West Virginia White Butterfly
(*Pieris virginiensis*)

Conservation Plan
Version 1.0

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BIODIVERSITY
alliance

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Lake Erie Allegheny Partnership

Conserving Nature for Future Generations

This document was prepared by Biodiversity Alliance in collaboration with members of the Lake Erie Allegheny Partnership (LEAP) for Biodiversity. This consortium of conservation organizations shares the common goal to enhance the biodiversity of its habitats and ecosystems. The geographic boundary of concern for LEAP members encompasses the glaciated lands and waters south of Canada from Sandusky Bay to the Allegheny Mountains. The mission statement of LEAP reads as: *We are dedicated to the identification, protection and restoration of biodiversity in our region and to the increased public awareness of biodiversity, through the support of our member organizations*. The West Virginia White butterfly has been identified by LEAP members as a species of concern for the region. Members have formed a West Virginia White Committee and meet on a regular basis. The current document should be considered a "living document" and will be updated on an annual basis or as needed. This first version of the Conservation Plan serves as an introduction to the butterfly and the threats against it.

Biodiversity Alliance is a partnership including the Cleveland Museum of Natural History, Cleveland Botanical Garden and Cleveland Metroparks Zoo. All three Alliance institutions are members of LEAP. The Alliance would like to fully acknowledge the members of LEAP for their expertise and assistance in developing and implementing this Plan for the West Virginia White butterfly.

Cover Photo Credit: Judy Semroc, CMNH

West Virginia White
Conservation Plan

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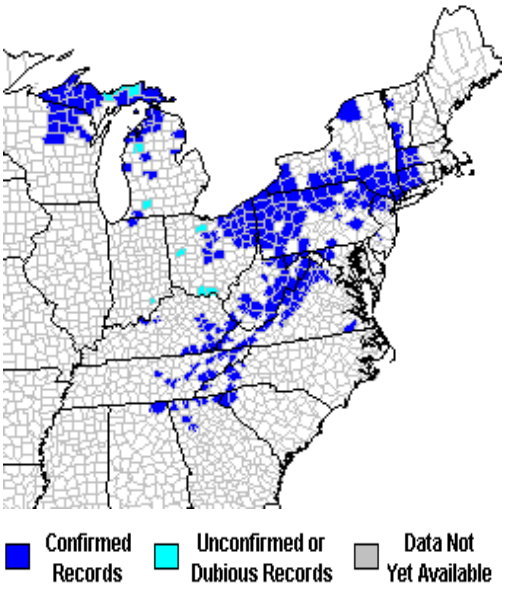
BACKGROUND

Taxonomy

Pieris virginiensis Edwards, 1870

Worldwide there are approximately 1000 species of Pierids, with 55-60 occurring in North America. These butterflies produce unique pigments known as pteridines that give them their characteristic yellow and white colors. As a group, Pierids are common and widespread around the world. They occur in a large range of sizes and typically use crucifers (whites) or legumes (sulphurs) as host plants. Many species within this family do not have well defined broods and instead continuously reproduce throughout the flight season (Glassberg 1999). Within Pieridae, *P. virginiensis* is included in the subfamily Pierinae and the tribe Pierini and is closely related to the Mustard White, *Pieris napi oleracea*. The only other congener in Ohio is the Cabbage White, *Pieris rapae*, an introduced species that now occurs commonly throughout the United States and is regarded as an agricultural pest (Iftner et al. 1992, Glassberg 1999).

Figure 1: Geographic range of *Pieris virginiensis* in the United States
Northern Prairie Wildlife Research Center
http://www.nearctica.com/butter/plate3/Pvirgin.htm



The historic range of the West Virginia White is limited to the northeastern region of the United States (Figure 1.). They are found as far west as Wisconsin and Michigan, extending eastward through Ohio and southern Ontario, southwest along the Appalachians to northern Georgia and Alabama, and northeast to southern Vermont and New Hampshire, and western Connecticut and Massachusetts (Opler and Krizek 1984).

It is theorized that throughout its range, the West Virginia White has been experiencing sharp population declines in association with habitat fragmentation, garlic mustard invasion, and deer overpopulation. Although it is not federally listed as threatened or endangered, the speed of its decline and the nature of the threats against it have warranted a global conservation status rank of G3/G4 by NatureServe. This ranking is based on a one to five scale and indicates that the status of the butterfly across its global range is Vulnerable/Apparently Secure. NatureServe has assigned *P. virginiensis* in Ohio a ranking of S3, which indicates that this species is Vulnerable due to a restricted range, relatively few populations(often 80 or fewer), recent and widespread declines, or other factors which make it vulnerable to extirpation. Information from NatureServe was obtained from their website (http://www.natureserve.org) and was last downloaded on 26 March 2007.

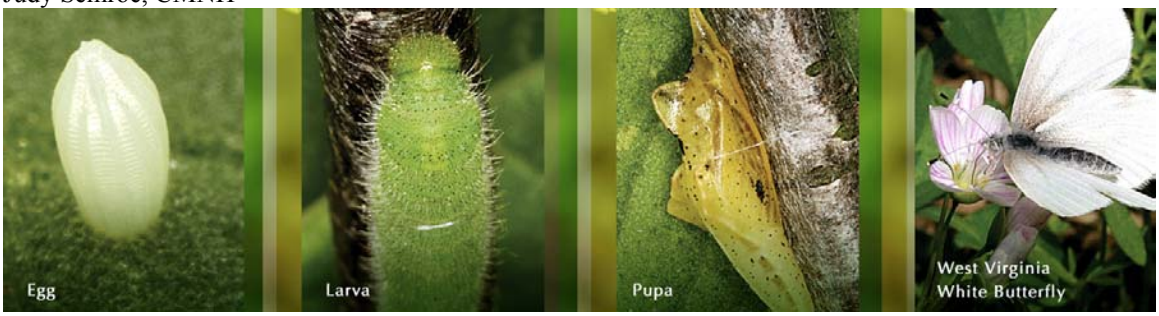
Biology

Reproduction

The West Virginia White is a univoltine (one brood per season) reproducer with a short flight season occurring between late March and late May. Individual ranges are confined to wooded areas and adults will not fly out from underneath the canopy. Thus, dispersal rate is very weak. Flight is typically low to the ground, but they may retreat to the canopy if disturbed (Glassberg 1999).

Eggs are laid singly on the underneath of the leaves of their host plant, the two-leaved toothwort (*Cardamine diphylla*). After a short period, the larvae emerge and begin feeding. Caterpillars are typical of the Pieridae family, elongate and yellow-green with a green stripe along the side. After undergoing several instar phases, the larvae become pupae around mid-June as the host plant enters senescence. The whole process from egg to pupae takes 4-5 weeks. The pupae then overwinter from June to the following March (Figure 2.).

Figure 2: Egg, larvae, pupae and adult of *P. virginiensis*
Judy Semroc, CMNH



Identification: Adults have a 1" wingspan, with translucent white wings unmarked on the dorsal surface and a rounded forewing. There is a slight tint of brown or gray along the veins on the ventral surface (Glassberg 1999). Females may have slight darkening of the forewing along the apex and anterobasal areas (Figure 2.). Emergence generally occurs in late March and adults continue to fly into May. Early spring wildflowers are their primary energy source, and they are often found in moist wooded areas where conditions favor the primary host plant, *Cardamine diphylla*.

The closely related Mustard White, *Pieris napi oleracea* looks similar to *P. virginiensis*, but possesses more prominent gray outlines along the wing veins (Figure 3.). This species has been extirpated from Ohio, likely due to many of the same pressures currently faced by *P. virginiensis*. Although the other North American congener *Pieris rapae* is also white, it is larger than *P. virginiensis*, has a much stronger flight and prefers open areas, so the two butterflies are rarely if ever found in the same area (Figure 4; Iftner et al. 1992, Glassberg 1999).

Figure 3. *Pieris napi oleracea*

Figure 3. Photo by Erik Nielsen
http://www.naba.org/chapters/nabambc/frames-1species.asp?sp=Pieris-napi

Figure 4. *Pieris rapae*

Figure 4. Photo © Marj Rines
http://www.naba.org/chapters/nabambc/frames-1species.asp?sp=Pieris-rapae

Habitat

Figure 5. Typical forest habitat of *P. virginiensis*
Photo by Shane Gebauer
http://www.acris.nynhp.org/guide.php?id=9988

The West Virginia White requires moist wooded areas that support a healthy population of wildflowers, including its host plant *Cardamine diphylla* (Figure 5.). One of the stated conservation goals of this plan is to preserve and restore the butterfly's habitat in northeastern Ohio where West Virginia Whites are already known to exist.

Figure 6. *Cardamine diphylla*
Photo by Eleanor Saulys
http://www.ct-botanical-society.org/galleries/cardaminediph.html

Host Plants

Two-Leaved Toothwort
Cardamine diphylla (Michx.) Wood
(synonym: *Dentaria diphylla* Michx.)

Cardamine diphylla is a member of the Brassicaceae family along with plants such as mustards and cabbages (Figure 6.). Members of Brassicaceae, also known as crucifers, number approximately 350 genera and 3000 species worldwide. They are all herbaceous plants, many of which are annuals. This group contains flowers with four petals arranged like a cross, hence the name 'crucifer,' and many species possess a group of

glycosinolate chemicals more commonly known as mustard oils. There are approximately 76 species of crucifers in Ohio. The genus *Cardamine* itself contains over 150 species of cress, bittercress, and toothworts. The leaves and flowers of these herbaceous plants range from very small to medium-sized, and seeds are produced in long pods known as siliques. Species closely related to *diphylla* include the cut-leaved toothwort (*Cardamine concatenata)* and large toothwort (*Cardamine maxima)*.

Ideal habitat for two-leaved toothwort is moist woodland areas, often found on the slopes of gullies or other low areas with adequate moisture. Like many other woodland wildflowers, it grows early in the spring to make use of the light available before the forest canopy leafs out. The flower opens in April, as the West Virginia White is beginning to fly.

At full maturity, two-leaved toothwort can stand 8-14 inches tall. Leaves are highly divided into three lobes and are oppositely arranged along the stem. Flowers are tubular and white with four petals, with several flowers branching off near the top of the stem on short stalks.

Figure 7. *Cardamine concatenata*
Photo by Janet Novak 2003
http://www.ct-botanical-society.org/galleries/cardamineconc.html

A close relative of two-leaved toothwort is *Cardamine concatenata*, cut-leaved toothwort (Figure 7.). It is easily distinguished from *C. diphylla* by its highly dissected leaves. Although this plant is a possible host for West Virginia White as well, it has been shown to be used very infrequently even when *C. concatenata* is present in much higher concentrations than *C. diphylla*. It appears that *C. concatenata* meets the nutritional requirements of the larvae, however it senesces earlier than *C. diphylla*, leaving incompletely developed larvae to starve. It is hypothesized that the slightly later growth period of *C. diphylla* is the main reason for the butterfly's closer association (Cappuccino and Kareiva 1985).

Figure 8. *Arabis laevigata*
Photo by Janet Novak 2001
http://www.ct-botanical-society.org/galleries/arabislaev.html

A third host plant has also been documented in central Ohio. Smooth rock cress, *Arabis laevigata*, another closely related member of the Brassicaceae family (Figure 8.). This plant has a tall erect stem clasped by long lanceolate leaves. It has been shown that West Virginia White will quite readily lay eggs on this plant, preferring the rock cress over *C. concatenata*, and larvae are able to complete development (Shuey and Peacock 1989). Rock cress (*A. laevigata)* is not ephemeral, so larvae have no threat of senescence before development is completed. Again it is postulated that the extended growing season of this plant is the reason for its evolutionary incorporation as a host plant by West Virginia Whites. While it seems to be a suitable host, its geographical range includes only the southernmost edges of the butterfly's range, and thus has no application in *in situ* conservation efforts in northeastern Ohio.

Nectar Plants
Many spring wildflowers serve as food sources for West Virginia White, including several species of violets (ex. *Viola papilionacea*; Figure 9.), toothworts (*Cardamine diphylla*), bluebells (*Mertensia virginica*), and trillium (*Trillium grandiflorum;* Figure 10.) (Iftner et al. 1992).

Figure 9. *Viola papilionacea*
Photo by Rob &Ann Simpson
http://www.enature.com/fieldguides/enlarged.asp?imageID=20717

Figure 10. *Trillium grandiflorum*
Photo by Janet Novak 2000
http://www.ct-botanical-society.org/galleries/trilliumgran.html

Threats
Forest Fragmentation
Forest fragmentation and land development have played a role in the decline of the West Virginia White. Because the butterfly avoids any open areas, a road through the forest can be a barrier to dispersal. Thus, habitat fragmentation prevents existing populations from re-colonizing areas where the butterfly once flew, or spreading to new areas that may be able to support their needs (Cappuccino and Kreiva 1985). Once the butterfly is lost from a given area, it is unlikely that it will return without human intervention.

Additionally, forest fragmentation may indirectly cause increased parasitization of the West Virginia White. Although the preferred habitats of West Virginia White and the much more common Cabbage White generally do not overlap, the species may come in contact with each other along the edges of forests. Fragmentation increases this edge habitat and increases exposure of West Virginia White to Cabbage White and its associated parasites. Furthermore, garlic mustard thrives in disturbed edge habitat created by forest fragmentation, and may also be spread more quickly throughout an area moving along these edges.

Garlic Mustard

The spread of garlic mustard (*Alliaria petiolata*), a non-native woodland herb, is suspected as a primary threat to the continuing survival of the West Virginia White (Figures 11. & 12.). Introduced to the United States in the 1860's as a nutritional garden herb by European settlers, garlic mustard quickly spread into surrounding woodlands and flourished in the absence of any natural pests or consumers.

Garlic mustard may pose a threat to the West Virginia White in two ways. One threat is due to the prolific and hardy nature of the plant resulting in large monocultures that cover the forest floor and displace native wildflowers such as toothworts and other flowers the butterflies use as nectar sources (Nuzzo 1991, Yost et al. 1991). A second threat associated with garlic mustard is that it exudes the chemical attractant sinigrin, which is also found in toothwort. The butterflies will lay their eggs on the garlic mustard, but once the caterpillars hatch, survival rates are decreased on the garlic mustard plants (Bowden 1971, Chew 1980). This makes the presence of garlic mustard a potential population sink for the West Virginia White.

Figure 11. *Alliaria petiolata* (Bieb.) Cavara & Grande
Photo by Janet Novak 2002
http://www.ct-botanical-society.org/galleries/alliariapeti.html

Unfortunately, the problems faced by the West Virginia White are not unique. A congener of the West Virginia White, the Mustard White (*Pieris napi oleracea*), has already been extirpated from Ohio (Ohio Department of Natural Resources, 2006) and it is thought that the spread of garlic mustard may have contributed to its demise in Ohio (Keeler et al. 2006).

Figure 12. First year *Alliaria petiolata*
http://www.oardc.ohio-state.edu/weedguide/singlerecord.asp?id=330

Garlic mustard not only affects the West Virginia White but studies have shown that it also affects the entire forest ecosystem. Large monocultures of garlic mustard can cover the forest floor and shade out native spring-blooming wildflowers and other plants, reducing understory diversity (Nuzzo 1991, Yost et al. 1991). The removal of garlic mustard will result in an increase in understory diversity (McCarthy 1997). Beyond its physical displacement effects, garlic mustard also inhibits the growth of underground fungi that fix nitrogen and supply it to our native plants through their roots. Examples of plants affected include native tree saplings such as the white ash (*Faxinmus americana*) and sugar maple (*Acer saccharum*) (Stinson et al. 2006). Over time, these allelopathic compounds alter forest composition and regeneration which in turn impact biodiversity and the natural associations of the native plants and animals. The eradication of garlic mustard is therefore necessary to maintain and restore the natural biodiversity, wherever it occurs.

Deer
Overpopulation of deer throughout much of the West Virginia White range poses another threat to the butterfly. In great numbers, white-tailed deer (*Odocoileus virginianus*) have been shown to reduce native forest understory plants in some cases to the point of near extirpation (Augustine and Frelich 1998). Constant browsing pressure by deer reduces the species richness and density of native plants such as toothwort, while increasing the density of browse-resistant plants such as garlic mustard (Horsely et al. 2003). Because deer preferentially browse on native plants over garlic mustard, the combined presence of both species creates a threat greater than the sum of the effects from each.

Pesticide Use
It is possible that the widespread use of the bacterial control agent Bt (*Bacillus thuringiensis*) to control the gypsy moth (*Lymantria dispar*) may have also affected many non-target Lepidopteran species throughout the range of the West Virginia White (Scriber 2001). Bt spraying is often done early in the year before the forest canopy leafs out, which is the time when the West Virginia White is most active and vulnerable.

CONSERVATION GOALS

- Maintain viable populations of West Virginia White throughout its range in northeastern Ohio and western Pennsylvania
- Preserve and restore the butterfly's habitat
- Educate the public about West Virginia White and the threat of invasives to biodiversity

CONSERVATION OBJECTIVES

- Determine the current distribution of West Virginia White throughout its range in northeastern Ohio and western Pennsylvania
- Control garlic mustard in areas where the butterfly is found
- Develop and distribute educational materials
- Develop outreach programs
- Identify research priorities for the butterfly and conduct needed research

PROTOCOLS

Several strategies will be employed by LEAP members for conservation efforts focused on the West Virginia White butterfly. Strategies will include ongoing monitoring of West Virginia White populations, control of garlic mustard within West Virginia White habitat areas, and

educational programs focusing on the West Virginia White for the general public, as well as for interested land managers.

West Virginia White Monitoring
There is currently little data on abundance within known populations of the West Virginia White and there exists the need to find additional habitat that supports the butterfly. A monitoring program must be put into place to locate populations, assess their abundance and evaluate the threats faced in those areas.

In order to determine the current status of the butterfly in the region and considering current available time and budget restrictions, initial monitoring efforts may be most effective if focused on collecting presence-absence data over more focused abundance studies (Joseph et al. 2006).

A preliminary data sheet has been created for West Virginia White monitoring for the Spring 2007 flight season (see attached document). Information to be recorded by each monitor will include site location, temperature, time, cloud cover, size of surveyed area, type of habitat, tree and plant species including toothworts, garlic mustard, and nectar sources, in addition to abundance, behavior and comments on any West Virginia White butterflies observed in the area. This form will be circulated throughout the LEAP member institutions and has been designed to accommodate a wide range of field experience and expertise.

Garlic Mustard Control
A comprehensive plan to eradicate garlic mustard from areas with known West Virginia White populations must be put into effect. This will involve monitoring for the presence of the plant, an evaluation of levels of infestation, and execution of control measures. Several methods of control have been tested for this widespread invasive plant, including pulling, mowing, flooding, burning, strategic cutting, covering with dark plastic or other opaque material, and several types of herbicide application. Herbicide application is most effective on the rosettes in early spring or late fall, when most other plants are not active. All management options should take care to prevent seed formation, or remove any seeds from the site completely. Uprooted or damaged plants are still quite capable of reproduction (Nuzzo 1991).

EDUCATIONAL OPPORTUNITIES

At times it can be difficult to relate complicated environmental interactions to interested members of the public; however, the story of the West Virginia White helps illustrate the impact of an invasive species on a native resident. Once the story of this basic relationship is told, it can be broadened to encompass the complete effect of garlic mustard on the long-term species composition of the forest through the inhibition of myocorrhizal fungi.

This message is also important for professionals in land management to ensure that stewardship decisions are made with an understanding of the effects of garlic mustard. As recent as this year, new discoveries have been made regarding the impact of garlic mustard on native species composition (Stinson et al. 2006). It is vital that this information is disseminated to the people who work to keep our natural areas healthy.

RESEARCH NEEDS

- Immersion survival of pupae
- Survival rate of lab-reared versus field collected material
- Survival rate of material reared on two-leaved versus cut-leaved toothwort
- Efficacy of rearing larvae on artificial diet versus rearing on living host plant
- Effect of deer on food plant using deer exclosures
- Survival rate of larvae feeding on garlic mustard

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