors, while the number of non-consumptive wildlife recreationists continues to increase steadily. As mentioned earlier, non-consumptive wildlife recreationists outnumber hunters and anglers two to one.

Beyond mere financing, there exists a partnership between hunters, anglers, and the commissions that does not exist between these agencies and non-consumptive recreationists. Cooperative projects between sporting groups and the commissions often result in win-win situations that benefit fish and wildlife resources, while improving hunting and angling opportunities. Such mutually beneficial relationships are limited between the commissions and Pennsylvania's non-consumptive wildlife recreationists. Furthermore, a strong constituency of support for non-game conservation and management is lacking. The partnerships built through the development of the WRCP and SWG programs have started to change that – nearly all projects supported by these programs have been conducted in partnership with Pennsylvania's conservation and research organizations, fostering important relationships between non-consumptive stakeholders and the commissions.

Though 'non-consumptive' wildlife recreation (viewing, feeding, and photographing wildlife) generates significant economic returns for the Commonwealth, there is no direct funding linkage between these recreationists and Pennsylvania's fish and wildlife agencies. Unlike the case with hunters and anglers, non-consumptive users do not directly support fish and wildlife management.

Wildlife-related recreation provides significant economic returns in Pennsylvania, generating \$5.87 billion in total economic impact in a single year. Yet a 1999 report by the Izaak Walton League of America revealed that Pennsylvania ranked 49th in the nation in its commitment to conservation, a figure derived by comparing the amount of revenues generated by fish and wildlife to the amount of public reinvestment in fish and wildlife management. The survey spurred increased awareness and renewed recognition of this historic, but still unresolved, problem. At the same time, public interest and demand for

wildlife-associated education, comprehensive management efforts, and additional wildlife recreation opportunities is extremely high.

A 1996 survey, Pennsylvania Residents' Opinions On and Attitudes Toward Non-game Wildlife clearly indicated that the public is willing to support various funding mechanisms to support non-game management. Funding mechanisms identified and supported by a majority of the public included: a voluntary conservation stamp (88 percent respondents supporting); increased speeding fines (63 percent support); a five percent user-fee on birdseed and outdoor-related equipment (57 percent support); a fee for non-sportsmen using state game lands (56 percent), and; a garbage tax (52 percent). At the time of the survey, Pennsylvanians' support for a small excise tax or "user fee" on outdoor equipment was noteworthy: it was the second highest level of support found among all states previously surveyed.

Funding mechanisms deemed unacceptable by a majority of Pennsylvanians included: a gas tax; an increase in the state sales tax; a realty-transfer tax; and a water-consumption tax. Interestingly, the garbage tax mentioned above received both strong support and strong opposition. Passage of such a tax would be feasible only if this strong opposition could be softened through a public information campaign.

As habitats continue to be lost and degraded and the management needs of fish and wildlife increase, the limited resources allocated to manage non-game species -- even many game species -- continue to be stretched to their limits. While short-term non-game research and monitoring projects are often subcontracted to private or academic interests, implementation of management recommendations is left to resource agencies. In many cases, management plans for vulnerable species and habitats have been developed, but remain unused because agencies lack the personnel and financial resources necessary to implement recommendations. Inflation, declines in hunting and fishing license sales, and rising energy costs compound the problem. Unless additional resources are allocated to, or revenue streams are developed to fund or subsidize comprehensive management efforts, the Commissions' non-game fish and wildlife management activities will remain largely inadequate to detect and halt species declines.

24.7 STATEWIDE GOALS AND OBJECTIVES FOR COMPREHENSIVE WILDLIFE MANAGEMENT – FUNDING

As described in Section 9 of this document, conservation partners from across the Commonwealth identified five broad goals for the WAP. Agency staff then developed a hierarchy of strategic and operational objectives to support the broad conservation goals. Many of these goals and objectives have relevance to the need for stable funding in conserving Pennsylvania's species of greatest conservation concern. The goals and objectives *most* relevant to comprehensive funding needs include the following:

Goal 4: Ensure that the necessary resources are available to conserve Pennsylvania's wildlife.

Strategic Objective 4.1: Broaden the financial support for fish and wildlife management beyond traditional constituents.

Operational Objectives:

4.1.1. Communicate the economic impact of wildlife as a way to develop public support for sustainable funding for wildlife conservation

4.1.2. Promote the Pennsylvania Non-game Tax Check off and the Wild Resources Conservation Program

4.1.3. Identify processes whereby people who do not hunt or fish can financially contribute to fish and wildlife management activities.

4.1.4. Seek funding from private foundations, individuals, corporations and/or institutions that can provide financial assistance for fish and wildlife management activities.

4.1.5. Maintain a grants and contracts program to support projects and activities at state and local levels that help achieve Program Objectives.

Strategic Objective 4.2: Engage the political process to ensure a steady and reliable stream of funding (>\$0)

Operational Objectives:

4.2.1. Maintain and increase state funding sources.

4.2.2. Seek cooperative funding with federal and state agency partners.

4.2.3. Support congressional approval of stable, long-term funding for state wildlife diversity programs.

Strategic Objective 4.3: Address the lack of expertise to address wildlife conservation needs

Operational Objectives:

4.3.1. Recruit and maintain qualified, well-trained, and well-equipped staff and volunteers.

4.3.2. Conduct an assessment of personnel, facilities, support services and equipment necessary to implement the Wildlife Diversity Program at state and local levels.

4.3.3. Staff and equip the Wildlife Diversity Program at state and local levels to carry out laws, administrative rules and meet Program Objectives.

4.3.4. Maintain an active volunteer program to assist in achieving Program Objectives.

4.3.5. Support an active agency personnel and volunteer training program to maximize the effectiveness of the Wildlife Diversity Program.

4.3.6. Maintain and expand annual recognition and award programs for cooperators, citizens and volunteers.

24.8 STATEWIDE GOALS AND OBJECTIVES FOR IMPROVED COORDINATION

Goal 5: Improve coordination of the public agencies and other partners in wildlife conservation planning and implementation.

Strategic Objective 5.1: Improve the integration and coordination of the Diversity program within each Commission.

Operational Objectives:

5.1.1. Integrate the WAP's goals, objectives and other plan elements throughout the Commissions' other administrative units, where feasible and appropriate.

5.1.2. Work closely with Commission bureaus, divisions, programs and regional offices to develop and implement the WAP and to ensure species' conservation objectives are collectively achieved.

5.1.3. Keep the Commission and other staff informed of WAP progress, planning activities, problems, needs and accomplishments.

5.1.4. Develop and maintain shared databases within the Commission.

5.1.5. Make use of internal training opportunities to build institutional support for holistic wildlife conservation efforts.

Strategic Objective 5.2: Improve coordination among public land management agencies to accomplish the objectives of the WAP.

Operational Objectives:

5.2.1. Work collaboratively through grants and contracts with other agencies and non-governmental conservation partners to facilitate the implementation of wildlife diversity projects and further program objectives.

5.2.2. Evaluate agency laws, authorities, rules, and cooperative agreements and their ability and effectiveness in addressing conservation needs; seek new authorities and partnerships as needed.

5.2.3. In areas of mutual interest and activity, clearly define who is doing what where.

5.2.4. Develop effective strategies to take advantage of opportunities to work together.

APPENDIX 24.1. PUBLIC SUPPORT OF VARIOUS FUNDING SOURCES

Most states rely upon a variety of funding mechanisms to finance management programs for non-game fish and wildlife. Eight states have established secure, long-term funding mechanisms specifically dedicated to land acquisition, wildlife diversity management, and public education efforts. Arizona and Colorado make use of annual funding from the state lottery to finance land acquisition and wildlife conservation. In Missouri and Arkansas, a portion of the state sales tax is dedicated to acquiring unique habitats and other projects. Florida's Preservation 2000 Act generates up to \$300 million per year for management of non-game species through speeding fines and a surcharge on out-of-state vehicle registrations. Tennessee, Maryland, and North Carolina fund wildlife management and habitat acquisition programs with a realty transfer tax.

In Pennsylvania, the Wild Resource Conservation Fund has been the primary funding source for wildlife diversity research and management in recent years. Unfortunately, the Fund is experiencing diminishing revenues and projecting critical shortfalls in the coming years, unless other funding sources can be found. In light of declining license sales by both the Fish and Boat Commission and Game Commission, and increasing match requirements for Federal appropriations such as State Wildlife Grants, it seems unlikely that the commissions will be able to increase non-game expenditures unless a dedicated non-game funding source(s) is established. Without adequate financial resources, it will be difficult to maintain existing non-game programs and services, much less expand programs to address unmet needs.

The 1996 Non-game Management Survey conducted by the Game Commission and Fish and Boat Commission tested the public's willingness to support various funding mechanisms for non-game management programs. Results of this survey and relevant information on the success of funding alternatives in other states is provided below.

Excise tax on outdoor equipment ("Teaming With Wildlife")

In the Commissions' 1996 survey, 63 percent of non-consumptive wildlife recreationists supported Teaming With Wildlife's proposed five percent excise tax on outdoor equipment to finance wildlife conservation, recreation, and education projects. Teaming With Wildlife is patterned after the highly successful Pittman-Robertson and Dingell-Johnson programs that have garnered millions of dollars for the management of game animals and sport fish nationwide. Under this program, the Game Commission, Fish and Boat Commission, and Department of Conservation and Natural Resources would be eligible for federal dollars on a 25:75 percent match basis. Pennsylvania's natural resource agencies could receive as much as \$13.5 million for fish and wildlife conservation, recreation, and education if the agencies contribute \$4 million in matching funds. An in-state funding source will have to be developed to take full advantage of revenues available under this program. At this point in time, Teaming With Wildlife legislation is in draft form awaiting Congressional introduction and action.

Voluntary Conservation Stamp

Eighty-eight percent of respondents to the 1996 Commission survey supported the idea of a voluntary collectors stamp as a way to fund non-game fish and wildlife programs. This was the funding option that received the highest level of public support. In all likelihood this is because it is a strictly voluntary source of donation, rather than a tax or fine that is levied upon individuals. Pennsylvania already has a voluntary collectible-merchandise program that supports non-game management efforts. The Working Together for Wildlife program annually raises about \$150,000 that is used to support the non-game programming efforts of the Game Commission's Bureau of Wildlife Management.

As of 1992, sale of merchandise by state fish and wildlife agencies contributed wildlife diversity program funding in 12 states, although this source of income generated only slightly more than \$525,000 for all 12 states combined. The average income from such programs was about \$40,000 for each state, but actual income ranged from a low of \$300 in Colorado to a high of \$243,460 in Missouri. Nationally, the sale of merchandise accounts for less than one percent of non-game program funding, suggesting that this is not an adequate funding mechanism. Also, given the fact that Pennsylvania already relies heavily upon merchandise sales to fund non-game efforts, it is unlikely that a new or expanded program will garner significant additional revenues.

Public Lands User Fee

Congress in 1996 authorized a three-year pilot program to test entrance fees at 200 forests, parks, and other federally-operated public lands across the country, with a goal of raising up to \$50 million over three years. Projects are underway in several national forests in Wisconsin, New Hampshire, and California. At present, these projects are still in the pilot stage, but recreation managers are considering a variety of fee schedules and instruments,

such as annual parking fees or permits, day use, seasonal, or yearly passes for high-use areas such as trailheads and beaches, and other types of entrance fees.

Enactment of a fee-for-access program in Pennsylvania would likely require extensive (and expensive) advertising, administration, marketing, and law enforcement efforts to be successful, because of the large amount of public lands and the dispersed nature of recreation activity on these lands. It may be prudent, however, to monitor the success of the federal user-fee efforts.

State Lottery

At least three states fund their wildlife diversity programs using state lottery revenues. In Arizona, this funding mechanism generates about \$4.1 million annually, about half of which is used to acquire habitat for threatened, endangered, and candidate species, and half used to acquire other natural areas. The Great Outdoors Colorado program also is financed using a state lottery. In this program, funds are dedicated to protecting crucial wildlife habitats, natural areas, and open spaces.

Speeding Fines

In a 1995 survey conducted by researchers at Slippery Rock University, 57 percent of respondents said they would support a surcharge on speeding violations as a supplemental source of funding for non-game wildlife programs. Similarly, in the 1996 Commission survey, 63 percent of respondents reported they would support such a fee to support non-game wildlife management programs.

Hundreds of thousands of birds, mammals, reptiles, and amphibians are killed on Pennsylvania highways annually. A successful program that uses a surcharge on speeding fines to finance fish and wildlife management efforts is in place in Florida. In 1992, the Florida legislature authorized a 25-cent-per-mile-over-the-speed-limit-fee be added to speeding violations to support non-game conservation. During its first three years, the program generated an average of \$2.6 million per year.

**A Minor Amendment to the
Pennsylvania Wildlife Action Plan:**

**Climate Change – An Emerging Issue in
Fish and Wildlife Management**

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Appendix 6: Amendment 2

A Minor Amendment to the Pennsylvania Wildlife Action Plan:

Climate Change – An Emerging Issue in Fish and Wildlife Management

1.0. BACKGROUND

In 2007, the Intergovernmental Panel on Climate Change reached a consensus position that human-induced global warming is already causing physical and biological impacts worldwide. The most recent scientific work demonstrates that changes in the climate system are occurring in the patterns that scientists had predicted, but the observed changes are happening earlier and faster than expected. Although serious reductions in anthropogenic greenhouse gas emissions may be undertaken to reduce the extent of future impacts, evidence is mounting to indicate that climate change is already beginning to impact ecological processes in North America. With the potential to have broad ecological impacts in Pennsylvania, climate change is an emerging issue that must be incorporated into the Pennsylvania Comprehensive Conservation Strategy, herein referred to as the Pennsylvania Wildlife Action Plan (PA WAP).

2.0. PENNSYLVANIA'S ANTICIPATED CLIMATE FUTURE

The Intergovernmental Panel on Climate Change's 4th Assessment Report (IPCC 2007) found that global climate change is "unequivocal" and largely attributable to human activities. There is evidence that climate change is currently underway and having an impact on natural resources, yet there are still many unanswered questions about how these climate effects will play out at local, state and regional

scales and how ecosystems will respond to those changes.

According to the IPCC report, global average temperatures have risen by 1.5° F and can be expected to rise another 2-11° F by 2100, depending on future emission levels. The effect this will have on the nation's wildlife and ecosystems could be dramatic. There is still uncertainty regarding regional variations in climate change impact, yet a recent climate change impact assessment conducted for the Pennsylvania Department of Environmental Protection predicts several impending changes to Pennsylvania's climate (ENRI PSU 2009).

Two IPCC global emissions scenarios were used to model Pennsylvania's potential climate future (ENRI PSU 2009). The "high" emission scenario assumes continued growth in global emissions throughout the 21st century and corresponds to the A2 scenario of the IPCC Special Report on Emission Scenarios (SRES). The "low" emissions scenario assumes global emissions growth is moderated to the middle of the 21st century and declines thereafter and corresponds to the IPCC SRES B1 scenario. Based on these analyses, predictions regarding Pennsylvania's climate include:

- Pennsylvania will warm throughout the 21st century; not a single model simulates cooling under two different emissions scenarios.

- Annual precipitation will increase and very likely winter precipitation will also increase.
- Projected climate change is independent of emissions scenario over the next 20 years and becomes substantially dependent on emissions scenario by late century.
- By the end of the century, the median projected warming according to the “high emission” scenario is almost 7° F, which is nearly twice that of the “low emission” scenario.
- By late century, the median low emission and high emission annual precipitation projections are 6 and 10% increases, respectively. Corresponding winter projections are 8 and 15% increases.
- Warming will lead to a longer growing season with median low emission and high emission projections of increases of nearly three and five weeks, respectively, by late century. Corresponding frost day decreases are nearly four and six weeks.
- Pennsylvania’s precipitation climate likely will become more extreme in the future with longer dry periods and greater intensity of precipitation.
- Substantial uncertainty exists in projections of future tropical and extra-tropical cyclones for Pennsylvania. Current research suggests fewer storms, but with increased intensity.

**3.0. BROAD-SCALE IMPACTS TO
NATURAL RESOURCES IN
PENNSYLVANIA**
(The following section adapted from ENRI
PSU 2009)

3.1. Water Resources

(for more information, see Section 6.0 of ENRI-
PSU 2009, pp. 68-91)

Conclusions regarding the future of
Pennsylvania’s water resources are based mainly

on changes to atmospheric moisture and energy availability. Precipitation is projected to increase in winter and stay relatively stable in summer with the potential for a small increase. Heavy precipitation events are also projected to increase. At the same time temperature is projected to increase relatively evenly throughout the year.

One consequence of this change would be a significant decrease in snow cover extent and duration throughout Pennsylvania. More precipitation will fall as rain rather than as snow. Increasing temperature is likely to lead to increasing evapotranspiration. Since most of the actual evapotranspiration in Pennsylvania occurs in the summer and summer precipitation and evapotranspiration are already about equal, droughts related to soil moisture will likely increase throughout late spring to early fall. The frequency of short and medium length soil moisture droughts is thus projected to increase. On the other hand, groundwater recharge may increase due to fewer days with frozen ground and more precipitation during the winter when evaporation is low and plants are not active. Summer floods and general flow variability are projected to increase. A reduced snowpack might cause a reduction in rain-on-snow events, a process which historically caused major flooding in Pennsylvania, though this conclusion is speculative without more detailed studies.

Pennsylvania is likely to see a small increase in runoff in the order of 5 to 10%, which will basically be during the winter months, while summer flows might be reduced. The interaction with changes to groundwater recharge and the potential for more baseflow is less clear. Stream temperature, an important water quality characteristic for aquatic ecosystems, is likely to increase, potentially causing problems for species which require cold water for at least part of their life cycle. Increases in water temperature in combination with flashier runoff due to more extreme precipitation and increased urbanization will negatively impact Pennsylvania’s water quality and potentially impair estuaries into which the river network drains. At the same

time, higher sea levels will increase salt water intrusion into coastal waters.

3.2. Forests and Wildlife

(for more information, see Section 7.0 of ENRI-PSU 2009, pp. 92-125 and Appendix 6, pp. 294-330 for mapped projections of impacts on individual forest tree species)

Climate change will likely cause many changes in Pennsylvania's forests. First, the state will become increasingly unsuitable for many of the tree species that are now present, especially those associated with northern hardwood ecosystems. Northern species, such as paper birch, quaking aspen, bigtooth aspen, and yellow birch, are projected to be extirpated in the state under high emissions scenarios, and greatly reduced, if not eliminated, even under low emissions scenarios. Other species, including American beech, black cherry, striped maple, eastern hemlock, red maple, sugar maple, eastern white pine, sweet birch, white ash, and American basswood, are projected to find increasingly less suitable habitats and will likely decline in numbers. In general, Pennsylvania is projected to become increasingly hospitable for more southern species, such as oaks and hickories, although the state's two most common oaks, northern red oak and chestnut oak, are projected to decline under high emissions scenarios. Some species that are currently rare or not present, such as loblolly pine, shortleaf pines, common persimmon and red mulberry, may become more common, although it is not clear how these species will come to the state without human intervention.

The warming climate will cause susceptible species to become increasingly stressed. Mortality rates will increase and regeneration success will decline, resulting in declining populations in the state of those species. The increasing stress due to climate change will also make some species more susceptible to a host of other stressors, including acid deposition, native and non-native insects, and disease. Tree mortality could rise due to these secondary

impacts, and it may be difficult to attribute these changes directly to a changing climate. Tree mortality could also increase if climate change increases the frequency of severe storms, and fires may become more common as temperatures rise.

Some studies suggest that the longer growing season, warmer temperatures, possibly higher rainfall, and a phenomenon termed "CO₂ fertilization" will increase overall forest growth rates in the state. These effects will likely be offset by increased mortality rates, at least until the climate stabilizes and the mix of tree species in the state is again in a more stable equilibrium with the state's climate.

Pennsylvania's forest products industry will need to adjust to the changing resource. The industry may benefit from planting faster-growing species and from salvaging dying stands of trees. On the other hand, if mortality is dramatic and sudden, as might occur with an extended drought or a major storm such as a hurricane, the industry might not be able to utilize all of the dead wood. Substantial investments in artificial regeneration may be needed if large areas of forests begin to die back due to climate-related stress.

Forests can contribute to the mitigation of climate change by sequestering carbon. While it may be difficult to substantially increase the growth rates of Pennsylvania hardwoods, additional carbon can be sequestered and stored in the state's forests by increasing stocking levels or reducing stocking reductions, especially those utilizing poor management practices such as high-grading and diameter limit cutting. Marginal lands, such as abandoned mine lands can be reforested, but, again, the best opportunities may be in preventing forest loss rather than increasing the number of forested acres. Since 70% of Pennsylvania's forests are privately owned, often in small family-owned parcels, it will be necessary to engage private forest landowners if significant changes are to be made in how Pennsylvania's forests are managed.

3.3. Aquatic Ecosystems and Fisheries

(for more information, see Section 8.0 of ENRI-PSU 2009, pp. 126 – 147)

Existing aquatic ecosystems and fisheries in Pennsylvania will be stressed by projected climate change. The most significant impacts predicted for stream and wetland communities are increased water temperature and increased hydrological variability. Hydrological variability may be influenced by changing seasonal patterns of water levels, reduced stream flows during dry periods, larger floods and longer droughts. Wetlands and headwater streams in Pennsylvania are already compromised in their ability to provide ecosystem services due to degraded conditions resulting from modification of hydrology and nutrient enrichment. These stressors primarily arise from human activities associated with agriculture and development.

Changes in temperature, water quantity and water quality will most certainly affect stream and wetland biological communities, and the largest negative impact may be in loss of biodiversity. Pennsylvania may see a decline in some of high-value coldwater communities and a simultaneous increase in the abundance of less desirable biological assemblages, especially invasive species. Of special concern is the impact of higher temperatures and altered flow regimes on eastern brook trout, not only because of its status as a recreationally important species, but because it is an indicator of high water quality and may be an early victim of deleterious impacts of climate change. Eastern brook trout will continue to decline as a result of higher water temperatures.

Wetlands may experience a similar change in habitat conditions as hydrologic variability changes habitat structure. Potential impacts on other valued ecosystem services of streams and wetlands (*e.g.*, carbon sequestration, nutrient removal, flood storage) cannot be predicted at this time. Impacts of climate change on aquatic

ecosystems will be difficult to detect because of the continuation of primary stressors, such as development and invasive species, to their condition.

At a larger spatial scale, climate change is likely to alter the biogeochemistry of the Chesapeake watershed via the large contribution of the Susquehanna River to its total freshwater input (51%). The direction of change is not well constrained given the uncertainty in flow projections as well as the lack of a mechanistic understanding of watershed processes. Nutrient and sediment loading during winter and spring will likely rise due to the anticipated increase in flow during this time, increased run-off and erosion of stream banks.

Current research suggests that ecologically relevant hydrologic responses to precipitation and temperature will vary over the spatial scale of a small watershed, making spatially-explicit predictions difficult. The general pattern appears to be a slightly wetter scenario, which may result in an expansion of wetland areas and a seasonal increase in stream discharge. However, changes in hydrological factors, such as flow amount, timing, and frequency, are significant variables in structuring plant and animal assemblages; alterations in the hydrology could greatly modify assemblage structure for plant, macroinvertebrate, amphibian, and fish communities.

3.4. Fish and Wildlife-Based Outdoor Recreation

(for more information, see Section 12.0 of ENRI-PSU 2009, pp. 241-257)

Changes in Pennsylvania's climate will have negative impacts for some activities (notably winter sports and trout fishing) and positive impacts for other activities (warm water fishing, swimming, boating, golf, and outdoor exercise). Adaptation options include those aimed at minimizing negative impacts and capitalizing on new opportunities.

Increased temperatures will reduce the number of stream stretches that can support wild trout populations. The direction of this impact is established with high confidence, although its magnitude is uncertain. Increased stocking can serve as a partial substitute for lost wild trout habitat, but some waters will become too warm to support even stocked trout. A reduction in the availability of cold-water fishing does not mean that fishing activity will decline. In fact, the evidence is that total demand for fishing days will most likely increase due to a longer season with pleasant weather and a desire to be near water on hot days. The direction of this impact is established with medium confidence. The Pennsylvania Fish and Boat Commission should consider this possible increase in warm-water fishing activity when planning its programs to provide anglers access to streams and lakes.

Predict the impacts of climate change on hunting participation is difficult. The most important game species in Pennsylvania are fairly widely distributed and tolerant of different climates. Changes in forest composition could affect wildlife abundance, but the direction of impact is difficult to predict. Changes in weather may affect hunter behavior, but again the direction of the impact is difficult to predict. Likewise, participation in non-consumptive forest-based recreation, such as hiking and camping, could be affected by climate change. Higher temperatures will lengthen the season for such activities, but may make them less enjoyable in the middle of summer. Changes in forest composition may also affect these activities. Thus, the direction that climate change might impact these activities cannot be established.

Warmer summer temperatures and a longer summer season will increase demand for water-based recreation other than fishing, such as swimming and boating. There is high confidence in the direction of this impact. Pennsylvania could capitalize on this increased demand by providing more opportunities for water-based recreation in the form of new stream access points and reservoirs.

25.4. CONSERVATION AND MANAGEMENT IMPLICATIONS

The predicted changes to Pennsylvania's natural resources described in section 25.3 could trigger substantial changes to the fish and wildlife populations of the Commonwealth:

- Migration of flora and fauna northward and/or to higher elevations in order to escape warming conditions.
- Altered seasons resulting in earlier spring and later fall which would be expected to result in migration pattern shifts of birds and migratory insects and misalignment of food availability.
- Decreased populations of freshwater and anadromous fish such as salmon and trout due to reduced snowpack and increased temperatures in streams.
- Altered flooding regimes will affect spawning and rearing habitat for many aquatic species.
- Altered timing of life history events for particular species.
- Altered or potentially-decoupled coevolved interactions, such as plant-pollinator relationships.
- Reduced population size for negatively-impacted species.
- Increased population size for positively-impacted species.
- Extinct or extirpated species or populations that are range-restricted or isolated.
- Extinct or extirpated species that are unable to migrate or lack the opportunity to migrate to a more suitable climate.
- Loss or significant alteration of historic habitats.

- Increased spread of wildlife diseases and parasites.
- Increased spread of invasive or nonnative species.

These on-the-ground changes to wildlife populations will alter management activities implemented by resource agencies and conservation organizations and how management efforts are prioritized. Individual species and habitats will have very different responses to climate change. Many species and habitats will be negatively affected by climate change and will require a special set of actions to ensure their survival. Some species may benefit from a changing climate and may expand their range or increase in abundance, requiring a separate set of actions. In addition, the movement of species will create new communities of species, which will require new management regimes.

Climate change itself is a major and growing threat to wildlife and natural systems, but it will also exacerbate many existing threats. Efforts to address climate change should not diminish the immediate need to combat threats that are independent of climate change, such as habitat loss, invasive species, pollution and wildlife diseases. The goal of fish and wildlife conservation remains: to sustain ecosystems and viable wildlife populations regardless of the threat.

5.0. VULNERABLE SPECIES OF GREATEST CONSERVATION NEED (SGCN)

Species may be susceptible to climate change impacts due to a variety of factors including ecological, behavioral, physiological and genetic traits. For species that are highly susceptible, the risk of extinction or extirpation increases markedly when coupled with large climatic changes.

The International Union for the Conservation of Nature (IUCN) identified five groups of traits that are believed to be linked to increased

susceptibility to climate change (IUCN 2008):

- Specialized habitat and/or microhabitat requirements.
- Narrow environmental tolerances or thresholds that are likely to be exceeded due to climate change at any stage in the life cycle.
- Dependence on specific environmental triggers or cues that are likely to be disrupted by climate change.
- Dependence on interspecific interactions which are likely to be disrupted by climate change.
- Poor ability to disperse to or colonize a new or more suitable range.

In September 2009, the Association of Fish and Wildlife Agencies (AFWA) developed a guidance document (AFWA 2009) for states agencies desiring to incorporate climate change considerations into their State Wildlife Action Plans (SWAP). This document suggests that “species conservation efforts that focus on identifying and protecting those habitats most likely to persist as climate changes will likely be better investments than those that depend on habitats which are likely to become unsuitable (AFWA 2009).” This recommendation provides Pennsylvania with a starting point for developing a strategy to prioritize management of fish and wildlife response to climate change and reinforces the approach taken by the PA WAP.

A guiding objective of the PA WAP is to reach beyond rarity. Rarity-based conservation is a reactive mode which forces managers to focus on declining populations and species-at-risk. Management agencies must reach beyond rarity in order to achieve comprehensive proactive management. During development of the PA WAP, significant effort was directed at identifying and emphasizing “responsibility species,” or those species for which Pennsylvania plays a critical role in conserving

important regional, national, or global populations.

The focus on Responsibility Species within the PA WAP is an effort to move toward proactive management of species and habitats for which Pennsylvania has some regional, national or global responsibility. This move from reactive to proactive management should result in increased conservation success on the ground as well as more efficient use of limited staff and funding. Alarming, for many taxa in Pennsylvania, rarity and responsibility are interrelated; many of the species for which Pennsylvania plays a crucial geographic role in their conservation *also* are imperiled in the Commonwealth.

Considering SGCN through the dual lens of responsibility *and* imperilment quickly reveals where conservation actions should be directed under the State Wildlife Grants program. Focusing endangered species prevention efforts and proactive management on Pennsylvania Responsibility species and their key habitats will provide conservation results that will have the greatest impacts at the state, regional, national, and global levels.

Given the new threat of climate change, a review the potential impacts of climate change on the Pennsylvania Responsibility species (Table 10.6 and 10.7 of PA WAP) is needed in order to target climate change adaptation attention to those species for which Pennsylvania plays an important regional or national role.

**PA WAP Table 10.6: Pennsylvania Vertebrate Species of Greatest Conservation Need
(Responsibility + Imperilment)**

	Mammals	Birds	Amphibians	Reptiles	Fish
IMMEDIATE CONCERN + PA RESPONSIBILITY					
	Allegheny Woodrat		Hellbender	Bog Turtle	Atlantic Sturgeon
	Eastern Small-footed Myotis		Mountain Chorus Frog	Timber Rattlesnake	Cheat Minnow
				Wood Turtle	Chesapeake Logperch
				Spotted Turtle	Eastern Sand Darter
					Longnose Sucker
					Shortnose Sturgeon
					Spotted Darter
HIGH LEVEL CONCERN + PA RESPONSIBILITY					
	Appalachian Cottontail	Cerulean Warbler		Mountain Earth Snake	Checkered Sculpin
		Golden-winged Warbler		Northern Coal Skink	Northern Madtom
		Henslow's Sparrow		Shorthead Garter Snake	
CURRENTLY ABUNDANT + PA RESPONSIBILITY					
	Northern Myotis	Louisiana Waterthrush	Jefferson Salamander		Longhead Darter
		Scarlet Tanager			Mountain Brook Lamprey
		Tundra Swan (migratory population)			Ohio Lamprey
		Wood Thrush			Streamline Chub
		Worm-eating Warbler			Tonguetied Minnow
					Native Eastern Brook Trout

PA WAP Table 10.7: Pennsylvania Invertebrate Species of Greatest Conservation Need (Responsibility + Imperilment). See Appendix 5 for information on species conservation tiers, habitat associations, and management needs.

IMMEDIATE CONCERN + PA RESPONSIBILITY	HIGH LEVEL CONCERN + PA RESPONSIBILITY	PA VULNERABLE + RESPONSIBILITY
<i>Stygobromus stellmacki</i> - Stellmack's cave amphipod	<i>Lemmeria digitalis</i> - A noctuid moth	<i>Stygobromus allegheniensis</i> - Allegheny cave amphipod
<i>Caecidotea kenki</i> - An isopod	<i>Margaritifera margaritifera</i> - Eastern pearlshell	<i>Cambarus monongalensis</i> - A crayfish
<i>Pyrgus wyandot</i> - Appalachian grizzled skipper		<i>Caecidotea pricei</i> - Price's cave isopod
<i>Papaipema sp. 1</i> - Flypoison borer moth		
<i>Speyeria idalia</i> - Regal fritillary		
<i>Gomphus viridifrons</i> - Green-faced clubtail		
<i>Soyedina merritti</i> - A stonefly		
<i>Alasmidonta heterodon</i> - Dwarf wedgemussel		
<i>Epioblasma torulosa rangiana</i> - Northern riffleshell		
<i>Lampsilis cariosa</i> - Yellow lampmussel		
<i>Pleurobema clava</i> - Clubshell		
<i>Villosa fabalis</i> - Rayed bean		
<i>Sphalloplana pricei</i> - Refton cave planarian		

Beyond Pennsylvania Responsibility species, a “continuum of concern” could further be developed in consultation with technical experts to identify other species which should receive heightened attention in light of climate change threats. This concept will require input from conservation partners and will be more fully developed in the 2015 PA WAP revision. However, such prioritization of management attention might proceed as follows:

Highest Degree of Management Attention

- PA Responsibility species vulnerable to climate change
- Northeast region species of concern
- Species relying on latitudinal corridors
- Species relying on altitudinal corridors
- Habitat specialists that rely on narrow geophysical habitats
- Habitat specialists that rely on narrow vegetative habitats
- State threatened, endangered and/or declining species which are secure outside of Pennsylvania

Lowest Degree of Management Attention

6.0. POTENTIAL CLIMATE CHANGE ADAPTATION STRATEGIES

A balance is needed between the desire to preserve all species and habitats as they currently occur in Pennsylvania and the reality of what can be accomplished with current resources. Actions that are important under both *current* and *future* climates should be prioritized. When the impacts of climate change are uncertain, agencies should focus on conservation actions likely to be beneficial regardless of future climate conditions (AFWA 2009).

Multiple stressors exacerbate climate change impacts on natural systems. In many cases, stressors that limit the ability of natural systems to resist stress from climate change are under human control, either directly or indirectly. Reducing non-climate stressors, restoring and managing for ecological function, managing high-priority species and sites, and maintaining

or restoring connectivity – these activities represent prudent resource management regardless of climate change severity and scale. These types of ‘no regrets’ actions will be the focus of Pennsylvania’s approach to managing fish and wildlife resources in the face of uncertain climate impacts.

6.1. Goals and Objectives of a Climate Change Strategy

6.1.1. Reduce the impact of non-climate threats

Because of the interconnectedness of climate and natural systems, climate change effects amplify long-standing ecological problems, such as land use change, pollution, disruption of flood and fire regimes, habitat fragmentation, wildlife disease, and the spread of invasive species. Addressing existing stressors is one of the most valuable and least risky strategies available for climate change adaptation in part because of the large existing body of knowledge about their impacts and solutions. Reducing the impact of non-climate threats is an excellent example of a ‘no regrets’ action.

6.1.2. Manage for ecological function and protection of biodiversity

Natural systems are supported by basic processes such as fire and flood and by the diversity of life at all scales. As previous and current goals that are designed around restoring or maintaining historic conditions become increasingly difficult or impossible to achieve, conservation actions should focus on maintaining and restoring ecosystem *processes* (such as fire regimes and hydrological cycles). For example, efforts to restore complexity and function to wetlands and riparian areas will benefit many fish and wildlife species regardless of future climate conditions. Efforts to maintain and restore ecological function represent excellent examples of the ‘no regrets’ approach to climate change adaptation: a well-functioning floodplain benefits a diversity of wildlife as well as providing flood-control benefit to surrounding human communities, regardless of the severity of climate change impacts. Likewise, forest management activities that focus on developing and maintaining the ecological function of a

forest stand will contribute to long term climate change adaption processes as well as provide immediate benefit to resident wildlife.

6.1.3. Maintain and restore habitat quality and landscape connectivity

In fish and wildlife management, the ability of individuals and populations to move across the landscape has been important to maintaining biological diversity. Fragmentation of landscapes by changing land uses has restricted these movements. Managing species and their habitats in the context of climate change will require an increased emphasis on connectivity. That will include the connectivity of core or crucial conservation areas with lands that are managed for multiple purposes (*e.g.*, working landscapes) to enable species to shift towards more suitable climates (*e.g.*, higher elevations or latitudes). Maintaining habitat connectivity at the scale needed for climate change adaptation will require strategic planning and investment and meaningful collaboration among public and private parties.

6.1.4. Manage high-priority SGCN negatively impacted by climate change

Species conservation will become more challenging as habitats change, resulting in new and sometimes unfamiliar combinations of plants and animals. A species historically found within one state may shift partially or wholly to another state, or shifts in vegetation may reduce the viability of species or populations that are common today. Species conservation efforts that focus on identifying and protecting those species and habitats most likely to persist as climate changes will likely be better investments than those that depend on habitats which are likely to become unsuitable (AFWA 2009).

Managers should not be paralyzed because of uncertainty about which species or habitats will be most affected. Instead, we should recognize that additional targets can be developed and added as new information becomes available. Both targets and management goals and objectives will likely need to be adjusted as the science improves. Continuing the focus on Pennsylvania Responsibility species will help

ensure that Pennsylvania is playing an important conservation role within a regional and national context.

6.1.5. Use adaptive management to help cope with climate change uncertainties and ensure long term success

Adaptive management is an effective method for decision-making in the context of incomplete information, uncertainty, risk and change. Adaptive management is a form of “learning by doing” that can be used to gradually build the information needed for good decision-making without postponing needed actions. Management decisions are designed to test hypotheses and provide data to inform future decisions. In the context of climate change, adaptive management can help managers see if their adaptation strategies are working. Any strategy for managing the effects of climate change on wildlife and ecosystems should be deployed within an adaptive management framework to enable managers to learn from previous management activities and to respond quickly and creatively to the challenges posed by climate change.

A recent review of the scientific literature on climate change adaptation as it relates to biodiversity conservation and wildlife management was summarized by the Heinz Center (*Strategies for Managing the Effects of Climate Change on Wildlife and Ecosystems*, Heinz Center 2008). The authors also reviewed climate change adaptation plans that have been developed in the United States, Canada, England, Mexico, and South Africa (Heinz Center 2007). From these reviews, they identified eighteen general strategies that could be used to manage the effects of climate change on wildlife and biodiversity (see list below under 6.3). Examining these strategies through the filter of ‘no regrets’ actions reveals a first approximation of a climate change adaption framework for safeguarding fish and wildlife resources in the Commonwealth.

6.2. Selecting Conservation Targets

Identifying the target SGCN and habitats to be addressed by climate change adaptation planning is a critical part of identifying goals and objectives. Targets might be selected because of existing priorities (*e.g.*, species or ecosystems with high economic or recreation value); regulatory requirements (*e.g.*, endangered species); or a state's particular conservation responsibility for that species (*e.g.*, PA Responsibility species). Of course, targets may also be selected because the species or its habitat is clearly vulnerable to changing climate conditions. Some targets may fit into several of these categories, and all of these reasons are valid for selecting a target to be addressed through climate change adaptation planning (AFWA 2009). The challenge is deciding where to start since there may be hundreds of potential targets of conservation concern in a state or region.

6.3. Potential Climate Change Adaption Strategies

A recent comprehensive review of climate change plans and adaption actions reveals that adaptation strategies fall into eighteen general strategies within three broad categories: (1) habitat protection and management; (2) direct management of species; and (3) adaptive management (Heinz Center 2007).

Potential actions relating to habitat protection and management include:

- (1) Increase the amount of protected areas.
- (2) Improve representation and redundancy within natural area networks.
- (3) Manage and restore existing natural areas to maximize resilience.
- (4) Design new natural areas and restoration sites to maximize resilience in the face of climate change.
- (5) Protect predicted movement corridors and "stepping stones."
- (6) Manage and restore ecosystem function rather than specific assemblages and components.
- (7) Increase connectivity and overall landscape permeability to species movements.

- (8) Reduce non-climate stressors on natural areas and ecosystems.

Potential actions related to direct management of species:

- 9) Focus conservation resources on species most vulnerable to threat (with an emphasis on Pennsylvania Responsibility species).
- 10) Translocate or assist in dispersal of species.
- 11) Establish captive populations of species that would otherwise go extinct.
- 12) Reduce pressures on species from sources other than climate change.

Potential actions related to adaptive management:

- 13) Review existing monitoring programs to insure that the information needed for the adaptive management of climate change effects is being collected.
- 14) Incorporate information on potential climate change impacts into species and land management plans.
- 15) Develop dynamic landscape conservation plans.
- 16) Insure that wildlife and biodiversity are included in broader adaptation plans developed by local, regional, or state governments.
- 17) Review existing laws, regulations, and policies regarding wildlife and natural resource management to insure that these instruments provide managers with the flexibility needed to address effects of climate change.
- 18) Propose new legislation and regulations as needed to give managers additional tools and approaches to facilitate responses to climate change.

Information on climate change vulnerabilities and opportunities can help identify which management strategies are most relevant to the species or system being targeted for adaptation action. Science and management experts can then assist with translating those strategies into feasible site and target-based actions for the future climate scenario(s) being considered. Not all actions will be equally feasible or desirable, so an evaluation of the tradeoffs will be

necessary to identify priority actions to be implemented. Such considerations will likely include balancing costs versus relative contribution to achieving a particular management objective and an assessment of the likelihood the actions will have similar utility across climate scenarios. This type of evaluation can inform prioritization of actions identified in State Wildlife Action Plans.

6.4. Selecting the Most Appropriate Strategies for Management

Not all of the strategies described in this document will be appropriate for every

management situation. For example, strategy 6 (manage sites for function, not specific components) is not useful to managers who are interested in promoting the survival of a single imperiled species. Strategy 11 (captive propagation) is probably going to be less useful for managers of large natural areas or national parks. To help managers and conservation practitioners make sense of the strategies presented in their report, the authors developed a simple decision tree that is based on terminology and approaches to management that are widely used by conservation practitioners (Heinz 2008, Figure 1).

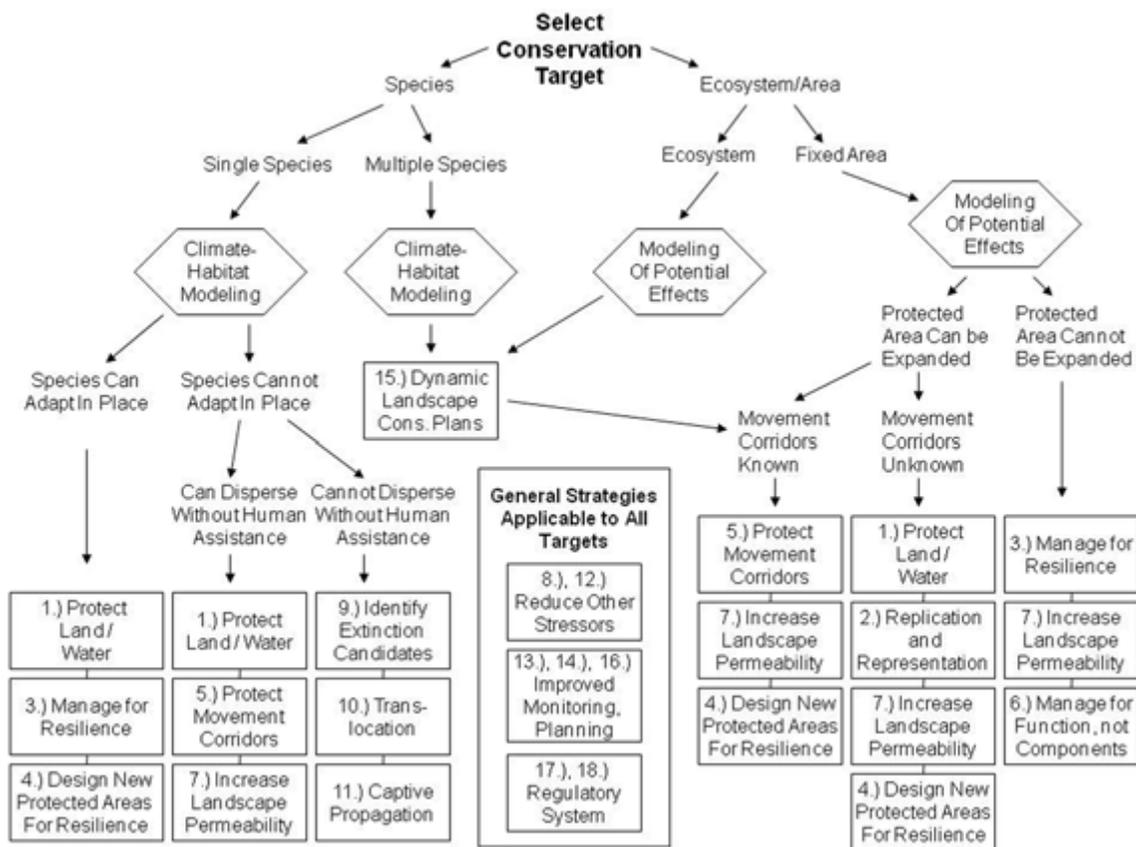


Figure 1: Decision tree for natural resource managers engaged in wildlife and biodiversity conservation. The numbers in the boxes refer to the numbered strategies presented in this document (Heinz 2008).

The decision tree first asks managers to identify a conservation target, which can be either a species, group of species, ecosystem, or fixed geographic area (such as a nature preserve or park). For each target, it is useful to have a sense of its vulnerability to climate change. Depending on the target, there already may be modeling studies or input from technical experts on species or habitat scenarios that can provide information about likely climate effects on the target.

Detailed climate modeling studies are not currently available for many of the species and ecosystems that are relevant to Pennsylvania. Given the cost and time required for these studies, managers will need to start to implement climate adaptation measures without waiting for their development. Given the uncertainties in the existing climate models and substantial differences between some model scenarios, even the best modeling studies may not provide definitive answers to specific management questions (Heinz 2008).

In the absence of clear results from modeling studies, managing the process of climate adaptation becomes more challenging, but is not impossible. In particular, several of the land conservation strategies are beneficial to a wide range of species. In many cases it may also be possible to identify species at-risk for extinction or extirpation (Strategy 9) and reduce non-climate stressors on species of conservation concern (Strategy 12) in the absence of detailed models of climate effects on particular species.

Some of these strategies will likely prove to be more broadly applicable than others. For example, targeted land protection or efforts to increase landscape permeability will probably be of direct benefit to a broad range of species. Other strategies, such as species translocation and captive propagation, will benefit only a handful of species and may ultimately be unsuccessful at preventing extinction despite our best efforts. The literature discussing these approaches clearly indicates that no one strategy is optimal; each has particular circumstances in which it may be more or less appropriate.

6.5. Identifying Statewide Priority Conservation Actions

A review of the Statewide Priority Conservation Actions identified in the PA WAP reveals that nearly all the actions are still relevant in the face of climate change (PA WAP 2005: Sections 10.11, 12.6-12.8; 13.6-13.7; 14.6-14.8; 14.10; 15.6; 15.8; 16.6-16.7; 17.5; 18.6; 19.6-19.7; 19.9; 20.8-20.10; 21.6; 22.5-22.6; 23.4-23.6; 24.7-24.8). The emerging issue of climate change, however, may alter the relative priority of statewide conservation actions and may necessitate the identification of new statewide priorities.

The scale of climate change presents issues that are well beyond the scope of any State Wildlife Action Plan. The broad issues of secondary impacts to wildlife through human population shifts, invasive species and wildlife diseases will likely impact fish and wildlife species and habitats in ways that are impossible to predict. Implementation of climate change mitigation measures in Pennsylvania (terrestrial carbon sequestration manipulations to habitat, infrastructure required by geologic carbon sequestration, alternative energy development) will also impact SGCN and habitats.

Given the varied threats facing the wild fauna of Pennsylvania, all proposed strategies must be viewed through the lens of multi-species management. Resource limitations do not allow for managers to constantly focus on a species-by-species or threat-by-threat basis. On-the-ground management of habitats is often most cost-efficient and successful if it is being conducted for multiple target species. The sheer number of SGCN requires that managers focus on multiple species management actions. Development of multiple species management guidance and best management practices should be an ongoing priority of Pennsylvania's fish and wildlife agencies in light of climate change.

6.6. Statewide Habitat-Based Priorities

Pennsylvania's ecosystems will almost certainly be affected by climate change in the coming decades, yet there is much the state can do to

mitigate and adapt to these changes. Very basic habitat management strategies have been developed with respect to climate change in the Commonwealth (Shortle, *et al.* 2009). Most of these strategies will provide benefits regardless of changes in the state's climate, and most of the strategies relate directly to already-recognized PA WAP priorities:

- Increase investments in managing for healthy, resilient forests with a high degree of biodiversity. [Relates to WAP 12.6 (p.12-32) Comprehensive Forest Management Planning]
- Support research to better predict the impacts of climate change on the state's forests. [Relates to WAP Goal 1 (p.9-3) Improve scientific basis for making conservation decisions]
- Monitor the health and productivity of the forest resource to identify and detect the effects of climate change. [Relates to WAP 23.4 (p.23-31 through 23-36) Improved Monitoring of Forest-Associated Species]
- Recognize potential climate-change induced impacts when planning forest management activities. [Relates to WAP 12.6 (p.12-32) Comprehensive Forest Management Planning]
- Maintain and improve the resiliency of aquatic systems through minimization of nutrient enrichment, hydrologic modification, habitat fragmentation and degradation, and species loss. [Relates to WAP 15.6 and 22.5 (pp.15-25; 22-13) Enhance and Restore High Priority Lotic and Riparian Habitats]
- Protect existing stream and wetland habitat, especially intact habitat for identified species of interest. [Relates to WAP 15.6 (p.15-24) Support Protection of Critically-Important Fish Habitat]
- Consider hydrological connectivity within and between stream and wetland habitats. [Relates to WAP 14.6 (p.14-38) Wetland Monitoring and Adaptive Management]
- Maintain riparian forests for moderation of stream temperature and treatment of run-off from adjoining lands. [Relates to WAP 22.5

(p.22-12) Targeted Management of High Priority Riparian Sites]

- Implement best management practices (BMP's) to reduce nutrient loading. [Relates to WAP 15.6 (p.15-26) Pursue Improved Water Quality of Priority Rivers]
- Restore aquatic ecosystems such as streams and wetlands wherever feasible. [Relates to WAP 14.6 and 15.6 (pp.14-34; 15-25) Coordinated, Strategic Wetland Protection and Restoration; Enhance and Restore High Priority Lotic and Riparian Habitats]
- Minimize groundwater pumping that removes water from aquatic ecosystems. [Relates to WAP 14.6 (p.14-33) Assess Impacts of Groundwater/Surface Water Withdrawal]

7.0 SUMMARY

This section presents a first draft of a Climate Change Adaptation Strategy for safeguarding fish and wildlife resources in the Commonwealth under the new threat of climate change. Targeted land protection or efforts to increase landscape permeability will probably be of direct benefit to a broad range of species. Other strategies, such as species translocation and captive propagation, may be used only in extreme circumstances, would benefit only a handful of species, and may ultimately be unsuccessful. The literature discussing these approaches clearly indicates that no single strategy is optimal; each has particular circumstances in which it may be more or less appropriate.

A detailed Climate Change Adaption Plan is beyond the scope of this document and will require significant input from partners, stakeholders, and technical experts involved with various SGCN as more clarity develops on the impact of changing climate. Such detailed treatment of the issue will be accomplished in the full PA WAP revision scheduled for 2015. Likewise, a detailed strategy addressing those rare plants and plant communities that do not provide critical habitat for SGCN identified in WAP Section 10 is beyond the scope of this document. The Department of Conservation and Natural Resources (DCNR) has jurisdiction over

plant species and is actively engaged in climate change planning to protect these resources.

To the extent possible, efforts will be developed collaboratively to ensure a cohesive and logical approach for conservation and management of Pennsylvania's natural resources. As an example, the Pennsylvania Natural Heritage Program (PNHP) is currently working on a project to identify species in Pennsylvania that are most likely to be impacted by climate change. Beginning this year, PNHP and several other state Heritage Programs, such as Nevada, are using a tool called the Climate Change Vulnerability Index (CCVI), which allows managers to assess the vulnerability of individual species to climate change.

A full inclusion of climate change adaptation priorities and pitfalls will be included in the PA WAP revision of 2015. But the basic principle found within the Wildlife Action Plan still applies: comprehensive management to limit the decline of species requires the ongoing implementation of actions that support the long-term protection of SGCN and their critical habitats. Thus, development of multi-species management guidance, the need to assess species status periodically, comprehensive habitat management planning, improved monitoring of species and an ongoing focus on adaptive management will remain critically important components of the PA WAP.

8.0. SOURCES

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