Conservation and Management of the Baltimore Checkerspot (*Euphydryas phaeton* Drury) in Maryland: Strategies for Statewide Monitoring and for Wetland Restoration, Captive Breeding and Release in the Piedmont Region

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Edited by:
Jennifer Frye, Invertebrate Ecologist
Maryland Department of Natural Resources
Wildlife and Heritage Service
Natural Heritage Program

Contributing Authors:
Pat Durkin
Washington Area Butterfly Club

Jennifer Frye, Invertebrate Ecologist
Maryland Department of Natural Resources
Wildlife and Heritage Service, Natural Heritage Program

Denise Gibbs, Park Naturalist
Maryland-National Capital Park and Planning Commission
Black Hill Regional Park

Rob Gibbs, Natural Resources Manager
Maryland-National Capital Park and Planning Commission
Little Bennett National Park

Matt Lustig, Teacher
Carroll County Public Schools

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Cover Illustration by Pat Durkin.

EXECUTIVE SUMMARY

This document is intended to provide a framework for conserving and managing populations of the Baltimore checkerspot butterfly (*Euphydryas phaeton* Drury) in Maryland where it is currently included on the Maryland Department of Natural Resources' 2010 list of Rare, Threatened and Endangered Animals. Within the state its distribution is limited to 11 sites, most of which are on the Appalachian Plateau. Others are located in the Piedmont, Blue Ridge, and Ridge and Valley Regions. The number of sites from which it was historically known has declined considerably over the last several decades. While the exact reasons for this decline are not completely understood, they certainly include habitat loss and degradation, deer browse, and succession of open wetlands to forest or dense shrublands. Other perceived threats include climate change, and a vulnerability to extirpation from fragmentation and isolation effects resulting in inbreeding depression and reduced population viability.

Until recently, conservation efforts have focused primarily on annual monitoring and habitat assessment in all areas of the state where Baltimore checkerspots occur, and on outreach efforts to landowners encouraging them to adopt conservation policies. However, even continued monitoring and habitat management of all known populations in the state are unlikely to ensure the long-term persistence of this species in Maryland, given the small number of remaining colonies and the distance by which they are separated. The majority of Baltimore checkerspot colonies in Maryland are small and apparently isolated. Conservation goals must therefore include not only protecting the remaining colonies, but also promoting the creation of new habitats and allowing for the introduction of Baltimore checkerspots to new sites, thus increasing the number of colonies in the state and promoting connectivity to prevent inbreeding depression.

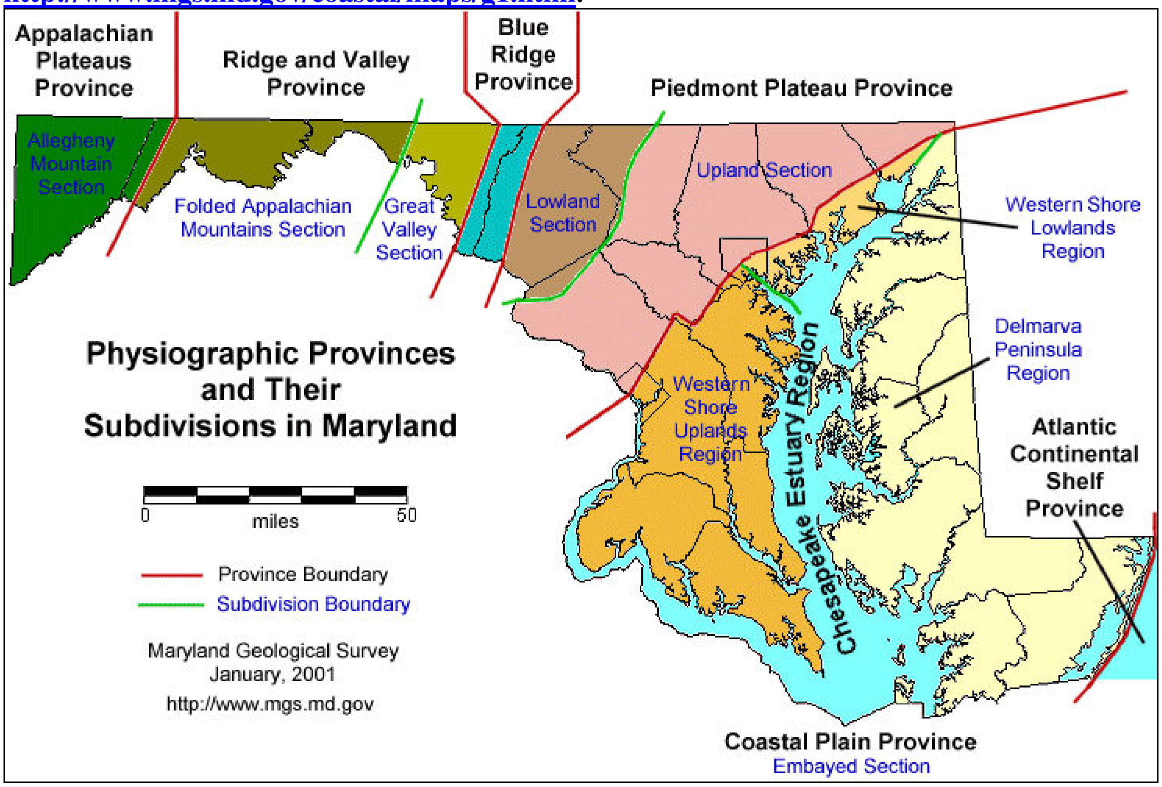
This conservation and management plan was initiated by the Baltimore Checkerspot Recovery Team (BCRT) of Maryland, a group of individuals representing federal, state, and county government agencies, university professors, local schools, and nature and education centers. The plan specifies a number of conservation goals put forth by the BCRT to conserve Baltimore checkerspots in Maryland. These include: (1) maintaining and monitoring current colonies; (2) locating wetland sites that could potentially support new colonies; (3) increasing management efforts to restore and enhance wetland habitats; (4) initiating a captive breeding and release program; and (5) conducting scientific research and monitoring to facilitate management actions and evaluate our results. The plan also outlines steps to measure progress over time (at least to some extent). For the most part, conservation actions taken in support of these goals will be implemented in the Maryland Piedmont in an effort to increase connectivity amongst the remaining Baltimore checkerspot colonies. The long-term objective is to link Maryland populations of Baltimore checkerspots with colonies in Pennsylvania where the species is more widely distributed and has seemingly stable colonies, at least in the western part of the state.

The plan outlines the life history, distribution and habitat requirements of the Baltimore checkerspot, as well as suspected threats. It then outlines conservation actions that will be taken to achieve the conservation goals detailed above. The plan also identifies information gaps that need to be addressed to inform long-term conservation and management strategies. It is designed to be modified as needed in response to management, monitoring, and research data.

1. INTRODUCTION

The Baltimore checkerspot (*Euphydryas phaeton* Drury) butterfly is a freshwater wetland species that ranges from Canada south into the eastern United States and into the mountains of Virginia and North Carolina, and west across the great Lakes Region (NatureServe 2012). In Maryland it is currently found on the Appalachian Plateau, the Blue Ridge, the Ridge and Valley Region and in the Piedmont (see Figure 1). It has a conservation status rank of S2, indicating that it is imperiled in Maryland because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres in the state) or because of factors making it vulnerable to extirpation (Maryland Natural Heritage Program [NHP] 2010). Species with this rank are actively tracked by the Maryland Department of Natural Resources (DNR), Wildlife and Heritage Service (WHS), NHP. There are currently 11 known Baltimore checkerspot in Maryland, most of which are isolated and supported by small wetland habitats.

Figure 1. Map Highlighting the Different Physiographic Regions in Maryland (Draft Version). Printed with permission of the Maryland Geological Survey. Available online at http://www.mgs.md.gov/coastal/maps/g1.html.



The Baltimore checkerspot became Maryland's State Insect in 1973 and is one of the most well-known insects in the state. This status, coupled with a downward trend in the population, has led many local organizations and individuals to become interested in addressing the conservation needs of this butterfly. Prior to 2012, several individuals had been independently monitoring wild populations of Baltimore checkerspots and trying to promote a greater public awareness of the threats to this species. Other organizations had initiated captive breeding programs and engaged in wetland restoration efforts to support the butterfly. While all of these efforts were well intentioned, few were successful and most occurred independently of one another with little or no collaboration between the different parties. As a result, many of the operations did not succeed despite a great deal of interest, time and labor.

In 2011, an attempt was made by Maryland NHP and local lepidopterists to get all the interested parties together for an initial meeting that would determine whether the group could develop a reasonable, scientifically-sound, collaborative conservation strategy that would protect this species throughout the state. In January 2012, following the first of these meetings, the Baltimore Checkerspot Recovery Team (BCRT) of Maryland was formed, comprising federal, state and county agency representatives, university professors, local schools, and nature and education center staff (see Section 9 for a complete list of BCRT partners). During the course of that first year, the BCRT met three times and drafted this conservation and management plan with the goal of protecting the Baltimore checkerspot in Maryland through habitat conservation and enhancement and by bolstering the population through captive rearing and release programs. The plan is designed to be largely proactive in that it will be enacted immediately, before the butterfly population declines to such an extent that any recovery efforts will be impossible or nearly so.

Section 1 – Short-term Action Items (to be completed within a year): none
Section 1 – Long-term Action Items (to be completed within the next two years): none

2. BIOLOGICAL AND HISTORICAL BACKGROUND

2.1 Taxonomy - The Baltimore checkerspot is a medium-sized butterfly in the family Nymphalidae, black in color with white, yellow, and red markings. It has been divided into at least two subspecies, *Euphydryas phaeton phaeton* and *E. phaeton ozarkae* (Masters 1968) although these classifications are not universally supported (Maryland Bowers, University of Colorado, pers. comm.). The two subspecies differ slightly in appearance, but more notably in their choices of habitats and host plants. *Euphydryas phaeton ozarkae* is recorded from Missouri, Arkansas, Kansas, and Oklahoma, is found on well-drained hillsides and utilizes False Foxglove (*Aureolaria* spp. Raf.) as its larval host plant (Masters 1968). *Euphydryas phaeton phaeton* is an eastern and northern subspecies, distinct from *E. phaeton ozarkae* in both habitat and host plant. It is associated with wetland habitats, where its larvae feed primarily on white turtlehead (*Chelone glabra* L.) (Scudder 1889, Bowers 1978; Stamp 1981a). The adult butterflies are relatively slow-moving (Bowers 1980), reportedly more so than the adult butterflies of *E. phaeton ozarkae* (Masters 1968). Despite these distinctions, Vawter and Wright (1986) found “very little genetic difference” among populations of *E. phaeton phaeton* from New York and *E. phaeton ozarkae* from Missouri “even though they are more than 1,000 km apart.” All references to Baltimore checkerspots in this document will deal specifically with *E. phaeton phaeton*, the subspecies found in Maryland, unless otherwise noted.

2.2 Life History - Stamp (1982a) reported adult Baltimore checkerspots flying in Virginia during June, while Bowers et al. (1992a) reported adults flying in July in Massachusetts and New York, suggesting a variance in flight period with latitude. In Maryland, they have been reported flying from late May into mid-July in Piedmont areas (Pat Durkin, Washington Area Butterfly Club, pers. comm.) and from early June to as late as July 20 in Garrett County (Bob Ringler, local lepidopterist, pers. comm.). Adults have been reported to nectar upon a variety of plants including common milkweed (*Asclepias syriaca*), dogbane (*Apocynum* spp.), and oxeye daisy (*Leucanthemum vulgare*) (see Section 4.1 for a more complete list of nectar plants).

After mating, Baltimore checkerspot females deposit eggs on the undersides of the leaves of white turtlehead (Scudder 1889, Bowers 1980). Eggs are deposited in clusters and may have multiple layers (Scudder 1889, Stamp 1981b; M Lustig, Carroll County Public Schools, Maryland, pers. obs.). Stamp (1982b) found that depositing an egg cluster took an average of 88 minutes, and that most females oviposited in the early afternoon. Females may oviposit next to the egg clusters of other females (Stamp 1982b). Bowers (1980) reported that eggs were deposited in clusters of 100 to 700 eggs; this is consistent with Scudder’s (1889) estimate of 100-600 eggs. Stamp (1982c) calculated a mean number of eggs per cluster of approximately 274. During her lifetime, which may last for 1-3 weeks (see Stamp 1982b and Opler et al. 2012), a female Baltimore checkerspot may lay multiple egg clusters, on occasion depositing two egg clusters in a single day and up to six egg clusters during her lifetime (Stamp 1982b).

Eggs develop over a period of about twenty days (Scudder 1889, Bowers 1978). During this time, the eggs change color, from bright yellow to tan and then red (Stamp 1981b). Eggs may be parasitized by a Trichogrammatid wasp (see reference in Stamp 1981b) but observed rates of parasitism can be quite low (Stamp 1981b). Upon hatching, first instar larvae (caterpillars) have no spines and are cryptically colored (Stamp 1982c). They begin feeding and build a communal web, often at the end of a turtlehead leaf (Scudder 1889, Bowers 1978, Bowers 1980). Second and third instar larvae are conspicuous with black spines. These older larvae spend more time outside the web than do the first instar larvae (Stamp 1982c).

Typically, third instar larvae will stop feeding in mid-August, although this time period may vary by latitude, elevation and climate (Bowers 1978). Detailed information on the overwintering behavior of Baltimore checkerspot larvae can be found in Bowers (1978). She observed that after they stop feeding, larvae will then thicken and compact a section of their web. Within the web, larvae molt into fourth instar caterpillars and enter diapause. While larvae are inside this diapause web, they reportedly do not feed at all, but may move slightly and will repair the web if it is damaged. About the end of October, larvae move out of the diapause web, descending to the leaf litter and debris below, forming a large aggregation. After about a week, groups of roughly 10-100 larvae move away from the main aggregation and roll up in leaves and debris. Leaf litter and snow cover likely protect larvae from the harshest effects of winter. Larvae may become active on warm winter days, move a short distance, and roll up in new leaves. Stamp (1982c) likewise found that larval groups were mobile between mid-November and mid-March, and that some larvae actually moved from one larval group to another.

As the weather warms, the larvae become active and begin feeding again. Although the timing for this likely varies across the range, Stamp (1982c) reported that larvae in Virginia were active by mid-April. In Maryland, larvae may become active as early as March (Barbara Kreiley, Black Hill Regional Park, Maryland, pers. comm.). These post-diapausal larvae do not spin a protective web. They will begin to feed on turtlehead, but often overwhelm the growing plants and in some cases defoliate them completely (Stamp 1982c). At this time, larvae may begin to feed upon other hosts and have been recorded from a variety of plants both in captivity and in the wild (see Scudder 1889 and references in Bowers 1992a). Section 4.1 provides a list of secondary host plants that are important for colonies of Baltimore checkerspots in Maryland.

Two specialist parasitoids, the Braconid wasp *Cotesia euphydryidis* Muesebeck (formerly *Apanteles euphydryidis* Muesebeck) and the Ichneumonid wasp *Benjaminia euphydryadis* Viereck, attack Baltimore checkerspot larvae (Stamp 1981a, 1982d and 1984). *Benjaminia euphydryadis* attacks pre-diapausal larvae only (Stamp 1984). *Cotesia euphydryidis* attacks pre-diapausal larvae, overwinters inside the host, and then emerges in the spring, when it is then also able to parasitize post-diapausal larvae (Stamp 1984). Stamp (1982a) reported that *Benjaminia euphydryadis* was the larger and rarer of these parasitoids at her study site in Front Royal, Virginia. Baltimore checkerspot larvae can also be parasitized by the exotic Tachinid fly *Compsilura concinnata* Meigen (Bowers 2012).

2.3 Unpalatability Related To Host Plants – All white turtlehead plants contain the iridoid glycoside catalpol and some plants also contain trace amounts of a second iridoid glycoside, aucubin (Bowers et al. 1993). Baltimore checkerspots are thought to sequester catalpol from the white turtlehead which is consumes. Bowers et al. (1992a) found that Baltimore checkerspot larvae that consumed white turtlehead developed into adult butterflies that contained “substantial amounts” of catalpol. When larvae were reared on white turtlehead, adult Baltimore checkerspot butterflies were both unpalatable and emetic to blue jays (*Cyanocitta cristata* L.); larvae and pupae were likewise unpalatable to the birds (Bowers 1980).

In 1978, Stamp (1979) observed Baltimore checkerspot females depositing eggs on English plantain (*Plantago lanceolata* L.), an introduced plant native to Europe, at two sites in New York State. Like white turtlehead, English plantain also contains both aucubin and catalpol (Bowers et al. 1992b, Stamp and Bowers 1994, Jarzomski et al. 2000). Bowers et al. (1992a) did not find a significant difference in total iridoid glycoside contents of Baltimore checkerspot butterflies which had been variously raised on white turtlehead or English plantain, although the relative amounts of aucubin and catalpol were different. When post-diapause larvae were reared on English plantain and the adult butterflies were later fed to blue jays, the birds found them to be "at least partially palatable" as the butterflies did not appear to be emetic (Bowers 1980). Bowers et al. (1992a) concluded that "larval feeding on [English plantain] is likely to make [Baltimore checkerspots] quite vulnerable to predators."

There are now entire populations of Baltimore checkerspots that feed on English plantain in Rhode Island (Bowers 2012), New York (Stamp 1979) and Massachusetts (Bowers et al. 1992a). It does not appear that this host plant shift has occurred in Maryland. While Bowers et al. (1992a) indicated that the use of English plantain by Baltimore checkerspots might contribute to a local and geographic range expansion, there may also be a cost. It addition to resulting in an apparently weakened defense against predators, English plantain appears to support large but short-lived colonies of Baltimore checkerspots, as increased numbers of larvae tend to overwhelm the available plantain and exhaust their food supply before their development is complete (Bowers et al. 1992a). In a similar instance, Edith's checkerspot (*Euphydryas editha* Boisduval) experienced local extirpations in areas where larvae began consuming the novel host *Collinsia torreyi* A. Gray in clear cut areas. After initially high breeding success, environmental perturbations decimated populations of *C. torreyi.* Subsequently, Edith's checkerspot was extirpated at these sites, whereas populations of Edith's checkerspot that had not shifted host plants and continued to utilize the typical rock-outcrop habitats remained intact (Thomas et al. 1996).

2.4 Habitat Characteristics – In all the physiographic regions of Maryland in which it occurs, the Baltimore checkerspot is found in early-successional, stream-fed wet meadows with few trees and shrubs. Large stands of white turtlehead are characteristic of all sites. Secondary host plants including arrowwood Viburnum (*Viburnum recognitum* Fernald) and honeysuckle (*Lonicera* spp. L.) are often present as well. In addition, all sites have nectar plants in or near the wetland that are in bloom when the adults are flying. (Section 4.1 lists both secondary host plants and nectar plants that are important for Baltimore checkerspots in Maryland). In general, sites are "weedy", with waist-high herbaceous vegetation including sedges and rushes and few woody plants. Wetland soils of Maryland colonies of Baltimore checkerspots are predominantly clay with a pH level of 6.8 or less. The water table varies from surface level to 8-9 inches below the soil; in many wetlands the water table varies throughout the wetland.

2.5 Population Dynamics - There is a paucity of data regarding the population dynamics of Baltimore checkerspots, but like other species of *Euphydryas*, it is thought to operate as a metapopulation. The term metapopulation was first coined by Richard Levins (1970) to describe a situation in which a given species is distributed among a network of habitat patches, each of which is capable of hosting a sub-population of that species. Individuals from the different habitat patches may interact with one another, with the result that sub-populations in some patches may go extinct while other patches may be colonized and form new sub-populations, resulting in a situation in which not every patch is occupied at any given time. Theoretically, the extinctions and colonizations should balance one another out and create a general equilibrium in which the entire population is capable of long-term persistence. Harrison et al. (1988) describes metapopulations for ecological purposes as "a set of populations (i.e., independent demographic units; Ehrlich 1965) that are interdependent over ecological time." They further state that "although member populations may change in size independently, their probabilities of existing at a given time are not independent of one another, because they are linked by processes of extinction and mutual recolonization, processes that occur, say, on the order of every 10 to 100 generations."

Baltimore checkerspots may be similar to other *Euphydryas* species including the bay checkerspot (*Euphydryas editha editha* Boisduval, formerly *E. editha bayensis* Sternitzky), which is believed to exhibit metapopulation dynamics. Mark-release-recapture studies by Ehrlich (1965) traced the movements of bay checkerspots at the Jasper Ridge Preserve in California between three isolated sub-populations and found that while the total number of individuals within the three sub-populations did not change when taken as a whole, the number of individuals within each patch did vary independently of one another. Migration between the patches was possible as there were no physical barriers to prevent it, but was somewhat limited due to the sedentary nature of the butterflies (Ehrlich 1961). In a second California study by Harrison et al. (1988), the sedentary nature of the bay checkerspot, coupled with the patchy distribution of its habitat and the frequent extinction of local populations, led researchers to conclude that the population constituted a discrete metapopulation. In the latter study, there was a large "mainland" population which served as a "source" population from which many butterflies emigrated to new patches.

Metapopulation dynamics have also been observed in the Glanville fritillary (*Melitaea cinxia* L.) in Finland. The Glanville fritillary does not have a main source population, but instead has a network of small habitat patches in relatively close proximity to one another, and the population appears to operate through genuine extinction-colonization dynamics (Hanski et al. 1994). Females were more likely to emigrant than males and to travel greater distances (Kuussaari et al. 1996). Kuussaari et al. also concluded that emigration was more frequent when patches had a low density of butterflies and when the patch was surrounded by open habitat with no barriers to movement. Larger habitat patches with a high density of nectar sources were more likely to be colonized than smaller patches with fewer resources.

While we do not know for sure whether the Baltimore checkerspot populations operate as metapopulations, the species does exhibit many of the characteristics of both the bay checkerspot and the Glanville fritillary in that it is relatively sedentary, occupies small and often isolated habitat patches, and in some wetlands in the Piedmont, is intermittently observed from year to year. While the latter observation could be the result of simply surveying at the wrong time of year or inability to detect the butterfly, it could also indicate the absence of the species from certain patches in a given year. It is unlikely, at least in the Piedmont Region, that there is a large mainland population that serves as the source population for other patches, although that may not always have been the case. Instead, it appears to occupy several small patches, most of which are apparently separated from one another by large distances.

2.6 Historical and Current Distribution – Baltimore checkerspots have exhibited a significant decline in Maryland since the 1960's and 1970's when local entomologists began accumulating detailed field notes on butterfly species distributions. The historical distribution of the Baltimore checkerspot in Maryland based on these data is depicted in Figure 2. A distinction is made between breeding colonies and adult sightings. Breeding colonies refer to those sites where breeding was confirmed (i.e., larvae or ovipositing females were observed) or suspected based on the presence of multiple adult butterflies typically observed over multiple years. Adult sightings denote areas where one or two adults were seen in a single year, and the existence of a colony was never confirmed. In part, this is likely the result of a shift in survey methods over the last several decades. With the recent knowledge of the Baltimore checkerspot's decline, surveyors today are inclined not only to count the numbers of butterflies seen, but also to seek out and estimate the size and quality of suitable breeding habitat wherever a butterfly is found in an effort to monitor and maintain the habitat. Several decades ago, however, when populations of the Baltimore checkerspots appeared secure, many lepidopterists were content to simply record the locations of adult butterflies and did not always take time to perform the above survey tasks or document the presence of turtlehead, which is often difficult to identify because it blooms months after the butterfly's flight period. Further, Baltimore checkerspots are known to be fairly sedentary and are not generally expected to stray far from their breeding habitat. Therefore, although we make the distinction here, it is very possible that many of our "adult sightings" once represented the presence of "breeding colonies."

By contrast, the current locations for wild (non-introduced) Baltimore checkerspot colonies are represented in Figure 3. All sites represent confirmed colony sites that were last observed between 2010 and 2012.

Figure 2. Historic distribution map of the Baltimore checkerspot in Maryland. Map contains approximate locations for all known, wild colonies (represented by open red diamonds) and adult sightings (represented by filled red dots) in Maryland from the 1960's to 2009.

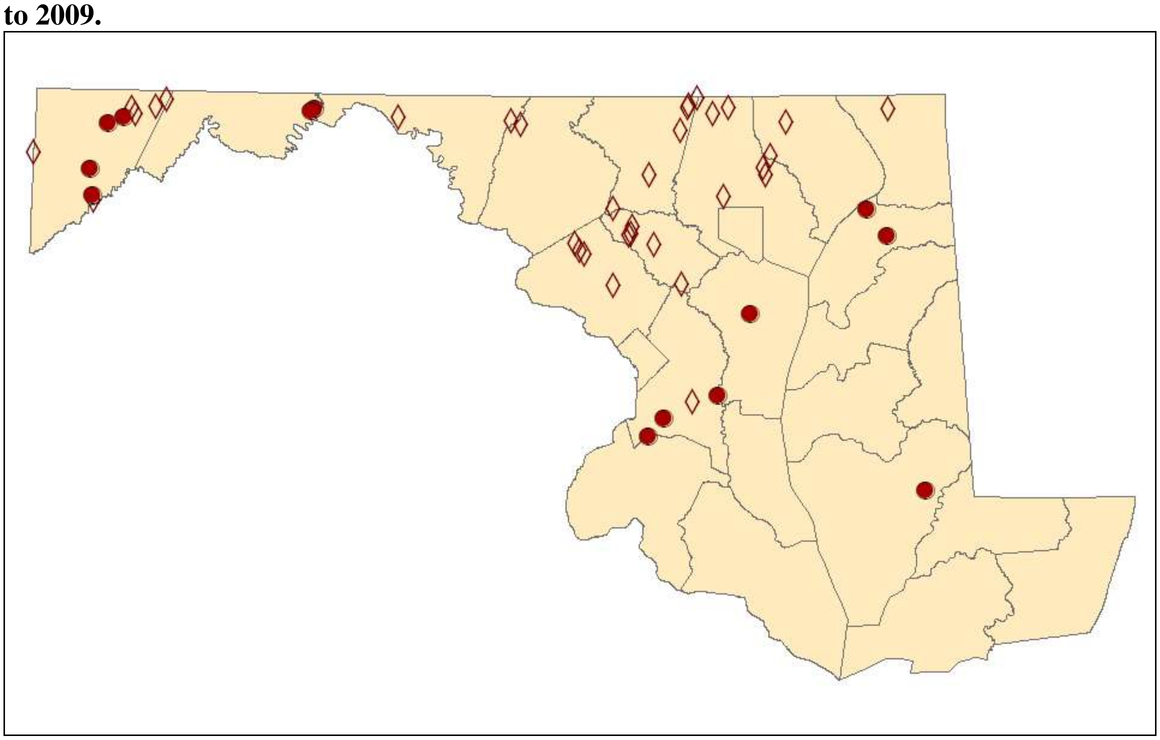
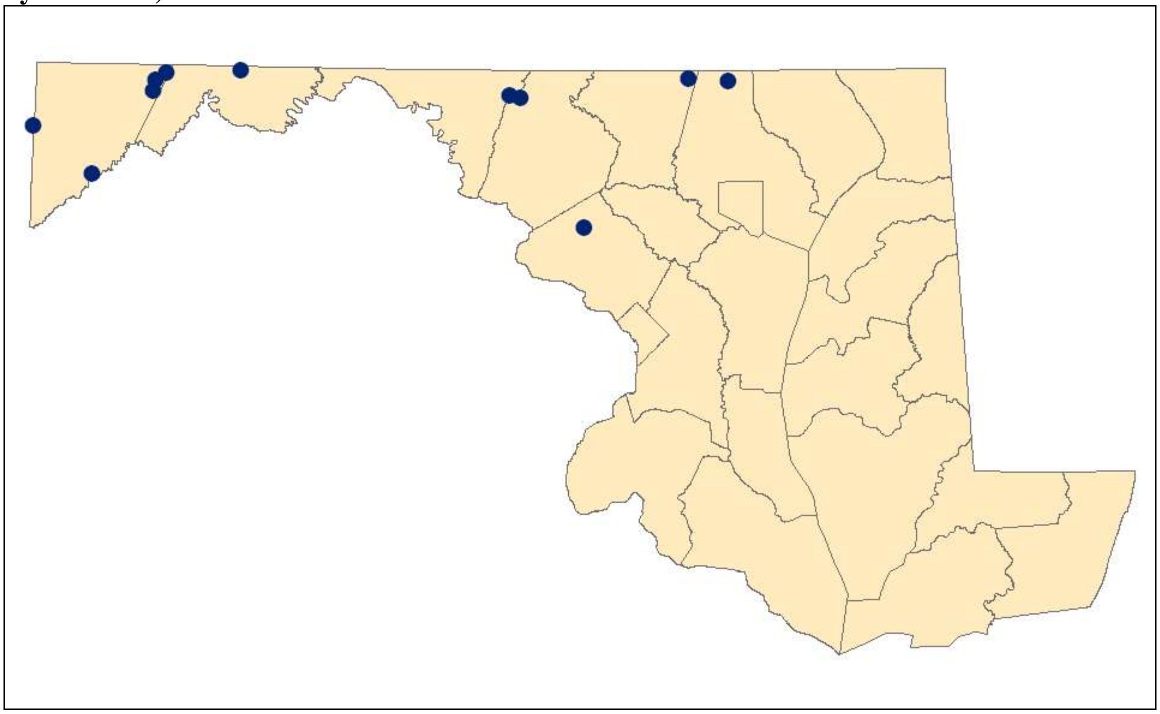


Figure 3. Current distribution map of the Baltimore checkerspot in Maryland. Map contains approximate locations of known, wild Baltimore checkerspot colonies (represented by blue dots) that were confirmed between 2010 and 2012.



2.7 Threats to Baltimore Checkerspot Populations – Reasons for the population decline likely include a number of factors:

- Direct destruction of wetland habitat;
- Lowered water tables of surface wetlands caused by ditching and containment, often as a result of development;
- Loss of open, sunny habitat for larval host and nectar plants as a result of forest succession, wildfire suppression or beaver control;
- Loss of larval clusters and vegetative resources due to deer browse;
- Decline of native host and nectar plants due to the proliferation of non-native invasive plants;
- Colony isolation and inbreeding depression as a result of habitat fragmentation;
- Local effects of global climate change;
- Insect predators and parasitoids.

Habitat destruction and degradation in the form of ditching, succession, or invasive plant proliferation have certainly played a major role in the decline of Baltimore checkerspots in Maryland and is probably one of the major causes for overall population declines in the state. Habitat destruction has also fragmented the landscape, creating what are now essentially remnant colonies that are often small, isolated and vulnerable to the effects of inbreeding depression. Isolated colonies may also be more vulnerable to stochastic weather events and disease outbreaks. The impacts of deer browse, predation and parasitism might also be exacerbated in small, isolated colonies. Finally, the impact of global climate change may be playing a role on the declining distribution of Baltimore checkerspots in Maryland; this topic is discussed in detail in Section 5.6.

Section 2 – Short-term Action Items (to be completed within a year): none
Section 2 – Long-term Action Items (to be completed within the next two years): none

3. WILD COLONY SURVEYS

The Maryland NHP maintains a database for all known wild colonies of Baltimore checkerspots in the state and will continue monitoring these colonies with assistance from local lepidopterists and BCRT partners on an annual basis. On public lands, monitoring responsibilities will be undertaken by BCRT members on a voluntary basis in order to ensure continuous monitoring efforts of as many wild colonies as possible. Sites on private land will be surveyed primarily by Maryland NHP. If possible, each site should be visited multiple times each year, since weather conditions, time of day, and fluctuations in the adult flight period can all affect observations. A wild colony survey field form is included as Appendix I. This form includes sections for both adult and larval data and should help standardize wild colony assessments.

3.1 Survey Areas and Methods – While BCRT captive rearing and reintroduction efforts will be focused on the Maryland Piedmont, wild colony surveys will be extended to include colonies on the Appalachian Plateau, the Blue Ridge, the Ridge and Valley and the Piedmont. BCRT partners will also continue to search for new colonies, primarily in the Maryland Piedmont, in areas that fall within 10 km of known wild colonies. We will also survey areas that are within 10 km of BCRT organizations that are engaged in wetland enhancement or restoration on their property for the purpose of new colony establishment. Section 4.1 discusses known characteristics of suitable wetland habitats for wild colonies; Section 5.1 provides an explanation for the 10 km distance metric.

There are several suggested strategies for monitoring butterflies at a given site. The most frequently used method for monitoring a specific species of butterfly is the Pollard Walk (Pollard 1977, Pollard 1982, Pollard & Yates 1993). Pollard Walk surveys employ fixed travel routes during counting (i.e., walking a transect). Each survey is conducted in a consistent manner with respect to area covered and time spent, and allows for frequent replication over a period of hours, days or weeks. Pollard Walks are generally recommended for long-term monitoring of a single species and can be carefully designed to focus on specialized habitats that support rare and endangered species (Royer et al. 1998, Collier et al. 2006). Thomas (1983) suggests an adaptation of Pollard Walk techniques that allows for comparisons of butterfly populations at multiple sites.

At sites in which a Pollard Walk is not practical (i.e. very small wetlands), an observer can instead use Checklist Surveys. These are simple to execute; an observer may simply identify a wetland site where Baltimore checkerspots are known or likely to occur and count the number of individuals present, making every effort to avoid re-counting the same individuals. Although this method is procedurally simple, it is subject to observer bias, making it difficult to compare results from year to year and sometimes masking population trends. This can be overcome to some extent by enforcing standards that make the survey method more rigorous, for example, using a single observer at a given site, or counting the number of butterflies observed within a set time period. Royer et al. (1998) provide a good overview of both methods.

Section 3 – Short-term Action Items (to be completed within a year):
a. Assign different individuals to monitor wild Baltimore checkerspot colonies in Maryland.
Section 3 – Long-term Action Items (to be completed within the next two years): none

4. HABITAT SURVEYS

Habitat surveys can be useful both in assessing site conditions for known wild colonies of Baltimore checkerspots and in determining the potential of unoccupied wetland sites to support new populations. A wetland habitat assessment field form is included as Appendix II. This form can be used to collect data on wetlands that are occupied by Baltimore checkerspots and should help standardize assessments.

4.1 Survey Areas and Methods – Habitats for wild colonies should be assessed whenever wild colonies are surveyed, and more frequently when there are identified threats to the site, such as succession to closed canopy forests or dense shrubland, or encroachment by invasive species. Habitat surveys of wild populations will include colonies on the Appalachian Plateau, the Blue Ridge, the Ridge and Valley Region and in the Piedmont. Searches for potential habitat should focus in areas within 10 km of known wild colonies and within 10 km of BCRT restoration sites. Section 5.1 provides an explanation for the 10 km distance metric.

Wetland habitats suitable for Baltimore checkerspot colonies may include the following plants:
(a) Pre-diapause (primary) larval host plant, white turtlehead; attempts should be made to quantify the amount of white turtlehead in the wetland by estimating the area covered and/or by estimating the number of plants present. Use of the following categories is recommended when estimating the number of plants: (1) <10 stems, (2) <50 stems; (3) <100 stems; (4) hundreds of stems; or (5) thousands of stems.
(b) Post-diapause (secondary) larval host plants, including one or more of the following (this list was compiled based on the observations of BCRT partners. Plants are listed from the most frequently used to the least frequently used secondary larval hosts):

- Penstemons (*Penstemon* sp. Schmidel, including *P. digitalis* Nutt. ex Sims and especially *P. hirsutus* (L.) Willd.)
- Narrow-leaved Plantain (*Plantago lanceolata* L.) – introduced, but nevertheless may serve as an important secondary host plant when turtlehead is scarce.
- Arrowwood Viburnum (*Viburnum recognitum* Fernald)
- Mapleleaf Viburnum (*Viburnum acerifolium* L.)
- White Ash (*Fraxinus americana* L.)
- Lousewort (*Pedicularis* spp. L.)
- Honeysuckle (*Lonicera* spp. L.) – native and introduced species are used
- Blue Toadflax (*Nuttallanthus canadensis* (L.) DA Sutton) – they may eat this when little else is available but do not prefer it.

(c) Nectar plants that bloom during the adult flight period, including:

- Milkweed (*Asclepias* spp. L.) – in the Maryland Piedmont, the first choice should be common milkweed, (*Asclepias syriaca* L.), because swamp milkweed (*A. incarnata* L.) blooms too late for the adults to use for nectar. Butterflyweed (*A. tuberosa* L.) blooms from late June to mid-July so will provide some nectar, but should be planted only in well-drained soil.
- Dogbane (*Apocynum spp.* L.) – in the Maryland Piedmont, this should be *Apocynum cannabinum* L.
- Daisy fleabane (*Erigeron annuus* (L.) Pers.)
- Hoary Mountain Mint (*Pycnanthemum incanum* (L.) Michx.)
- Short-toothed Mountain Mint (*Pycnanthemum muticum* (Michx.) Pers.)
- Virginia Mountain Mint (*Pycnanthemum virginianum* (L.) Rob. & Fernald)
- Wild blackberry (*Rubus spp.* L.)

In addition to the required plant species, wetlands should be relatively free of invasive species, and persist in open, sunny areas with limited or no canopy cover. Soil and site hydrology characteristics, including the source of the wetland, water table depth, soil type and pH, should be noted; pH paper can be used to quickly assess soil levels and can be purchased from most biological supply catalogs. Any threats to hydrology should be considered, for example, the potential threat of wetland drainage or changes in water quantity or flow patterns when nearby areas are developed. Topography should also be noted; the presence of hummocks throughout the wetland, for example, is characteristic of many Baltimore checkerspot sites. Impacts of deer should be evaluated and actions to protect turtlehead plants from deer browse should be taken when necessary. See Section 6.4 for more information of preventing deer browse on turtlehead.

All surveyors are encouraged to document changes to the habitat over time. Photo point monitoring can be very useful for this purpose. By periodically and repeatedly taking photographs at a site from the same point(s) each time, one can quickly and effectively document major changes in vegetation. In some cases it may also be worthwhile to visit sites during the winter to assess conditions such as snow cover which may have an impact on overwintering larvae.

Section 4 – Short-term Action Items (to be completed within a year): none
Section 4 – Long-term Action Items (to be completed within the next two years): none

5. LANDSCAPE LEVEL EVALUATION

In order to maintain existing populations of Baltimore checkerspot colonies and create new colonies to enhance metapopulation dynamics, we must consider how the current landscape will foster interaction and interbreeding between individuals at multiple sites. Habitat connectivity, barriers to movement and climate change dynamics will all impact the movement of Baltimore checkerspots across the landscape. Specifically for this plan, our focus will be on facilitating the movement of individuals between populations in the Piedmont, including Harford, Baltimore, Montgomery, Howard, Carroll, and Frederick Counties. We may consider a larger landscape as the project progresses.

5.1 Methods – Landscape level evaluation has been partially completed in ArcMap GIS Version 9.3. We began by mapping all existing Baltimore checkerspot colonies in the six counties mentioned above. We then mapped the locations of all BCRT organizations currently engaged in on-site wetland restoration activities for the purpose of creating new habitats for Baltimore checkerspots. Two buffers were placed around each colony and around each BCRT organization, a 2 km buffer and a 10 km buffer (Figure 4). These buffers are meant to represent the potential dispersal capabilities of Baltimore checkerspots as reported by NatureServe (2012); Baltimore checkerspots are estimated to be able to travel 2 km through "unsuitable habitat" and 10 km through "suitable habitat." These dispersal distances are estimates based largely on what is known about the dispersal of other species of Lepidoptera. The actual dispersal capabilities of Baltimore checkerspots have not been studied and are largely unknown. These buffer distances may be changed as more information on Baltimore checkerspot dispersal becomes available.

Even highly localized, so-called "sedentary" Lepidoptera have been frequently observed to be capable of dispersing distances of one to several kilometers (Hanski & Kuussaari 1995). Singer and Hanski (2004) specifically discuss various studies of checkerspot dispersal (both field studies and modeling applications), concluding that most dispersing individuals travel within 2.5 km of source populations, although a small percentage of individuals can and have been noted to travel as many as 4-5 km. Studies of bay checkerspot butterflies found that measured dispersal distance rarely exceeded 4.5 km (Harrison 1989), although this may be due to several factors and is not necessarily due to an inability of adult bay checkerspots to travel greater distances. Long-distance dispersal may be an infrequent event and therefore difficult to quantify.

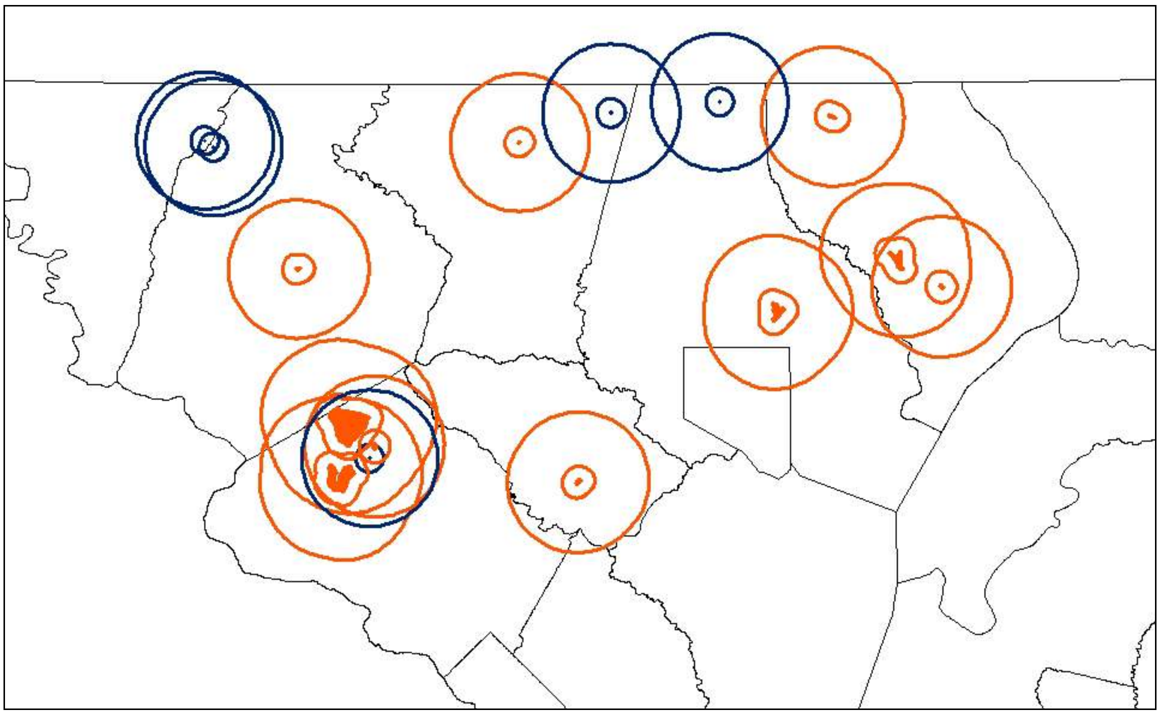
The 2 km and 10 km buffers around wild Baltimore checkerspot colonies indicate areas in which the adult butterflies are thought to be able to disperse (Figure 4). In some areas, these buffer zones overlap with 2 km or 10 km buffer zones around BCRT sites where wetland restoration efforts are in progress (Figure 4); buffer zones around these BCRT sites indicate the areas in which adult butterflies from newly introduced colonies will likely be capable of dispersing. The areas in which these various buffers overlap one another on the landscape will be targeted for wetland restoration and enhancement and eventually, reintroduction activities, as spatially they have the greatest chance of fostering interaction between different populations of Baltimore checkerspots. We will attempt to establish connections between current and newly established colonies through several means described in Section 5.3.

5.2 Identification of Managed Lands – Geographic Information Systems (GIS) allow for the display of geographically referenced information, allowing users to visualize data and trends in the form of maps and other media. Often, the data is available in "layers" which may be described as a visual representation of a geographic dataset (Esri 2012). For the purposes of this plan, for example, a data layer may be a set of points showing the locations of all the historic Baltimore checkerspot locations in a defined area (as in Figure 2). Multiple data layers will be examined as the project progresses, including land use layers, aerial imagery, quad maps and others.

The primary mapping software that we will employ will be ArcGIS Version 9.3 produced by the Environmental Systems Research Institute, Inc. (Esri). There are a number of "protected lands" data layers that can be accessed using ArcGIS software that identify properties on public lands that may support potential Baltimore checkerspot habitat. These include federal, state and county owned or managed properties as well as properties of non-profit organizations, such as the Nature Conservancy. Managed lands that fall within the 2 km and 10 km buffers will be targeted for surveys of suitable habitat that could potentially support Baltimore checkerspot colonies. Surveys will focus on areas in or near stream valleys and in areas recommended for survey by public land managers familiar with the properties (Section 6.1 provides further details on determining wetland suitability for Baltimore checkerspots). The land manager for all public sites visited should be contacted prior to visitation.

If there are significant gaps in the connectivity of managed lands, we may extend our survey efforts to private lands. Necessary landowner contacts must be made and permission obtained before visiting private lands.

Figure 4. Section of a Maryland County map highlighting the locations of current, wild Baltimore checkerspot colonies (central blue point) and the locations of BCRT organizations (central orange point or shaded polygon) where wetland restoration is ongoing or completed. The small, inner circles or polygons represent a 2 km buffer around each site while the larger, outer circles or polygons represent a 10 km buffer around each site. Such maps will aid in determining potential areas of the landscape on which to focus wetland restoration efforts and create or enhance Baltimore checkerspot dispersal corridors.



5.3 Identification of Dispersal Corridors – Dispersal corridors can allow for the movement of Baltimore checkerspot butterflies between sites by providing habitat through which they can disperse. Potential corridors connecting wetland habitats can include managed lands on public or private land, power line or natural gas rights-of-way, transmission lines, rivers and streams, and railroad tracks. If additional corridors are identified we will map these as well. Barriers to movement should also be identified and mapped; these may include large urban areas, areas of dense forests, or interstate highways. Linear habitats including rights-of-way, may be important for maintaining connectivity in cases where colonies are separated by significant barriers. It is crucial that we work with power company personnel to ensure whenever possible that these areas are being managed in a way that does not harm Baltimore checkerspots or their habitat. Herbicides may kill host and nectar plants and mowing while larvae are actively feeding may result in direct larval mortality. Rights-of-way in the Maryland Piedmont are maintained by Baltimore Gas and Electric (BGE), Trans-Potomac or Potomac Electric Power (PEPCO); in Frederick County some rights-of-way are managed by First Energy.

5.4 Identification of Potential Wetland Habitat – The Maryland NHP Vegetation Plot Database may serve to identify wetland areas in the Maryland Piedmont that support populations of white turtlehead. Aerial imagery, quad maps and various ArcMap GIS data layers will also be used to identify wetlands, some of which may provide suitable or restorable habitat for Baltimore checkerspots. Wetlands of Special State Concern and bog turtle wetlands that fall within the buffered areas will be targeted for field surveys. Additional wetlands can be investigated as necessary. Because bog turtles are federally listed species vulnerable to collection, these areas will be investigated primarily by Maryland NHP in order to ensure that the locations remain protected; many are on private land and require landowner permission for access.

BCRT members in the Maryland Piedmont may be able to work with local government agencies to identify additional wetlands that would benefit from restoration efforts. For example, in Harford County, the Department of Public Works (DPW) identified multiple water resources engineering projects within 10 km of each BCRT organization in the county. There may be potential to establish turtlehead in some of the stream valley sites where the county is involved in mitigation projects. Storm water management areas identified by DPW may also provide an opportunity for turtlehead propagation. Similar efforts could be considered in other counties as well.

A process will be put in place to determine whether a given wetland is suitable – in either its current state or through restoration activities – to support Baltimore checkerspot colonies. This process will consider the presence or absence of turtlehead at the site, the suitability of the site for turtlehead propagation (see Section 6.2), the ability of the site to support secondary host plants as well as appropriate nectar plants, and the ability of the BCRT organizations to maintain the site as an open meadow. Further considerations are discussed in Section 6.1, and a field form for use in determining the suitability of a wetland for restoration is included as Appendix III.

5.5 Plans for Maintaining Metapopulation Dynamics – Ideally, many Baltimore checkerspot wetlands in the Maryland Piedmont will be within 2 km of one another to foster interaction and interbreeding amongst different populations of butterflies. As stated previously, Baltimore checkerspots are thought to be capable of traveling distances of 2 km even through "unsuitable habitat" (NatureServe 2012). Given the development pressures and fragmented nature of the Piedmont, we should assume that unless an obvious corridor is available, Baltimore checkerspots will often need to traverse "unsuitable habitat." Thus, an attempt should be made to connect sites by a distance of 2 km or less whenever possible. Distances connecting sites should not exceed 10 km even in areas of suitable habitat unless new research finds that dispersal capabilities of Baltimore checkerspots can exceed this distance.

Monitoring must be done at all Baltimore checkerspot sites to track numbers of individuals, habitat conditions, and potential threats (see Sections 3.1 and 4.1 for details). If time and funding permit, mark-recapture studies may be considered to see whether or not individuals are moving between sites. See Section 7.1 for further discussion on mark-recapture studies.

5.6 Regional Climate Change Considerations – Two climate models were used to determine the potential impacts that climate change may have on Baltimore checkerspots. The first climate model was NatureServe's Climate Change Vulnerability Index (CCVI); the model was run by Dana Limpert (Maryland NHP). The CCVI considers the magnitude of change predicted to occur within the range of a species and measures that against the physiological characteristics of that species. Using this tool, we first examined the distribution of Baltimore checkerspots within the state and estimated how much of their range was likely to be impacted by a long-term change in climate. We then looked more specifically at various aspects of the Baltimore checkerspot's ecology and life history (e.g. habitat, dispersal ability, drought sensitivity, host plant requirements, etc.) to assess its sensitivity to climate change. According to the CCVI, Baltimore checkerspots are in the most critical category and are ranked "extremely vulnerable" to climate change. While this is of concern, the rank is based largely on aspects of the Baltimore checkerspot's life history that are not fully understood or are completely unknown. Thus, while worthy of consideration, the result is based largely on assumptions.

The second climate model used was the Maximum Entropy (MAXENT) Climate Envelope Model (CEM); the results of this model were developed by Dana Limpert (Maryland NHP) and Heather Cunningham (Natural History Society of Maryland). MAXENT is one of several CEMs used to predict the distribution of a species by inferring its environmental requirements (temperature, rainfall, etc.) from localities where it is currently known to occur (Hijmans & Graham 2006). CEMs have been successfully used by Willis et al. (2009) to predict suitable reintroduction sites for two species of butterflies in the United Kingdom in areas that were initially beyond the range of both species. Unlike the CCVI, the MAXENT model is based on a combination of climate data as well as Baltimore checkerspot locality data (presence-absence data) not only for Maryland but for all states in which it is tracked; these include Delaware, North Carolina, Pennsylvania and others (see NatureServe 2012 for a complete list). The MAXENT model is probably a better indicator of the projected distribution of Baltimore checkerspots because it is based on real data (although the datasets may be incomplete for states in which the species is not tracked). MAXENT models climate space – not habitat – and the resulting maps (Figures 5, 6 and 7) project the suitability of climate space for Baltimore checkerspots throughout the state and in the surrounding region:

Figure 5. Current Maximum Entropy (MAXENT) Projection of climate space for Baltimore checkerspots in the mid-Atlantic Region; cool colors indicate highest probability of occurrence, warm colors represent lowest probability of occurrence. Black dots (point data) represent Baltimore checkerspot colonies for Maryland only.

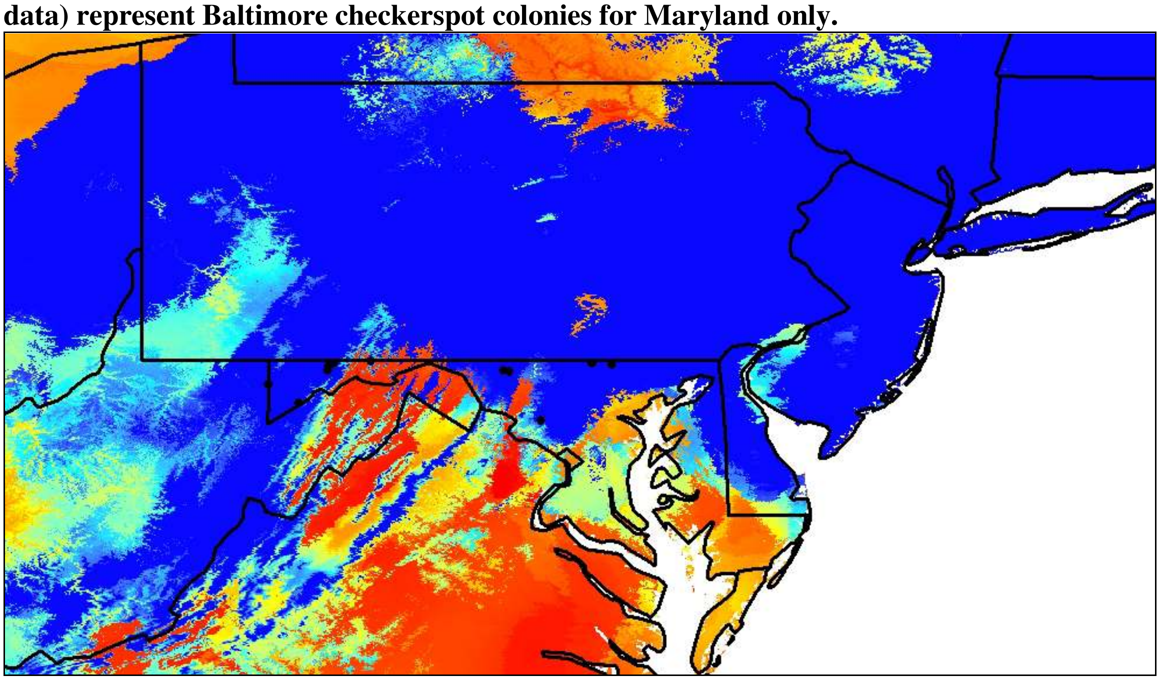


Figure 6. Year 2020 Maximum Entropy (MAXENT) Projection of climate space for Baltimore checkerspots in the mid-Atlantic Region; cool colors indicate highest probability of occurrence, warm colors represent lowest probability of occurrence. Black dots (point data) represent Baltimore checkerspot colonies for Maryland only.

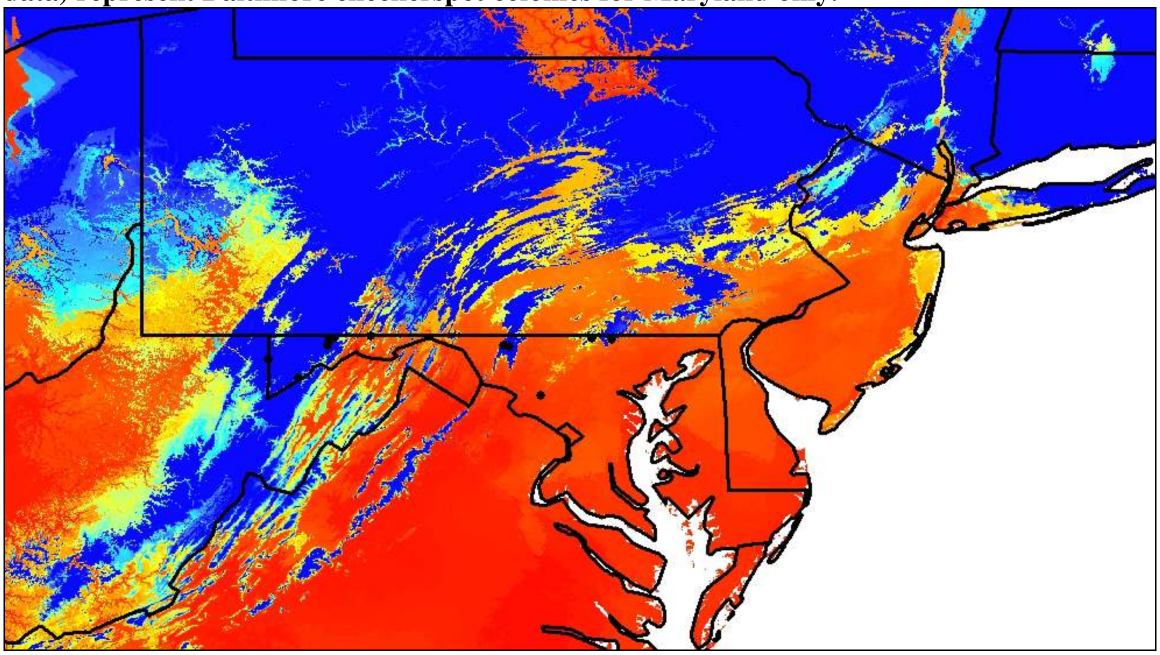
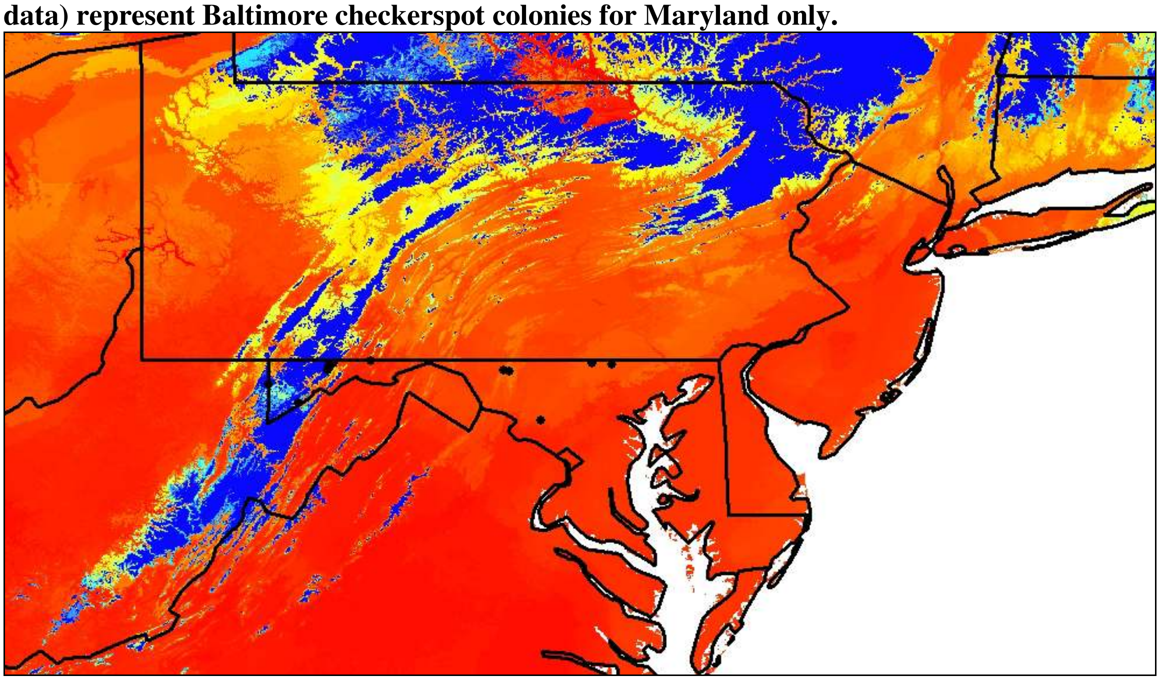


Figure 7. Year 2050 Maximum Entropy (MAXENT) Projection of climate space in 2050 for Baltimore checkerspots in the mid-Atlantic Region; cool colors indicate highest probability of occurrence, warm colors represent lowest probability of occurrence. Black dots (point data) represent Baltimore checkerspot colonies for Maryland only.



The MAXENT models indicate that the changing climate will not support persistent populations of Baltimore checkerspots in the Maryland Piedmont. The trend shows the species persisting in higher elevations and indicates a shift north of the Maryland Piedmont. While this is a projection that may or may not come to fruition, it nevertheless warrants serious consideration as we move forward. While we will not rule out the possibility that the Maryland Piedmont could harbor future populations of Baltimore checkerspots, we will focus our efforts on creating corridors that allow the species to move into the northern stretches of the Piedmont Region and into Pennsylvania. We will contact individuals at the PA Department of Conservation and Natural Resources (DCNR) to propose a collaborative effort that will extend dispersal corridors into Pennsylvania and perhaps even further north, if deemed necessary.

We will also contact individuals at state agencies in surrounding states to determine the status of Baltimore checkerspot colonies there, especially where the species is not tracked. While many colonies are reported to be doing well to our north, less is known about colonies to our south. On the Atlantic Coast, North Carolina is the only state south of Maryland that tracks Baltimore checkerspots; it is imperiled there.

We will need to continually assess both wild and introduced colonies of Baltimore checkerspots, particularly those in the most at-risk portions of the state, for possible negative impacts of climate change. Literature reviews for other butterfly species impacted by climate change may be helpful in this regard (see Heikkinen et al. 2010 for an example). Long-term survey data from Massachusetts, for example, has shown a significant climate-induced range shift in Lepidoptera, characterized by northward expansions of warm-adapted species and retreat of cold-adapted species (Breed et al. 2012). The numbers of Baltimore checkerspots in Massachusetts were shown to have increased; this is believed to be due to recent wetland restoration efforts as well as its use of English plantain as a primary host plant (Sharon Stichter, Massachusetts Butterfly Club, pers. comm.).

<u>Section 5 – Short-term Action Items</u> (to be completed within a year):
a. Review maps for potential managed areas, wetlands, and corridors. Make contacts with land managers and conduct site visits to look for potential Baltimore checkerspot habitats. Focus on areas near stream corridors.
b. Work with Maryland NHP staff to locate wetlands that have white turtlehead.
c. Contact Pennsylvania DCNR to explore collaboration possibilities for corridor creation.
d. Contact other NHPs and local lepidopterists societies in other states to determine the current status of Baltimore checkerspot populations.

<u>Section 5 – Long-term Action Items</u> (to be completed within the next 2 years):
a. Review literature on climate change impacts on Lepidoptera.
b. Contact power company personnel to explore the possibility of collaborative management of potential Baltimore checkerspot corridors.

6. REINTRODUCTION SITES: EVALUATION AND RESTORATION

6.1 Determining Wetland Suitability – Before any butterflies can be released to a wetland site, and even before any restoration activities take place, the potential of a given wetland to provide habitat for Baltimore checkerspots should be carefully assessed. Since we really don't have complete knowledge of what makes a given habitat suitable or unsuitable for Baltimore checkerspots, our assessments will be based largely on what we know about existing habitats in Maryland. Initial assessments must be completed in a manner consistent among sites. A field form for determining wetland suitability is included as Appendix III. This form contains more detailed information than the habitat assessment field form included as Appendix II. While the habitat assessment is geared toward maintaining sites that already support Baltimore checkerspots, the wetland suitability field form is meant to evaluate the potential of a given site to meet all the requirements necessary to sustain a Baltimore checkerspot colony following appropriate restoration activities.

Of primary importance is to make some assessment of the long-term viability of the wetland. For example, what is the water source of the wetland, and is that source vulnerable to contamination (i.e., pesticide or fertilizer run-off) or drainage (i.e., is it near a new or proposed development)? If the site is on private land, is there a commitment from the landowner to continue to manage the site for the sustainability of Baltimore checkerspots? Is this agreement in the form of a handshake or is the landowner prepared to commit to legal protection in the form of a conservation easement, for example? Finally, is the wetland likely to be threatened by any other factors in the vicinity, such as additional developments, insecticide spraying or ATV use on site? Because wetland restoration can be difficult, costly, and time-consuming, every effort should be made to focus on sites that will be protected in the long-term and are buffered to some extent by natural areas to protect the integrity of the wetland.

The availability of turtlehead, as well as secondary host plants (especially if turtlehead is limited due to early summer larval use or deer browse) and nectar plants, particularly those that are in bloom when adult butterflies are active, is critical. Section 4.1 contains a list of secondary host plants and nectar plants. If turtlehead is present but in limited abundance, it is a good indicator that soils and hydrology are adequate and that attempts to plant more of it may be met with success. If turtlehead is absent from the wetland, soil type, soil pH, and water table levels should be evaluated to see if conditions are suitable. As mentioned in Section 2.6, turtlehead wetlands generally have clay soils with a pH of 6.8 or less. While water table depth may vary, even within a wetland, Denise Gibbs (Black Hill Regional Park, Maryland, pers. obs.) has found that if the water table is approximately 8 inches below the ground, turtlehead will probably be successful. Experiments to plant turtlehead in areas with varying water table depths are currently being undertaken by Black Hill Regional Park in Montgomery County (herein referred to as Black Hill).

The presence or absence of other plants common in Baltimore checkerspot sites should be recorded. Some combination of obligate wetland species including native rushes, sedges, and perennial herbaceous species like swamp milkweed and cardinal flower (*Lobelia cardinalis* L.) is desirable and may even be required for long-term persistence of Baltimore checkerspot colonies. At one site in Montgomery County, larvae almost always pupate on the tallest rushes, and adults seek shelter from the sun by perching in the shade provided by the broad leaves of swamp milkweed and cardinal flower (D Gibbs, pers. obs.). Natural or man-made corridors are also important for movement of the post-diapausal larvae from their overwintering site to the secondary host plants. Larvae at the Montgomery County site have been observed moving en mass along dirt roads, fallen logs, and muddy banks of narrow feeder streams to reach secondary host plants (D Gibbs, pers. obs.); some of these features can serve as corridors for adults as well. The presence of invasive plants should also be noted, including the species and some general estimate of the area covered. Assessments should be made yearly and in a consistent manner in order to detect the spread of invasive species.

The amount of sunlight that the wetland receives is also important. Succession to forest or dense shrubland is a threat to many Baltimore checkerspot habitats, so any encroachment of trees or large shrubs that threaten the open nature of the wetland should be noted. Photo point monitoring can be very useful for this purpose. By periodically and repeatedly taking photographs at a site from a given point(s), one can quickly and effectively document major changes in vegetation.

Finally, we will record any noticeable impact from deer browse, and attempt to assess the severity of deer browse to determine whether or not some kind of protection for turtlehead, secondary host plants or nectar plants is warranted. Section 6.4 contains additional information on deer browse.

6.2 Propagation of Turtlehead, Secondary Host Plants and Nectar Plants – At most wetland sites, we will need to plant white turtlehead before Baltimore checkerspots can be released. This section outlines several methods for propagating turtlehead. The techniques outlined in this section are intended to be used as part of a coordinated strategy for restoring and connecting known Baltimore checkerspots sites as part of this Conservation and Management Plan. However, there are several ways for private citizens, schools, and local organizations to provide additional assistance with conservation efforts. An educational brochure and web page are currently being drafted and will include a list of the most effective ways that concerned citizens can become involved in Baltimore checkerspot conservation.

<u>Method 1</u>: Cuttings (the most reliable, least time-consuming and least expensive method)

Outdoors: Using sharp clippers or scissors, take 6-inch stem tip cuttings anytime in June. Remove the lower leaves from the cuttings and insert at least one node (preferably two) into a rooting hormone; powdered *Rootone* works well, as do gel and liquid rooting hormones. Mix up a rooting medium of half peat moss and half sand, or use a commercial light soil-less mix. Place cuttings in a cool shady spot and keep them moist, but not soggy. Most cuttings will be well rooted in 4-5 weeks and will need to be repotted into bigger pots. Transplant rooted cuttings into the garden or wetland area at least a month before the expected first frost date. For overwintering, place them in a coldframe or in a protected location outside, and plant in early spring. Horticulture-grade heavy, milky-white (not clear) plastic sheeting works well for protecting overwintering potted plants. This is often called a landscape winter blanket and is available online from horticulture supply websites.

In a greenhouse: Overwinter white turtlehead outdoors under a landscape blanket. In February, bring plants into the greenhouse to mimic spring and break dormancy. Even in a warm greenhouse, it may take over a month for plants to break dormancy, and another month for stems to grow tall enough to take cuttings from. Cuttings can be taken and rooted in 3-4 weeks, then potted up and planted in the ground after the last expected frost date in May. This method is recommended if a greenhouse is available.

<u>Method 2</u>: Division

Divide clumps of established plants (at least 2 years old) when leaves first appear in spring. White turtlehead does not form basal rosettes of leaves; it sends up stems a few inches apart. Using a long trowel, spade, or gardener's knife, section off 2 or 3 stems. Pot up the new divisions, and water both the mother plant and the divisions thoroughly. If planting divisions directly in the ground, apply a 3 inch layer of mulch to conserve moisture.

<u>Method 3</u>: Seed

Collecting seed: In the mid-Atlantic Region, white turtlehead blooms in August to October. Seeds generally ripen and are ready for harvest at or near the first frost in October. Note that prolonged rainy periods during flowering may reduce pollination and result in low seed production in some years. The seeds are found in ½ inch capsules arranged tightly against the stalk. The capsules turn darker shades of brown as the seeds mature. Individual seeds are flattened, less than ⅛ inch in size, and have a thin light-brown outer margin and a teardrop-shaped center (embryo). *The timing of seed collection is the key to success.* If collected too early, seeds will not be ripe and will not germinate. If collected too late, seed embryos may have become infested with insect larvae. Periodically remove a capsule to check seeds for maturity. If the centers of the flat paper seeds are dark and slightly swollen and they shake out of the seed capsule easily, they are likely ripe. Snip the ripened stalk just below the lowest seed capsule, and place on paper in a warm dry location to air-dry for a few days. Once the capsules are dry, break them open and shake out the seeds. Remove any plant litter by running seeds through a sieve. Spread seeds out on paper for another day to make sure they are dry. Pour seeds into a paper envelope but do not seal it. Coin envelopes from office supply stores work well for storing seeds.

Pre-treating and storing seed: For best results, fumigate seeds to kill any insect larvae that may be present. Skipping this step can result in low germination rates or total crop failure. Use a plastic, shoebox-size container with tight-fitting or latch-type lid. Taking care to follow all the safety instructions, place a *No-Pest Strip* inside the plastic box; these are available in the pesticide sections at local hardware stores and home-improvement stores. Next, prop open the seed envelope and place it in the box next to but not touching the *No-Pest Strip*. Secure the lid and place the box in a location away from pets and children. After 3 days, remove the seed envelope, seal it, label it, and store it in a cardboard box in the refrigerator until early December. Include a desiccant packet in the cardboard box (one of the small packets that comes in a bottle of aspirin, for example) to keep seeds moisture-free. The use of plastic *Zip-lock* bags, plastic jars, or glass jars in lieu of a lidded container to store seeds is discouraged, as it may result in fungus-covered seeds.

Sowing seed: In early December, sow seed into flats or containers filled with seed-starting medium. Moisten the mix before sowing seed. Seeds need light to germinate, so cover only lightly with seed-starting mix to hold seeds in place, or do not cover the seeds at all. Set flats out on the ground and water with a liquid fungicide/water solution. Allow the seed container to drain for a few hours. Cover the container with a plastic bag left open or loose on one end. Store in a refrigerator or outside in a consistently cold, dry location for 10-12 weeks. Check periodically to make sure the soil mix remains moist. If it does not, mist it heavily. This 3-month period of cold-moist stratification duplicates the natural conditions of the wet, cold of winter necessary to break seed dormancy. At 10 weeks, begin checking seeds for signs of germination every other day. If seeds are beginning to germinate, remove seed container and place it on bottom heat. If not, keep refrigerated another week or two. Once the seeds begin to germinate, place the container in a sunny location and water daily.

Alternatively, sow fumigated seeds in the fall in an outdoor raised bed or coldframe. Cover the seeds lightly with sand to hold them in place. Cover the coldframe with fine mesh screening or old window screens and secure to keep out rodents. The screen diffuses rain so that seeds don't wash away. In the spring, seedlings may need thinning shortly after germinating, or can be potted up once they have their first set of true leaves.

<u>Method 4</u>: Cultivation

Containers: White turtlehead grows best when it is grown in a light, humus-rich soil with a pH of 6.8 or less. Keep soil moist by amending it with compost or by mulching with rotted leaves or shredded hardwood mulch. Potted plants may also be kept in plastic tubs or inflatable children's swimming pools with 1-2 inches of water maintained in the bottom. Organic fertilizers and liquid chelated iron should be added periodically to keep plants dark green and robust. First-year plants do well in half-gallon or gallon pots; second-year plants will need 2-gallon pots for their root systems. After that, potted plants should either be divided or planted in the ground.

In the wild: White turtlehead grows in seeps, springs, wet meadows, vernal pools, and moist stream banks. It grows best in soils with a pH of 6.8 or less. When looking for suitable spots to plant, dig down about 8" and wait to see if the bottom 1-2" of the hole fills with water. If so, turtlehead should grow well there. Given proper soil conditions, it will thrive in shade or dappled sunlight. Sunnier sites are suitable if soil moisture remains constant. If turtlehead has everything it needs to thrive, it will spread rapidly. Staking may be required if there are no other plants in the immediate vicinity on which its 3-4 ft tall stems can lean. When planting at a site slated for Baltimore checkerspot release, plants should be spaced about 8-10 inches apart so that the leaves touch, enabling larvae to move between plants. Native rushes and sedges should also be planted around the turtlehead plants in order to provide cover for larvae and places for larvae to pupate.

Sources for white turtlehead plants and seeds, including local suppliers, are included in Appendix IV. A list of propagation techniques for secondary host plants and nectar plants are listed in Appendix V.

6.3 Controlling Invasive Species - Control of non-native invasive plants (NNIs) is extremely important for overall reintroduction success and for protection of extant colonies. Several NNI species are extremely aggressive and successful at invading wetland sites. If not treated, they have the potential to displace stands of white turtlehead, thereby reducing or eliminating the Baltimore checkerspot's host plant. Any management efforts, either mechanical or chemical, to control NNIs must be implemented with care to avoid unintended impacts to existing host plants, nectar plants, and various stages of Baltimore checkerspots, as well as other plants and animals that may be utilizing the habitat.

At many Maryland sites, white turtlehead tends to grow along the edge of wetlands in shallow or temporarily flooded areas, and along the edges of streams. It grows in both sunny and shaded conditions and is thus vulnerable to impacts from many different species of NNIs. In wet locations, species that pose the greatest threat include hairyjoint grass (*Arthraxon hispidus* (Thunb.) Makino), reed canary grass (*Phalaris arundinacea* L.), common reed (*Phragmites australis* (Cav.) Trin. ex Steud), Japanese stilt grass (*Microstegium vimineum* (Trin.) A. Camus) and purple loosestrife (*Lythrum salicaria* L.). In drier locations, NNIs may include Japanese honeysuckle (*Lonicera japonica* Thunb.), multiflora rose (*Rosa multiflora* Thunb.) and mile-a-minute vine (*Persicaria perfoliata* (L.) H. Gross).

Effective methods for treating NNIs depend on the species, level of infestation, time of year, and surrounding habitat. They include hand pulling, mechanical pulling or grubbing, mowing or cutting with mechanical equipment and the use of herbicides. Small infestations of annual or biennial species can often be controlled by hand pulling or other mechanical methods such as mowing or otherwise removing seeds for an extended period spanning several seasons. Large infestations of well established perennials or woody shrubs and vines will require considerable labor to be effectively controlled by hand or even large machinery. Often, the use of herbicides may be required. Herbicides should be considered when the labor and soil disturbance of hand removing established plants over the long-term becomes too great. Significant soil disturbance can lead to additional infestations by other NNI species that could pose a greater threat to host plants than the original NNI. Herbicides can be safe and effective when chosen carefully and applied according to their labels. Often, a combination of treatments can be used, such as cutting back extensive growth of NNI shrubs and then applying an herbicide treatment to stumps or re-sprouting plants.

Several publications are available to assist in choosing effective treatment methods for various species and situations, and many management practices can be implemented by volunteers. The *Citizen's Guide to the Control of Invasive Plants in Wetland and Riparian Areas* (Alliance for the Chesapeake Bay, 2003), for example, provides an excellent overview on using volunteers to manage NNIs. Some management practices, however, will require large mowers and other machinery or specialized herbicide applications, making professional assistance necessary. The number of contractors specializing in environmental work and offering NNI management services is growing, so several options may be available. Additional information on NNI's can be found on the websites of the Maryland Department of Agriculture (MDA) at www.mda.state.md.us and the Maryland Department of Natural Resources at www.dnr.state.md.us.

6.4 Controlling Deer Browse – While little scientific research has been done to quantify the impact of high deer populations on white turtlehead and regional populations of the Baltimore checkerspot, anecdotal evidence strongly suggests that white-tailed deer (*Odocoileus virginianus* Zimmermann) are negatively impacting the species. While deer populations in Maryland have declined since 1998, largely as a result of statewide regulation and management, the overall numbers remain high and exceed carrying capacity in many areas of the state, posing a threat to both natural and agricultural resources (Maryland WHS 2009). White-tailed deer feed primarily on leaves, buds and twigs of herbaceous and woody species. Numerous studies have documented that an overabundant deer can have a profound impact on native vegetation and wildlife (see McShea et al. 1997); this could potentially include other Maryland butterflies (Frye 2012). In some cases, preferred food plants may completely disappear from the landscape (McGraw & Furedi 2005). The potential impacts of white-tailed deer on Baltimore checkerspots are considerable, especially given that while feeding on plants during early summer, deer likely consume large numbers of eggs and young caterpillars. Deer browse of turtlehead in the spring limits the use of the plants by post-diapausal larvae, a stage at which their food requirements are particularly high. Continued browsing into the summer prevents the plants from recovering for use by post-diapausal larvae in mid to late summer. Reducing deer impacts is therefore critical to the successful establishment of new habitat and breeding colonies as well as the long-term viability of existing Baltimore checkerspot colonies.

There are essentially two ways to reduce deer impacts to Baltimore checkerspots: either the number of deer must be reduced on a site-by-site basis to levels where they can not overbrowse desired plants, or they must be excluded from Baltimore checkerspot habitat by a barrier, usually some type of fencing. Maryland DNR has implemented managed hunts in some areas where deer browse is a significant problem (Maryland DNR 2012, Maryland WHS 2009), but these efforts are costly, time consuming, and often take years before desired results are obtained. Deer management programs at the Maryland county level and within local jurisdictions have also sought to reduce deer populations (M-NCPPC, 2012, see examples in MD WHS 2009) and may be effective on park or other locally-controlled properties, but again, a significant cost and long-term commitment is required. Even when deer populations are fairly well controlled, deer are likely to continue feeding on preferred plants including white turtlehead.

A more effective and immediate method of protecting critical populations of white turtlehead is to use fencing, which will likely be critical at both existing sites as well as newly restored sites. Deer fencing can be constructed of various materials ranging from relatively inexpensive, heavy-duty plastic mesh fencing specially designed for deer exclusion, to very expensive chain-link fencing. To be "deer proof", a fence that protects a large area must be at least 8 ft tall. It must also be flush to the ground and firmly tacked down to prevent deer from pushing their way under it – this can be difficult where ground is uneven or where fencing must cross streams or ravines. Some types of shorter fencing can also prevent deer damage in certain situations. Electric fencing can be effective but requires a high level of maintenance and a reliable source of power. The use of 4-5 ft tall welded wire fencing can be very effective in protecting small patches of turtlehead less than 10 ft in diameter since deer will rarely jump into a small enclosed area. Very small exclosures less that 10 ft in diameter can also be fitted with a fenced "top" or "roof." Examples of deer fencing can be found in Appendix VI; Kays (2000) also illustrates a number of examples of both electric and non-electric fencing options. Maintenance of deer exclosures may include fencing repair as well as periodic pruning of vines and other plants.

Section 6 – Short-term Action Items (to be completed within a year):
a. Create an educational brochure and web page on Baltimore checkerspot conservation for Maryland citizens.
b. Review monitoring information on all known sites and evaluate the level to which NNIs are impacting sites. Prioritize the most imperiled sites and develop site-specific NNI management plans for each.
c. Review monitoring information on all known sites and evaluate the level to which white-tailed deer are impacting each site. Prioritize the most imperiled sites and determine whether and what type of fencing should be implemented.
d. Evaluate potential reintroduction sites for existing NNIs and remove or treat prior to planting turtlehead.

Section 6 – Long-term Action Items (to be completed within the next 2 years):
a. Solicit volunteers and funding for NNI management at sites where the problem seems to be a limiting factor for Baltimore checkerspot colonies.
b. Initiate NNI management where necessary on publicly owned sites in coordination with the land manager. For sites on private land, draft a letter to the landowner(s) describing the problem and asking for permission to protect white turtlehead on those sites.
c. Monitor both existing sites and potential reintroduction sites at least twice a year and implement management to remove or treat NNIs as needed to protect host and nectar plants.
d. Solicit volunteers and funding for fencing turtlehead at sites where the problem seems to be a limiting factor for Baltimore checkerspot colonies.
e. Construct deer fencing where necessary on publicly owned sites in coordination with the land manager. For sites on private land, draft a letter to the landowner(s) describing the problem and asking for permission to fence white turtlehead on those sites.

7. REINTRODUCTION METHODOLOGY AND CONSIDERATIONS

It is an unfortunate fact that most butterfly reintroduction efforts fail (see reviews by Pullin 1996 and Schultz et al. 2008). There are multiple reasons for this, but the most common are (1) lack of suitable habitat for reintroduced populations to inhabit, and (2) limited knowledge of the life history requirements of the species being reintroduced. To alleviate these pitfalls, we will utilize a two-part strategy for Baltimore checkerspots. First, we will undergo multiple habitat restoration projects and monitor the success of these projects *before* introducing any butterflies to these sites; this will help ensure the availability of multiple, sustainable habitat patches. Second, and concurrent with habitat restoration and monitoring efforts, we will attempt to answer important questions regarding unknown aspects of the Baltimore checkerspot's life history and habitat requirements.

7.1 Current Programs – Captive breeding and wetland restoration have been identified as major components of this Conservation and Management Plan. Both have been attempted several times in different areas of the state. Some of these efforts were short-lived but several have been ongoing for multiple years and continue to expand or thrive. A short summary of BCRT rearing operations and wetland restoration efforts include the following:

<u>Allegany County</u>
Rocky Gap State Park – Rocky Gap has a wild population of Baltimore checkerspot butterflies that was discovered in 2009. Park staff has engaged in population monitoring and in NNI removal efforts over the past two years. In 2013, Park staff will plant more turtlehead in the wetland and will continue efforts to remove NNIs. Some of the turtlehead plants will be fenced since deer browse has been an issue at the site. Park staff will coordinate monitoring efforts at this site, as well as at several sites in Garrett County where wild populations are documented.

<u>Baltimore County</u>
Cromwell Valley Park, Baltimore County – Cromwell Valley Park has been propogating turtlehead in a half-acre children's garden at the park for several years, where it is thriving. While there are no Baltimore checkerspots at the site, the area serves as an environmental educational facility that teaches adults and children about the Baltimore checkerspot, habitiat changes and impacts, and restoration efforts. Park staff have evaluated the potential for creating Baltimore checkerspot habitat in two additional areas of the Park, one of which was planted with turtlehead in 2013 and is currently being monitored. If successful, the Park may serve as a future checkerspot release site.

Robert E. Lee Park – In 2012, 200 turtlehead plants were planted within two exclosures in the Park. Additional turtlehead was also planted inside a new butterfly enclosure, where Park staff hope to rear Baltimore checkerspot caterpillars in the future. If the recently planted turtlehead establishes in the exclosures, additional turtlehead will be planted in 2014. While there are no documented records of Baltimore checkerspots in the park, white turtlehead was apparently present in past years. Park staff hopes to reintroduce turtlehead to those areas in the Park where it used to grow, and to eventually introduce Baltimore checkerspots to these areas.

<u>Carroll County</u>
Sites on Private Land – Staff from Maryland NHP is working with two private landowners to establish relatively large turtlehead populations in their wetlands in northern Carroll County. One site currently supports a small colony of Baltimore checkerspots, although the wetland is overgrown and supports only a small number of turtlehead plants. The second site also has very little turtlehead, although the wetland is open and could likely support additional plants. At this second site, Baltimore checkerspot larvae were found on the turtlehead in 2012, but it is unlikely that they survived as there was very little for them to eat; no adults or larvae were observed here in 2013. Secondary host plants were not observed in the immediate vicinity of the wetland. In 2013, each site was planted with approximately 80 plants. All plants were fenced to protect them from browse and are monitored periodically. Both sites are currently being managed with goats which primarily graze on woody vegetation, including many invasive species, but they also appear to be eating the naturally-occurring turtlehead at the first site. In the future we may need to fence the naturally-occurring turtlehead as well to protect it from both goats and deer.

<u>Frederick County</u>
Fountain Rock Nature Center – Staff at Fountain Rock Nature Center have been patiently monitoring a fragile population of turtlehead to see if it will establish there. It was originally planted 8 years ago with hundreds of other plugs, but limestone deposits may be preventing much

of it from establishing. Most of the plants have not survived. As of the fall of 2012, there were approximately 50 plants that were still persisting in certain areas of the Nature Center. Nature Center Staff have been dedicated to maintaining those surviving plants and have also planted new ones, continuing to experiment with planting in different areas of the Nature Center as they try to locate areas where turtlehead might be able to persist in the long-term. One promising aspect of Fountain Rock Park is that it is entirely fenced in and does not have a deer problem.

<u>Harford County</u> – After attending the state checkerspot meeting in January 2012, Harford County participants, including staff at Anita Leight Estuary Center, Harford Glen Environmental Center, and Eden Mill Nature Center and others organized the Checkerspot Corridor Team (CCT), involving public and private groups in a coordinated effort with the mission "to promote research, monitoring, propagation, conservation, and awareness of the Baltimore checkerspot and its threatened habitats that leads to the establishment of viable self-sustaining metapopulations of the checkerspot in Harford County."

Anita Leight Estuary Center – Staff at Anita Leight Estuary Center have been actively involved in searching for habitats with existing turtlehead or with restoration potential in an effort to connect habitats at the Estuary Center with other turtlehead wetlands in Harford County, with the goal of restoring or enhancing as many sites as possible, extending the potential range of the Baltimore checkerspots into the northern stretches of Harford County. In 2013, Anita Leight and the CCT hope to continue their surveys of butterflies and potential habitat, but also plan on expanding these surveys to incorporate the assistance of local citizens. Future plans include initiating a turtlehead propagation program at the Estuary Center and eventually at North Harford High School, and actively managing an existing Baltimore checkerspot enclosure at the Estuary Center. The development of these goals will be based upon the results of the 2013 habitat surveys, and on whether any sites that have restoration potential are found.

Eden Mill Nature Center – Eden Mill Nature Center has a restored wetland on site where they maintain an enclosure for rearing Baltimore checkerspots. Because this endeavor has been met with limited success, Eden Mill has suspended their captive rearing efforts and is focused primarily on habitat restoration. The wetland at Eden Mill does not currently have enough turtlehead to support a Baltimore checkerspot colony, but plans are to continue planting turtlehead so that it may become a future site for the introduction of Baltimore checkerspots.

Harford Glen Environmental Education Center – The staff at Harford Glen Environmental Education Center (herein referred to as Harford Glen) has maintained a captive-bred colony of Baltimore checkerspots since 2006. In addition to an enclosed Baltimore checkerspot breeding area, turtlehead was planted in a wetland on the property. Baltimore checkerspots were first released to the wetland in 2008 and have been breeding on their own since that time. Monitoring was initiated in 2012 at which time several hundred larvae were observed in the vicinity of the wetland. In addition to actively propagating this species for conservation, lesson plans have been created to teach students about the life cycle of Baltimore checkerspots and the environmental issues that threaten this species. Students assist with the planting and maintenance of turtlehead as well as data collection. Recently, staff and students at Harford Glen located an additional patch of turtlehead, and planted two more small stands of turtlehead which they fenced and are actively monitoring and maintaining. Because the non-captive butterflies have been doing so well at Harford Glen year after year, staff is considering whether or not to continue captive rearing efforts and focus instead on finding new areas to plant turtlehead to help sustain the introduced colony.

Howard County
Robinson Nature Center - The butterfly house at the Robinson Nature Center in Howard County is scheduled to open in 2013. In preparation for this event, Nature Center staff plan on exploring the idea of trying to propagate turtlehead in the butterfly house garden. Some of the turtlehead will be planted at the Nature Center over the next couple years in an effort to create suitable habitat for Baltimore checkerspots. There is also a sharp shooting program in place to help manage the deer population. Staff would eventually like to have a Baltimore checkerspot colony in the Nature Center's garden for education purposes and add rearing tents for the larvae.

Montgomery County
Black Hill Regional Park – The Friends of Black Hill Nature Programs, volunteers, and Naturalist staff have long operated a successful Baltimore checkerspot captive rearing and release project, coordinated by a project leader. Greenhouse gardener volunteers propagate white turtlehead, a few secondary host species for post-diapausal larvae, and several species of nectar plants. Several thousand turtlehead plants are grown in the greenhouse each year, and workshops on the propagation of white turtlehead have been offered periodically. Over the last decade, turtlehead has been planted in four wetlands sites within a 3-5 km radius of the only known wild Baltimore checkerspot colony in Montgomery County. In 2011, Baltimore checkerspot larvae, pupae, and mated adults were released at three of the restoration sites first time. All three release sites had naturally-occurring turtlehead which was fenced and supplemented with additional plantings, and two of the three (one site was overtaken by invasive species) have been actively managed as Baltimore checkerspot habitat. Montgomery County Parks is even looking into purchasing a corridor that would connect the wild colony to one of the introduced colonies on County Park land. However, the captive rearing program at Black Hill Regional Park ended in 2013 because key staff retired. Remaining Baltimore checkerspot larvae that overwintered in the rearing tents at Black Hill were placed in new sites in the spring of 2013 but very few survived. Several volunteers plan to maintain at least one of the restored habitats in the coming year, and Park staff plan on expanding the restoration effort by planting more turtlehead. The long-term view is more uncertain, however, as there will be no one to coordinate this effort once the project leaders retire. This is unfortunate as the restoration sites require the regular removal of NNIs. Monitoring of the introduced colony sites in Montgomery County by volunteers will occur if the replacement Volunteer Coordinator at Black Hill has the time and incentive to continue the project with volunteers, but there is no way of knowing that at this time.

Washington Suburban Sanitary Commission – The Washington Suburban Sanitary Commission (WSSC) has a mission to provide "clean and reliable" drinking water to all 1.8 million residents in their service area, which covers nearly one thousand square miles in Montgomery and Prince George's Counties. They are also interested in environmental stewardship, and thus are interested the enhancement and protection of natural resources and the environment. To this end, they have begun planting turtlehead at water remediation project sites in the northern stretches of Montgomery and Prince George's Counties. So far they have planted over 100 plants between two sites.

Washington/Frederick Counties
Wild Colony Management – BCRT partners are planning to reach out to the power company First Energy (formally First Electric) to discuss long-term management of the two wild Baltimore checkerspot sites along the power line corridor that traverses Washington and Frederick Counties (there is one existing colony in each county along the same power line corridor). At the moment, the power line is being managed in a way that is apparently beneficial in keeping the habitat open, so to a large degree the intent is to let them know this that so that they can continue to maintain the same type and level of maintenance. However, there are some problems with invasive species

and deer browse so there are several discussion points, including the possibility of constructing deer fencing if this becomes necessary. To this end, BCRT partners will also contact Integrated Vegetation Management Partners, Inc., a non-profit organization that applies "integrated vegetation management practices to provide safe, reliable and accessible utility and highway rights-of-way, improve wildlife and endangered species habitats, [and] control exotic weeds…" IVM Partners has coordinated projects in various states including Maryland (Elk Neck Wildlife Refuge).

7.2 Captive Breeding Methodology – Mass-production of Baltimore checkerspot livestock for release at designated habitats will help us meet our expectations of rebuilding depleted colonies, restoring extirpated colonies or launching new colonies. Our goal is to create self-sustaining metapopulations that require minimal long-term management in the Maryland Piedmont. Section 7.1 provides a brief summary of ongoing BCRT programs, some of which are actively involved in captive-breeding to varying degrees.

Pre-Planning Considerations – Prospective breeders should plan to arrange for daily staffing for approximately four months beginning in late March/early April, when post-diapause larvae resume feeding, through late July/early August, when larvae of the year begin their aestivation period. Training and supervision should be built into the plans. The time required for daily care depends on varying factors that include the livestock's stage within the metamorphic cycle, weather conditions, and the solving of inevitable, unforeseen problems. Adequate hours to water, weed and otherwise care for dozens to hundreds of host plants should be factored into the plan.

The captive-rearing effort at Black Hill is staffed by several trained volunteers working under a project leader. Most of the care at Harford Glen is done by one person, the project coordinator, with occasional help from students at the education center. In 2012, the Harford Glen captive-rearing project began receiving assistance from two students at North Harford High School, a magnet school for students interested in natural resource management or agriculture. One student is mapping the wetland release site at Harford Glen, while the other is mass-propagating white turtlehead for the project in the high school's greenhouse.

Source of start-up livestock – Obtaining founding livestock for a captive breeding project presents a dilemma for Maryland's prospective Baltimore checkerspot breeders. Maryland's wild colonies of Baltimore checkerspots are too fragile for the withdrawal of start-up stock, and Baltimore checkerspot livestock cannot be brought in from out of state. USDA's Animal and Plant Health Inspection (APHIS) rules prohibit transportation of most insect species, including Baltimore checkerspots, across state lines without a permit. One reason for this is the concern that Baltimore checkerspots from other regions of the country may be adapted to different environmental conditions including climate, elevation or photoperiod, and may not thrive under Maryland conditions. Alternatively, existing Maryland breeders with excess stock may be able to provide start-up stock for new captive-breeding projects as well. Prospective breeders are encouraged to explore larvae-sharing possibilities early in their planning process.

In rare cases, it may be necessary to obtain some larvae from wild colonies in the Maryland Piedmont to supplement captive breeding operations. We must exercise caution in such instances, given that most if not all Piedmont colonies are small and fragile. Maryland NHP, in consultation with BCRT members and local lepidopterists, will determine whether or not larvae may be taken from a given site to start, maintain or supplement a captive colony.

Location of the captive-breeding site – Because butterflies at all stages require sunlight, the breeding site should be located in an open area with enough space around the breeding enclosure for natural air circulation. To avoid overheating, the site should be located away from pavement, masonry buildings or other heat sinks. If potted host plants are used, the site should be large enough to accommodate any plants held in reserve outside the breeding structure. A source of water is required to hydrate plants and wash equipment. The site should be within reasonable proximity to caretakers and provide parking.

The breeding enclosure – Captive rearing is often done outdoors within a screened cage or well-ventilated tent with a floor. The enclosure should be spacious enough to accommodate several dozen host plants and tall enough for a caretaker to maneuver comfortably inside. Within the structure, livestock should have access to full sun, which is necessary for larval development and to stimulate mating. There should be enough plants within the enclosure to provide shade during very hot weather. The cage door or tent entry should seal tightly and quickly to prevent entry of predators and parasitoids. Adult butterflies at a former rearing facility (Carroll County Outdoor School in Maryland) showed a tendency to congregate on the south-southeast side of their cage, suggesting that enclosure doors should be located at some other bearing (M. Lustig, pers. obs.). The breeding enclosure at Harford Glen is a sturdy wood-framed cage, approximately 10’ x 10’ x 6’ high, enclosed in plastic window screening that is backed with two-inch gauge hardware cloth. The enclosure has a dirt floor and is accessed at one end through a double door, which is kept locked. White turtlehead and *Penstemon digitalis* host species are planted directly in the ground within the cage. Black Hill uses the largest available camping tents as breeding enclosures and provides host plants in two-gallon pots. However, volunteers find tents unsatisfactory because maneuvering under the sloped sides is awkward, tents tend to blow down during heavy storms, and tent material tends to deteriorate after several months’ exposure to sunlight. The more elaborate rearing house used for breeding Karner blue butterflies (*Lycaeides melissa samuelis* Nabokov) in New Hampshire resembles a commercial greenhouse, and is large enough to contain several rearing centers, a host plant cultivation area, and a work space for caretakers (Webb 2010).

Availability of adequate host plants – An uninterrupted, immediately available supply of healthy, mature, insecticide-free host plants is critical to the survival and optimal development of larvae confined for captive breeding. A single Baltimore checkerspot web, which may contain dozens to hundreds of pre-diapausal larvae, can defoliate a mature, multi-stemmed white turtlehead plant in a matter of hours. For even a small breeding operation, dozens of mature (second year or older) turtlehead plants are required. Post-diapausal larvae, which feed alone in the spring, are also voracious eaters, rapidly consuming secondary host plants as well as turtlehead, so these should also be available in large quantities. Section 4.1 provides a list of secondary host plants. Prospective breeders are urged to accumulate as many primary and secondary host plants as possible before larvae become active, and to make plans ahead of time for the placement of larvae should their supply of host plants become decimated. In 2012, Black Hill had to find places for several hundred excess larvae.

Purchasing host plants in such numbers is not only costly, but also risks introducing plants into the breeding operation that may have been treated with insecticides or other chemicals detrimental to butterflies. Nurseries can seldom supply plants in numbers on an emergency basis, such as when larval production is unexpectedly high. Black Hill has recruited volunteers to propagate most of its host and nectar plants, using locally collected seed when possible. A limited number of white turtlehead “plugs” (first-year plants) are purchased each year from a trusted wholesale nursery, using funds raised by park volunteers. The plug-size plants are allowed to grow another year before they are used. At Harford Glen, host plants are purchased from wholesale nurseries and held in reserve for a year to make sure they are insecticide-free.

Care of larvae – Confined larvae require daily care during the course of their overlapping active periods, roughly late March through early August. Their most critical need is nourishment. Larvae are voracious consumers of host plants, and thus larval care necessarily assumes considerable host-plant care. Section 6.2 provides detailed information on the care and propagation of white turtlehead.

If potted host plants are used, these must be frequently replaced with fresh plants that have been checked thoroughly beforehand. Any insects found on these plants should be removed. During periods of high heat and low humidity, desiccation of livestock can be prevented by misting lightly with water using a fine-mist spray bottle (not a hose, as this will make the cage too wet). During rainy weather, a tarp or other temporary cover may be required to prevent conditions within enclosures from become overly wet and prone to mold. At all stages, larvae should be handled as little as possible. Artist's brushes may be used to safely relocate them.

Controlling predators and parasitoids – Predators of Baltimore checkerspots include spiders, stink bugs, hornets and other insects, wasp and fly parasitoids, and small vertebrates such as snakes and voles. Breeding enclosures should be designed to exclude these organisms, although some inevitably find their way in. To minimize their entry into cages or tents, caretakers should be trained to close cage doors or tent openings quickly when coming and going. Insects should be removed from any plants before they are placed within breeding enclosures. Enclosures should be checked daily for predators. Any found should be removed or dispatched.

Sections 2.2 and 7.4(3) discuss the generalist and specialist parasitoids that utilize Baltimore checkerspot larvae as hosts. Caretakers should learn to recognize parasitized livestock and should check enclosures periodically for parasitized livestock; any found should be dispatched in alcohol. Guidelines for identifying parasitized individuals will be developed by experts in this area and distributed to all breeders. This will permit individuals at each facility to conduct periodic monitoring and remove any infected individuals to help prevent the spread of parasitoids.

To control disease, wash enclosures and equipment annually, or more often if needed, with a 10-percent bleach solution.

Care of adults – Adult butterflies require nectar or a nectar substitute for nourishment. At Black Hill, adults are supplied with nectar plants in pots and cut flowers in water. Alternatively, Gatorade dispensed in commercially available butterfly feeders can be used as nectar substitute. Adults at Harford Glen are hand-fed on alternate days, using a diluted honey solution that is 8 parts water to 1 part honey.

Reproduction – Females are ready to mate as soon as they eclose. Males, which usually require several days to mature, demonstrate readiness to mate by increased activity, such as agitated flight and chasing other males. Pairings can be allowed to occur naturally within the rearing enclosure or individuals may be hand-paired. To hand-pair, gently clasp a female's forewings between thumb and forefinger. Clasp a male similarly in the other hand. Align the butterflies side by side, lightly rubbing the female's posterior against the antennae of the male. If stimulated, the male curls his abdomen in the direction of the female. Coupling takes place while the pair is horizontally aligned. The pair then aligns posterior to posterior. At this point, set the pair down to finish mating. After mating, females should be placed on white turtlehead plants to oviposit.

Overwintering – In captivity, larvae overwinter in webs, within leaf litter, on the ground and sometimes within webs on plants. If captive-bred individuals will be released before winter diapause, a small number should be retained in captivity to assure the next year's breeding stock.

At Black Hill and Harford Glen, larvae have successfully overwintered outdoors within rearing enclosures without any special attention or care. Staff at Black Hill will often put mulch down at the bottom of the rearing tents; larvae have been observed overwintering in the mulch and within thickened webs at the base of the plants within the tent. Begin looking for larvae that may be coming out of diapause early in the spring (approximately mid-March) when the temperature reaches about 50°F and ensure that adequate food is available. Larvae generally start feeding by early April.

The necessity for a prepared release site – To prevent mortality of Baltimore checkerspot livestock, one or more release sites must be identified and any necessary habitat enhancements completed *before* the release. Each release site should be protected, either on public land delegated for the protection of wildlife habitat or on privately owned land under a butterfly-oriented conservation easement or other legally enforceable protection plan. Any long-term agreement concerning the site should include a specific management plan to preserve the Baltimore checkerspot habitat.

A colony cannot survive without adequate food resources. Several years are usually required to determine if the required primary host, secondary hosts, and nectar plants can thrive in the conditions at the site. Site monitoring should be ongoing in order to determine this and is discussed in Section 6.1.

Habitat enhancement is a huge project in itself. An argument can be made for recruiting a gardening group or to take it on, although this is not necessary in all cases. Staff and volunteers at Black Hill began massive plantings of white turtlehead and secondary host plants at three county park sites more than a decade before launching its captive-rearing project in 2010. Deer exclosures were built around the stands of turtlehead. Releases began in 2011, and supplemental plantings of primary and secondary hosts remain ongoing. At Harford Glen, hundreds of white turtlehead plants were planted near the rearing cage in 2006, the same year captive-rearing and releases began. That first year, deer browsed the unprotected turtlehead plants. Subsequently, Harford Glen built three 10’ x 10’ x 8’ deer exclosures, and planted dozens of white turtlehead plants in each one. At both Black Hill and Harford Glen, ongoing and aggressive weeding is required to prevent other vegetation from overtaking the plantings.

Maintaining diversity and fitness – Over time, captive-bred stock may become genetically homogeneous and possibly suffer a loss of fitness. The potential impacts of inbreeding depression are discussed in Section 7.4(2). To maximize genetic diversity, exchanges of individuals may be made with other breeders, especially those using different genetic lines. To maintain fitness for wild conditions, captive-bred females may be bred with wild-caught males, which can then be freed to breed again in the wild. Maryland NHP, in coordination with BCRT members and local lepidopterists, will evaluate whether it is appropriate to remove individuals from wild populations on a site-by-site basis in order to increase genetic diversity in captive-bred butterflies.

A long-term commitment – Prospective captive-breeders should anticipate a sustained effort of at least five years. A review of 29 successful British reintroduction efforts reported that reintroduction attempts spanned an average of 15 years (Schultz et al. 2008). Captive-reared Karner blue livestock releases to the Concord Pine Barrens in New Hampshire was done so on an annual basis for over a decade and continues today (Webb 2010; John Kantor, New Hampshire Fish and Game, pers. comm.). While the overall effort has been largely successful, the colony is still not considered to be self-sustaining.

7.3 Population Monitoring for Captive-Bred Individuals and Introduced Colonies - Monitoring of captive bred colonies will be the responsibility of each partnering organization that manages a breeding colony. This responsibility should continue after captive bred individuals are released. If the number of release sites becomes too great, we will need to have a plan for others to monitor the sites. We may need to monitor every two years if annual monitoring is not possible. Field forms used to monitor wild colonies (Appendix I) can be used by partnering organizations to also monitor introduced colonies. This will ensure that all surveyors are collecting the same information in a standardized fashion. Standardizing data collection methods will also make it easier for volunteers, students, and seasonal workers to assist in data collection efforts.

7.4 Research and Management Questions and Answers

(1) How can we restore and maintain metapopulation dynamics in Piedmont populations of Baltimore checkerspots? The dramatic decline in Maryland populations of Baltimore checkerspots force us to question whether a breakdown in population dynamics has occurred. In order to try to achieve a landscape in which different populations of Baltimore checkerspots are able to interact and interbreed, we must increase our understanding of (a) how far Baltimore checkerspots can disperse and through what environments they can move; (b) how many sites are needed to maintain a viable metapopulation; and (c) how big each site needs to be in order to support a self-sustaining colony.

For an answer to part (a), we can look to previous research on the dispersal of other species of checkerspots as discussed in Section 5.1; estimated dispersal distances averaged 2.5 km with a small percentage of individuals dispersing as many as 4-5 km (Harrison 1989, Singer and Hanski 2004). These studies support our goal to try and connect sites by a distance of 2 km or less whenever possible; this is discussed in detail in Section 5.5. While mark-recapture studies would allow us to achieve a better estimate of how far individual Baltimore checkerspots can disperse between sites and have successfully been used (Hanski et al. 1994, Kuussaari et al. 1996, Lewis et al. 1997, Roland et al. 2000, Ricketts 2001, Matter & Roland 2002) and analyzed (Ovaskainen 2004, Ovaskainen et al. 2008) elsewhere, populations in the Maryland Piedmont are likely too small and therefore too fragile to serve as the target for such a study (see Murphy 1988). One way we may try to gain insight on the dispersal abilities of Baltimore checkerspots is to delay the introduction of captive reared butterflies to recently restored sites, particularly those that are within several kilometers of known Baltimore checkerspot colonies. If butterflies start colonizing restored wetland sites on their own, we may deduce how far they have traveled based on our knowledge of the locations of other colonies.

In the long-term, we may be able to research Baltimore checkerspot dispersal through a mark-recapture study by focusing on an area that currently supports a viable metapopulation of Baltimore checkerspots. Potential study sites include areas of Maine (P Durkin, Washington Area Butterfly Club, pers. obs.), Vermont, Rhode Island, and upstate New York (MD Bowers, pers. comm.). If we can determine a basic study design and designate staff and funding to such an effort, we will then contact state or local representatives at the determined study area and attempt to coordinate a research project.

Parts (b) and (c) can be determined to some degree through data collection on the number of observable sites that make up viable populations of this species as well as the size of each site; part (c) has also been answered in part by Ehrlich & Hanski (2004), who note that habitat patches for checkerspot species in general may range from a few hundred square meters to a few hectares. Again, a long-term goal would be to include not only Maryland sites in this effort, but also to collect data from sites in northern states where many Baltimore checkerspot populations appear to operate as true metapopulations.

(2) Will captive reared individuals compromise the fitness of wild colonies in the Piedmont? Butterflies can exhibit local adaptation to their environments, and may be less fit if moved to an environment where they must adapt to differences in temperature, humidity, photoperiod, and other environmental factors. To account for this, one goal of the BCRT is to ensure that all Baltimore checkerspots reared in the Piedmont region from local stock are also released in the Piedmont region. At the same time, we also want to ensure that captive-bred individuals do not introduce any deleterious genes into wild colonies. Pertinent research questions include: Will captive reared individuals be as "fit" as wild individuals? Will captive reared individuals be as genetically diverse as wild individuals? Will captive bred individuals be likely to introduce disease or parasitoids into wild colonies?

There is no feasible way for us to fully evaluate whether captive-reared individuals will be as "fit" as wild individuals, but we can attempt to alleviate the concern that captive reared individuals will introduce undesirable genes into wild colonies by carefully monitoring captive individuals. As mentioned previously, guidelines for identifying parasitized larvae will be drafted and distributed to all breeders, allowing them to monitor captive bred individuals for evidence of parasitism or disease before moving them to a site where they are likely to interact with wild colonies. Part (c) of this section specifically addresses the topic of disease and parasitoids.

We can also monitor restored wetland sites where captive bred individuals have been released. Annual monitoring will provide data on the numbers of adults present, the number of larval webs present, larval survival over the winter, and any evidence of disease. If the numbers of adults and larvae remain relatively stable over time, for example, the population will be deemed healthy enough to justify the relocation of individuals to other sites when necessary.

Recent reviews (Frankham 2010, Frankham et al. 2011) suggest that gene flow between isolated populations is almost always positive. Tallmon et al. (2004) also report on the many positive impacts that immigrants can have on small, isolated, at-risk populations. The introduction of deleterious genes from one isolated population leading to the detriment of another isolated population is documented very infrequently and occurs under very specific (and often extreme) circumstances. Inbreeding depression, by contrast, has repeatedly been shown to have adverse impacts on multiple species, including butterflies (Saccheri et al. 1998, Haikola et al. 2001, Nieminen et al. 2001, Haikola 2003).

It is also unlikely that we will have the resources to evaluate and compare the genetic diversity of wild and captive bred individuals. However, we can try to alleviate this concern in two ways. First, we can make sure that individual larvae used to start a captive breeding colony come from multiple sources. This may include wild Maryland colonies, reared larvae from other Maryland captive breeding partners, and larvae from the existing site, assuming the operation has been ongoing. As discussed in Section 7.2, at this time we are not considering importing larvae from other states or from other physiographic regions in Maryland outside of the Piedmont where the climate differs significantly, nor are we planning on removing larvae from wild colonies in the Maryland Piedmont to stock captive breeding operations except in necessary circumstances as determined by Maryland NHP in consultation with BCRT members and local lepidopterists. BCRT partners interested in starting captive breeding colonies may not all be able to do so in the same year given these limitations.

The second way in which we can alleviate the concern of low genetic diversity in captive reared populations is to ensure that each rearing operation starts with an adequate number of larvae. Karner blues are one of the few butterfly species that have been successfully reintroduced to multiple sites in United States; these efforts required hundreds of larvae in order to sustain new populations (Tolsen et al. 2009; John Kantor, New Hampshire Fish and Game, pers. comm.). It would be more worthwhile to stock a single captive rearing operation or a small number of rearing operations with a large number of larvae than it would be to start multiple operations with limited numbers of larvae, since these populations will be more likely to become inbred and crash.

Seminal theoretical work by Wright (1931, 1940), which remains the foundation for ongoing research on population genetics, suggests that even low levels of gene flow, as from the migration of just a small number or proportion of individuals, can alleviate inbreeding depression and maintain genetic variation in isolated populations. This theory continues to form the basis of current research, of which Tallmon et al. (2004) provide a concise review. Recent studies have shown that inbred populations of insects and other arthropods are capable of rapid recovery when genes from even small numbers of new immigrants (including a single individual) are introduced into the population (Saccheri et al. 1996, Ebert et al. 2002, Saccheri & Brakefield 2002, Spielman & Frankham 1992). This research suggests that even limited migration events could enhance the genetic diversity of wild and captive-reared colonies.

After a lengthy discussion at the first two meetings of the BCRT, we concluded that the benefits of increasing interactions between isolated populations greatly outweigh the potential risks of introducing parasitoids or disease to wild populations; this viewpoint has been supported elsewhere (i.e., McCallum & Dobson 2002). Parasitoids associated with Baltimore checkerspots include the specialist wasps *B. euphydryadis* and *C. euphydryidis*, and the generalist Tachinid fly *C. concinnata*. These species are considered to be widespread and have already been documented at several Baltimore checkerspot sites. However, given that our wild populations are generally small and isolated, it is possible that some of our sites have not been inhabited or are no longer inhabited by these parasitoids. In addition, parasitoid levels at any given site may vary dramatically from year to year (MD Bowers, pers. comm.).

Known parasitoids of Baltimore checkerspots may impact eggs, larvae and in the case of *C. concinnata*, may impact both larvae and pupae. Once an individual becomes an adult, it is essentially free from parasitoids and could not introduce them to other populations. This is also true for diseases, both viral and fungal. However, it is also not known whether parasitoids have the ability to track dispersing adults and thus follow them from one site to another. It is also not known, and is beyond our capabilities to investigate, whether adults from captive reared populations may harbor genes that make them more susceptible to disease. Review of the current literature may provide insights into this area. As stated previously, inbreeding depression almost certainly poses a greater risk to wild populations than the possible introduction of individuals with potentially deleterious genes.

(3) What is the most advantageous metamorphic stage for release of individuals? Baltimore checkerspots can be introduced to restored habitats in any life stage, but in general we recommend the release of either adult butterflies or post-diapausal larvae.

The release of pupae is discouraged because it involves a significant amount of time to accomplish, as individual pupae will need to be attached to plants. The attachment must be done in a way that conceals the location of the pupae from potential predators and parasitoids, and we question whether humans know enough to take adequate steps to ensure concealment. Further, *C. concinnata*, which also parasitizes Baltimore checkerspot larvae (Bowers 2012, P Durkin, pers. obs.) can emerge from both the larvae and the pupae in other species of Lepidoptera (J Frye, Maryland DNR, pers. obs.), so even Baltimore checkerspot pupae are not guaranteed to be parasitoid-free. Likewise, Baltimore checkerspot eggs can be parasitized by a native, generalist Trichogrammatid wasp (see reference in Stamp 1981a). Both *C. concinnata* and the Trichogrammatid wasp are believed to be relatively widespread and can attack multiple species in addition to Baltimore Checkerspots.

The release of pre-diapausal larvae has been discouraged because there is typically high mortality of overwintering larvae. For this reason, experts have encouraged the release of post-diapausal larvae (MD Bowers, pers. comm.). The introduction of post-diapause larvae does risk introducing the parasitoids *C. euphydryidis* and *B. euphydryadis* from any infected larvae, a particularly important consideration if the reintroduction site is in close proximity to other populations of Baltimore checkerspots. However, after much discussion, experts conceded that this may not be a great concern given the likelihood that the parasitoid is already present at other Piedmont sites. Furthermore, parasitoids may be able to locate newly established Baltimore checkerspot colonies even if the released larvae are parasitoid-free.
Only the release of adults will guarantee that parasitoids will not be released as well, as there are no parasitoids known to infect the adult butterflies. However, the release of adults is sometimes discouraged because adults may disperse and not remain at the release site (although the release of adults to new sites coordinated by Black Hill has been successful). One solution to this problem is to release the adults at night when they are unlikely to disperse (W Wehling, US Department of Agriculture, MD, pers. comm.).

In the end, the release stage will likely vary from site to site in an effort to experimentally evaluate which method(s) are most successful; results will be carefully monitored.

(4) How many individuals should be released per site? As there is currently no data available to provide an answer to this question, we will need to make an informed estimate of this number. While we want to make certain that the available host plants can sustain the numbers of individuals that are released, we also know that the release of too few individuals can be met with poor results.

Successful reintroductions of Lepidoptera have typically involved the continuous release of multiple individuals. For Karner blue releases at the Concord Pine Barrens in New Hampshire, well over one thousand butterflies were initially released at the 400 acre site. Additional releases continued every year from 2001 to the present (John Kantor, pers. comm.). Karner Blue releases in Indiana, Ohio and New York also involved the release of thousands of individuals (Schweitzer 1994, Tolson et al. 2009).

Our releases should balance the number of butterflies with the availability of turtlehead in the wetland, most of which will be considerably smaller than the 400 acre Concord Pine Barrens. It may be appropriate to first estimate the number of larval webs or number of adults present in wild populations in wetlands of various sizes, and use this information to determine the range of the numbers of individuals that should be released at new sites. Parker (2012) explains the arithmetic details on the translocation of the silver-studded blue (*Plebejus argus* L.); he considered (1) the number of butterflies that needed to be introduced to the release site in order to successfully establish a new colony there, and (2) ensure that a sufficiently small percentage of individuals were removed from the donor populations in order to prevent the collapse of the donor colony. Releases of the marsh fritillary (*Euphydryas aurinia* Rottemburg) were based on the size of wild populations; fourth-instar larvae were released in groups of 100 individuals, which equated to the size of wild overwintering groups at the time that the introductions were made (Porter 2012).

(5) Which habitat characteristics suggest likely success for creating a viable colony? This topic is discussed in detail in Section 6.1. Once the wetland has undergone initial restoration, it should be monitored for some period of time (2-3 years) to ensure that host and nectar plant populations are persistent, and that any threats (i.e.; succession, NNIs, deer browse) will be manageable in the long-term. An approximate determination of the quantity of host or nectar plants, either in terms of area covered or number of plants, should be estimated at each site; these estimates may be used at a later date to assist in determining the amount of host and nectar plants required for the long-term establishment of Baltimore checkerspot colonies.

Given that wild stock that can be used for captive breeding is extremely limited and that wetland restoration and reintroduction attempts will be rather labor intensive, reintroductions will be limited to wetland sites on protected lands (i.e.; federal, state or county lands) or on private lands where the site is expected to be maintained in the long-term as discussed in Section 6.1.

(6) What remediation approaches should be used to improve individual sites? Since every site will be different, the answer to this question will be site-specific. Considerations should include the following: What plantings are necessary? Will the site support turtlehead and other necessary plantings? Will deer fencing be required? Are invasive species a problem? Is the hydrology of the site stable? Is the site in a protected area or is it vulnerable to development or other land use changes?

Most if not all successful butterfly reintroduction attempts were preceded by some form of habitat remediation to guarantee long-term survival of the new populations, as well as allow for the dispersal of the species and subsequent establishment of metapopulations. The success of Karner blue reintroduction efforts in Indiana, Ohio, New Hampshire and New York all involved intensive habitat restoration efforts before butterflies were released (Schweitzer 1994, Tolson et al. 2009, John Kantor, pers. comm.). These efforts primarily involved managing for the larval host plant through a combination of prescribed fire and mechanical means. The same is true for the reintroduction of the regal fritillary (*Speyeria idalia* Drury) in Neal Smith National Wildlife Refuge in Iowa, where extensive habitat restoration was done in advance of the introduction through extensive prairie restoration efforts (Shepherd & Debinski 2005). Over 2000 host plants were planted at sites within the refuge in preparation for the release of this butterfly.

There have also been several successful reintroduction efforts in Europe. In the case of the Apollo butterfly (*Parnassius apollo* L.) in the Polish Carpathians, intensive habitat preparation projects were initiated in order to support a metapopulation of this species (Witkowski et al. 1997). They continuously created new sites and released new individuals to the area starting in the 1990's. The large blue butterfly (*Phengaris arion* L., formerly *Maculinea arion* L.) in Britain thrived for over 25 years due to reintroduction efforts (Pullin 1996). Their original demise was due to their dependence on a single species of ant. Changes in grazing practices and a viral infection in rabbits caused grasses to become overgrown until the habitat could no longer support the ants. Re-establishment of grazing practices and habitat restoration was the major factor contributing to the success of the large blue butterfly. Similarly, silver-studded blue translocation efforts in the UK, which have been seemingly successful since 2007, were preceded by extensive heathland management in order to create suitable habitat for both the butterfly and the ants on which the butterfly depends (Parker 2012). New populations of the marsh fritillary in the UK were established only in areas that had supported historical populations of the species; multiple patches of grassland habitat have been restored through scrub removal, cutting, and supplemental plantings (Porter 2012). Such examples illustrate the critical importance of understanding the life history and habitat requirements of a species and ensuring that those requirements are met before individuals are released.

(7) What kind of site maintenance should be expected? Periodic clearing of trees and shrubs to maintain the open quality of the wetland should be anticipated. If this is done every 2-4 years, it can probably be done by hand to avoid the burden and cost of having to use heavy equipment. Clearing of trees and shrubs should be done in the late fall or winter, when the ground is frozen and larvae will have entered diapause.

Annual mowing of fields and roadsides will also be important for most Baltimore checkerspot sites in order to maintain early-successional sites for nectar plants. The best time to mow is in early winter after Baltimore checkerspot larvae have retreated to the leaf litter and entered diapause. The mower blade should be set high (several inches from the ground) so that any larvae or pupae (of any species of Lepidoptera) that may be in the leaf litter are not harmed.

If herbicides are used, as in the maintenance of NNIs, trees or shrubs, treatments should be done during the growing season so that plants can take up chemicals into the roots or cambium. Late summer or very early in the fall may be an ideal time for this.

In many cases, wetlands may be separated from meadows with nectar plants by forested or shrubby areas. If this is the case, it is recommended that a cleared and regularly mowed corridor (using the above specifications) be created so that butterflies can move freely between areas of host and nectar plants.

(8) What are some sources for host and nectar plants? Appendices IV and V include a list of recommended suppliers for white turtlehead, and for some secondary host plants and nectar plants. General recommendations for purchasing host and nectar plants include the following: (1) make sure that the supplier does not use systemic pesticides on the plants; (2) avoid nectar plant cultivars when possible, as many do not contain nectar; (3) when possible, get plants from growers who have propagated the plant from seed, as this will ensure that previous growers did not use pesticides or take any other actions that may harm butterflies or other insects; and (4) try to obtain plants from regional sources (in our case, the mid-Atlantic region), as many native plant nurseries do not grow their own plants and may obtain them from other regions of the country. Plants obtained from areas with vastly different climates (i.e., Canada) may have low survivorship. When necessary, call ahead and custom order plants according to the above specifications.

(9) What actions should be avoided? In addition to the above considerations, there are several actions we will not undertake at this time. As mentioned previously, we will not obtain Baltimore checkerspot stock from any other states, or from western Maryland where the climate is very different from the Piedmont Region. At the same time we will take care not to decimate or reduce populations in the Maryland Piedmont by removing individuals from wild populations for captive rearing operations. While this may be have to be done on some level, it will be kept to a minimum and coordinated by Maryland NHP in consultation with BCRT members and local lepidopterists responsible for annual site monitoring.

We will also avoid planting non-native plants, including English plantain, for captive rearing efforts. If Maryland Piedmont populations of Baltimore checkerspots start using plantain as a host on their own we can reevaluate this decision, but since evidence for plantain use by Maryland populations is limited to a handful of observations, our efforts will concentrate on turtlehead propagation and on making native secondary host and nectar plants available.

(10) What are the potential impacts on other species? Many species inhabit the same type of wetland habitat that is utilized by Baltimore checkerspots, including the federally threatened bog

turtle (*Glyptemys muhlenbergii* Schoepff), and other species of Lepidoptera including the black dash (*Euphyes conspicua* WH Edwards) and the mulberry wing (*Poanes massasoit* Scudder). Wetland restoration for Baltimore checkerspots is expected to benefit these species as well. All restoration activities will be done in consultation with site managers or landowners, as well as other biologists to ensure that our efforts do not harm other species. At the same time, when existing wetlands are targeted for restoration, we will consult with various individuals in an attempt to determine whether there are any rare species (plant and animal) that may be impacted; this consultation may include the landowner or land manager, Maryland NHP biologists, and local naturalists familiar with the site.

Summary – Until we can evaluate whether or not our reintroduction efforts are posing a risk to wild colonies, we will proceed slowly and with caution, and carefully evaluate the impacts of our actions to ensure that they do not threaten wild colonies of Baltimore checkerspots. Our strategies should be based, at least in part, on other reintroduction efforts that have worked for other species of Lepidoptera. We should also take a lesson from failed reintroduction efforts to avoid the pitfalls that other researchers have experienced. Reasons attributed to the failure of reintroduction efforts have included the following: a lack of available habitat, a lack of understanding about the life history requirements of the species, dramatic weather events, releasing individuals to an area of unsuitable climate, releasing too few individuals, inbreeding depression, invasive species proliferation, climate change and infections in reintroduced caterpillars. Schultz et al. (2008) gives an excellent overview of reintroduction efforts in the US and Britain.

We should also be cognizant of the fact that while there is much to be learned from other butterfly reintroduction efforts, most of those efforts have taken place in non-wetland habitats. The fact that the Baltimore checkerspot is a wetland species whose life stages also require an upland buffer zone where adults can obtain nectar, suggests additional challenges in determining which habitats will be suitable for reintroduction and what actions may be needed to prepare a site for a successful reintroduction.

<u>*Section 7 – Short-term action items*</u> (to be completed within a year):
a. Determine some measure (i.e., area, number of plants, etc.) of host and nectar plants needed to sustain reintroduced colonies of Baltimore checkerspots.
b. Determine some measure of how many individuals need to be released at wetlands of various sizes and with varying amounts of turtlehead to enhance the probability of a successful reintroduction effort.
c. Create guidelines for breeding facility monitoring highlighting the warning signs that larvae are infected by parasitoids or viruses.
d. Through photo, video or written text, document the various breeding facilities and captive breeding procedures with the long-term objective of creating a Baltimore checkerspot captive breeding manual.

<u>*Section 7 – Long-term Action Items*</u> (to be completed within the next 2 years): none

8. DEFINING GOALS AND MEASURING PROGRESS

8.1 Outline of Short Term Goals

(1) Maintain and monitor all known wild Baltimore checkerspots colonies in Maryland. To this end, we will also conduct field surveys to locate undiscovered wild colonies of Baltimore checkerspots (assuming any exist). This may include the initiation of a public survey effort that

informs citizens of how to identify Baltimore checkerspots and encourages them to send their data to a partnering organization for inclusion in a comprehensive database.
(2) Locate wetland sites that have the potential to support colonies of Baltimore checkerspots. These wetlands should fall within 10 km buffer zones (see Section 5.1 for an explanation of 10 km distance). Land owner permission must be established prior to survey work.
(3) Increasing management efforts to restore and enhance wetland habitats. While some wetlands may exist in a state already suitable for Baltimore checkerspots, most will require restoration. Restoration tasks may include removing invasive species, clearing the wetland of encroaching trees and shrubs, planting host plants (turtlehead as well as late-instar secondary host plants), planting nectar plants, and protecting plants from deer browse. Restored wetlands should fall within 10km buffer zones (see Section 5.1 for an explanation of 10 km distance) and work should be completed with permission and cooperation from the land manager. Care must be taken to ensure that the wetlands remain suitable for other species that may be currently using them, including other invertebrates, reptiles and amphibians that also require wetland habitats.
(4) Initiate a collaborative captive breeding and release program. This will involve not only the actual construction of breeding facilities, but also the maintenance of the facilities, the exchange of butterflies with other facilities engaged in captive breeding, and the introduction of reared individuals to new wetland sites.
(5) Conduct scientific research and monitoring to facilitate management actions and evaluate our results. This will involve outlining research methods, selecting study sites, collaborating with other agencies or organizations, and designating individuals to carry out the work assuming funding and manpower are available.

8.2 Plans for Measuring Progress:
(1) Track the number of wetlands located and/or restored for use by Baltimore checkerspots.
(2) Track public interest and public participation in education efforts. This may include tracking the number of volunteers assisting with survey and restoration efforts (or the number of volunteer hours), public attendance at educational programs or events, student participation in school programs, and public participation in data collection efforts.
(3) Track the number of collaborating partners. The number of partnering organizations involved in this conservation effort, the sustainability of those relationships, and the range of tasks involved can all serve to measure our success. One nature center that may have worked in isolation at the start of their projects may have since altered their approach to work across a larger area of the Piedmont by partnering with other organizations. Restoration efforts that were started in Maryland could expand to include other states. Evidence of collaboration or project growth may be more subjective in terms of measuring progress but should nevertheless be noted.
(4) Track the number of individuals released.
(5) Track the number of new colonies and their sustainability over time.
(6) Record evidence of interaction between colonies (both wild and introduced).
(7) Track the overall sustainability of colonies (wild and introduced) OR the succession of colonies to colder climes.

Section 8 – Short-term action items (to be completed within a year): none
Section 8 – Long-term Action Items (to be completed within the next 2 years): none

9. BCRT PARTNERS

Anita C. Leight Estuary Center
Otter Point Creek Component
Chesapeake Bay National Estuarine Research Reserve
Harford County Department of Parks and Recreation
700 Otter Point Road
Abingdon, MD 21009
Phone: (410) 612-1688
Active Partners: Kriste Garman (Park Manager), Kathy Baker-Brosh (Naturalist) & Nicole Eller (Intern)

Black Hill Regional Park
Maryland-National Capital Park and Planning Commission
20930 Lake Ridge Drive
Boyds, MD 20841
Phone: (301) 528-3490
Active Partners: Denise Gibbs (Former Park Naturalist) & Barbara Kreiley (Former Project Leader)

Carroll County Public Schools
125 North Court Street
Westminster, MD 21157
Phone: (410) 751-3000
Active Partner: Matt Lustig (Teacher)

Cromwell Valley Park
2002 Cromwell Bridge Road
Baltimore, MD 21234-1419
Phone: (410) 887-3014
Active Partner: Justine Schaeffer (Naturalist)

Eden Mill Nature Center
Harford County Department of Parks and Recreation
1617 Eden Mill Road
Pylesville, MD 21132
Phone: (410) 836-3050
Active Partners: Frank Marsden (Program Director) & Aimee Harris (Recreation Specialist)

Fountain Rock Park and Nature Center
Frederick County Department of Parks and Recreation
8511 Nature Center Place
Walkersville, MD 21793
Phone: (301) 898-1460
Active Partners: Alice Nemitsas (Park Naturalist) & Kelly Ketzenberger

Harford Glen Environmental Education Center
502 West Wheel Road
Bel Air, MD 21015
Phone: (410) 638-3909
Active Partner: Ruth Eisenhour (Teacher in Charge)

Maryland Department of Natural Resources
Wildlife and Heritage Service
Natural Heritage Program
Tawes State Office Building, E-1
580 Taylor Avenue
Annapolis, MD 21401
Phone: 410-260-8540
Active Partners: Jennifer Frye (Invertebrate Ecologist), Jim McCann (State Zoologist), Kerrie Kyde (Invasive Plant Biologist), Kerry Wixted (Natural Resources Biologist), Bradley Kennedy (Landowner Incentive Program Biologist) & Dana Limpert (Conservation Specialist)

Maryland Entomological Society
Active Partner: Richard Smith

Maryland-National Capital Park and Planning Commission
Montgomery County Parks
12535 Milestone Manor Lane
Germantown, MD 20876
Phone: 301-962-1341
Active Partner: Rob Gibbs (Natural Resources Manager)

Robert E. Lee Park
Baltimore County Department of Recreation and Parks
1000 Lakeside Drive
Baltimore, MD 21210
Phone: (410) 887-4156
Active Partner: Shannon Davis (Park Ranger)

Robinson Nature Center
Howard County Department of Recreation and Parks
7120 Oakland Mills Road
Columbia, MD 21046
Active Partners: Sue Muller (Project Leader, 410-313-4697), Helen Metzman (Natural Resource Specialist, 410-313-3708), Katie Peet (Naturalist) & Tracy Gelner (Naturalist)

Rocky Gap State Park
12500 Pleasant Valley Road
Flintstone, MD 21530
Phone: (301) 722-1480
Active Partners: Julia Wieners (Park Ranger) & Nicole Love (Intern/Volunteer)

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Pest Permitting Branch
4700 River Rd., Unit 133
Riverdale, MD 20737
Active Partner: Wayne Wehling (Senior Entomologist)

University of Colorado
CU Museum and Department of Ecology and Evolutionary Biology
University of Colorado UCB 334
Boulder, CO 80309
Active Partner: M Deane Bowers (Curator and Professor)

University of Maryland Baltimore County
Department of Biological Sciences
Active Partner: Austin Platt (Assistant Professor Emeritus)

Washington Area Butterfly Club
Active Partner: Pat Durkin

Washington Suburban Sanitary Commission
14501 Sweitzer Lane
Laurel, MD 20707
Phone: (301) 206-9772
Active Partner: Kimberly Knox (Community Outreach)

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APPENDIX I
DATA COLLECTION FIELD FORM
BALTIMORE CHECKERSPOT COLONY SURVEYS

Please fill in as much information as possible keeping in mind that accuracy is important. If you are uncertain about a plant species or other data, note that on the form. GPS data is helpful, but if you not have access to a GPS device, please include specific directions or other location data, like a map. Email or call Jen Frye at 410-827-8612 x102 with any questions.

DATE __/____/____ TIME____________________EXAMINER NAME__________________ COUNTY ____________________________
SITE NAME AND LOCATION:
GPS LAT LONG:

TYPE OF SURVEY (**Pollard, Checklist**):

WEATHER CONDITIONS:
Temperature (Fº):
Wind (e.g. light breeze from NW):
Percent Cloud Cover:
Other Weather Notes:

SPECIES INFORMATION (ADULT SURVEYS):
Number of Adults Observed:
Gender: ___ males ___ females ___mixed ___unknown

Condition: ___ fresh ___ flight-worn ___ other damage

Distribution within site (concentrated, widespread, sparse):

Behavior(s): (e.g., nectaring (give plant species below), patrolling, ovipositing, courting, mating, basking, puddling):

Other Observations:

If no individuals observed, explain (e.g., clouds moved in, area recently burned, no obvious explanation):

Other butterflies observed and any observational data associated with those species:

SPECIES INFORMATION (LARVAL SURVEYS)
If Pre-Diapause: Number of Webs Observed:

If Post-Diapause: Approximate Number of Caterpillars Observed:

Distribution within site (concentrated, widespread, sparse):

Host Plants:

Other Observations:

If no individuals observed, explain (e.g., host plants not available, no obvious explanation):

HOST AND NECTAR PLANTS (If possible, estimate abundance, general distribution at site, etc.):

Potential Threats or Site Concerns (i.e. deer browse, invasive plants):

Maps and Directions (Please attach a map and directions to the site if possible).

APPENDIX II
DATA COLLECTION FIELD FORM
WETLAND HABITAT ASSESSMENT FOR BALTIMORE CHECKERSPOT SITES

Please fill in as much information as possible keeping in mind that accuracy is important. If you are uncertain about a plant species or other data, note that on the form. GPS data is helpful, but if you not have access to a GPS device, please include specific directions or other location data, like a map. Email or call Jen Frye at 410-827-8612 x102 with any questions.

DATE __/____/____ EXAMINER NAME__________________ COUNTY ____________________________
GPS LAT LONG : ____________
GPS LOCATIONAL UNCERTAINTY (SPECIFY FEET OR METERS)______________________
PHOTO POINT MONITORING CONDUCTED? (RECOMMENDED!)
DIRECTIONS TO SITE:

GENERAL DESCRIPTION: (Describe the ecological and landscape setting, topography, offsite influences, site ownership, etc. Feel free to attach additional photographs. Specify whether the site is or has been occupied by Baltimore checkerspots or is being considered as a release site.)

VEGETATION LIST: (Fill our species list below in order of cover dominance)

Dominant Species (species and *abundance)	Exotic Species (species and *abundance)
1: ____	1: ______________________________________ ____
2: ____	2: ______________________________________ ____
3: ____	3: ______________________________________ ____
4: ____	4: ______________________________________ ____
5: ____	5: ______________________________________ ____
6: ____	6: ______________________________________ ____
7: ____	7: ______________________________________ ____
8: ____	8: ______________________________________ ____

*Exotic species abundance codes within or immediately adjacent are: Rare, Infrequent, Occasional, Frequent, or Abundant

VEGETATION COMMENTS: (Provide any additional comments on wetland condition or vegetation information here. Include notes on the abundance of turtlehead (area covered or approximate number of plants by category: (a)<10; (b)<50; (c)<100; (d)hundreds; or (e)thousands.), presence and abundance of late-instar secondary host plants, and on nectar plant availability).

LIGHT LEVELS: (Full sun, partial shade, filtered or dappled sunlight, closed canopy, etc.)

SIZE: (Approximate size of the community or wetland. Include your survey effort, e.g. walked through most of it, explored only one section, etc.).

CONDITION: (Land use history, anthropogenic disturbance, exotic species, alterations of natural processes, etc.).

RESTORATION OR MANAGEMENT NEEDS:

APPENDIX III
WETLAND SUITABILITY CRITERIA FOR BALTIMORE CHECKERSPOT SITE RESTORATION
(FOR SITES BEING CONSIDERED FOR RESTORATION AND RELEASE)

Please fill in as much information as possible keeping in mind that accuracy is important. If you are uncertain about a plant species or other data, note that on the form. GPS data is helpful, but if you not have access to a GPS device, please include specific directions or other location data, like a map. Email or call Jen Frye at 410-827-8612 x102 with any questions.

DATE __/____/____ EXAMINER NAME__________________ COUNTY ____________________________
GPS LAT LONG : ____________
DIRECTIONS TO SITE:

IS THE SITE IN THE VICINITY OF AN EXISTING COLONY OR ANOTHER PLANNED RESTORATION SITE? (Please be specific):

GENERAL DESCRIPTION (Describe the ecological and landscape setting, topography, size, light levels, condition, etc. Feel free to attach photographs):

SITE OWNERSHIP (If privately owned, does landowner have an easement on the property? Would they consider one?):

WETLAND SOURCE (Is source vulnerable to contamination (i.e. fertilizers), drainage (i.e. new housing developments) or other factors?):

POTENTIAL THREATS (HUMAN-INDUCED) (ATV use, pesticide spraying, etc.):

POTENTIAL THREATS (NATURAL) (Forest succession, deer browse, etc.):

OFFSITE INFLUENCES (Is site well buffered? Does it fall within a natural landscape? Is the surrounding area developed?):

IS TURTLEHEAD PRESENT? IF NO, ARE CONDITIONS SUITABLE TO SUPPORT IT?
SOIL TYPE:
pH LEVEL:
WATER TABLE DEPTH:

IF YES, IS IT ABUNDANT? CROWDED BY OTHER PLANT SPECIES?

SECONDARY HOST PLANTS AND NECTAR PLANT PRESENT:

OTHER VEGETATION PRESENT (Native and Invasive. If possible, try to estimate relative cover of the most dominant plants):

RESTORATION NEEDS:

APPENDIX IV
SUPPLIERS OF WHITE TURTLEHEAD (*Chelone glabra*)

Nurseries that sell white turtlehead plants in the Mid-Atlantic Region
http://www.signaturehort.com/
www.edgeofthewoodsnursery.com
www.amandagarden.com
www.sunfarm.com
www.AmericanNativeNursery.com
www.toadshade.com
www.sylvanative.com
www.northcreeknurseries.com

Nurseries that sell white turtlehead seed in the Mid-Atlantic Region
www.ernstseed.com

Local sources for white turtlehead plants (Maryland and DC Metro Area)
NOTE: For all nurseries listed, call or e-mail for species availability. It is also strongly recommended that customers ask the questions listed below before purchasing plants.
1. Have the plants been sprayed with a pesticide? If so, which pesticide was used and when was the plant treated?
2. Have the plants been treated with a systemic insecticide?
3. Are the plants from local genotypes?

If the answer to question #1 is yes, you can wash the spray off both surfaces of each leaf with soap and water, or with an organic vegetable wash solution, and then rinse thoroughly.

If the answer to question #2 is yes, don't buy a butterfly host plant that has been treated with a systemic insecticide.

If the answer to question #3 is no, try to find a supplier that has local genotypes. Many native plant nurseries do not grow all of their own plants and the genotypes may be from other regions. When possible, attempt to trade seeds or cuttings with local growers.

Non-Profits:
Adkins Arboretum
12610 Eveland Road
Ridgely, MD 21660
Phone: 410-634-2847
Website: www.adkinsarboretum.org

Black Hill Regional Park Greenhouse
Friends of Black Hill Visitor Center
Website: www.blackhillnature.org
E-mail: mary.mcknight@starpower.net (greenhouse manager)
Annual spring native plant sale, last weekend in April. Pre-orders accepted.

Chesapeake Natives, Inc.
Rochelle Bartolomei
Pope Farm Nursery
7400 Airpark Rd
Derwood, MD 20855
Website: www.chesapeakenatives.org
E-mail: chesnatives@gmail.com

Environmental Concern, Inc.
201 Boundary Lane
P.O. Box P
St. Michaels, MD 21663
Phone: 410-745-9620
Website: www.wetland.org
E-mail: horticulture@wetland.org

Irvine Nature Center
11201 Garrison Forest Road
Owings Mills, MD 21117
Phone: 443-738-9217
Website: www.explorenature.org Plants are for sale in spring and fall at the visitor center.

National Arboretum
3501 New York Ave, NE
Washington, DC 20002
Phone: 202 245-2726
Website: http://www.usna.usda.gov/index.html
Annual Lahr Symposium in March hosts native plant nurseries w/ plants for sale.

Retail and Wholesale:
American Native Plants
4812 East Joppa Road
Perry Hall, MD 21128
Website: www.americannativeplants.net

Ernst Conservation Seeds
8884 Mercer Pike
Meadville PA 16335
Website: http://www.ernstseed.com

Herring Run Nursery
(A Program of Blue Water Baltimore)
6131 Hillen Road
Baltimore, MD, 21234
Website: http://www.bluewaterbaltimore.org/herring-run-nursery/about-the-nursery/

Kollar Nursery
5200 West Heaps Road
Pylesville, MD 21132
Phone: 410-836-0500
Website: www.kollarnursery.com

Kurt Bluemel Nursery
2740 Greene Lane
Baldwin, MD 21013
(800) 498-1560 • (410) 557-7229
http://www.kurtbluemel.com/botanical/perennials_a.html
This nursery sells several species of *Chelone* and its cultivars; be sure to order the true *Chelone glabra* species

Nature by Design
300 Calvert Avenue
Alexandria, VA 22301
Phone: 703-683-4769
Website: www.nature-by-design.com
Accepts special orders with advance payment.

Signature Horticultural Services
Kevin Fabula
Freeland, MD
Phone: 410-329-6466
Fax: 410-329-2156
http://www.signaturehort.com/

Wakefield Valley Nursery
Frank Vleck
1690 Wakefield Valley Road
New Windsor, MD 21776
Phone: 410-635-2169
Website: www.wakefieldvalleynursery.com
E-mail: wfvn@quis.net

Water's Edge Nursery
Scott Haschen
6526 Dion Road
Federalsburg, MD 21652
Phone: 410-479-9037

Wicklein's Water Gardens
Erik Wicklein
1820 Cromwell Bridge Road
Baltimore, MD 21234
Phone: 410-823-1335

Websites with general information about white turtlehead:
http://www.Marylandflora.org/resources/publications/wildflowerinfocus/pim_white_turtlehead.pdf
http://www.beautifulwildlifegarden.com/turtlehead-for-baltimore-checkerspot-butterflies.html
http://plants.usda.gov/java/profile?symbol=CHGL2
http://www.izelplants.com/plants/mapsearch/perennials/item/chelone-glabra
http://www.riwps.org/Chelone_glabra.pdf
http://www.wildflower.org/plants/result.php?id_plant=CHGL2
http://www.diamon-naturals.us/turtlehead.htm

APPENDIX V
PROPAGATION TECHNIQUES AND SUPPLIERS FOR SECONDARY HOST AND NECTAR PLANTS

NOTE: For all nurseries listed, call or e-mail for species availability. It is also strongly recommended that customers ask the questions listed below before purchasing plants.
1. Have the plants been sprayed with a pesticide? If so, which pesticide was used and when was the plant treated?
2. Have the plants been treated with a systemic insecticide?
3. Are the plants from local genotypes?

If the answer to question #1 is yes, you can wash the spray off both surfaces of each leaf with soap and water, or with an organic vegetable wash solution, and then rinse thoroughly.

If the answer to question #2 is yes, don't buy the plant. Never purchase butterfly host plants that have been treated with a systemic insecticide.

If the answer to question #3 is no, try to find a supplier that has local genotypes. Many native plant nurseries do not grow all of their own plants and the genotypes may be from other regions. When possible, attempt to trade seeds or cuttings with local growers.

Propagation and/or Nursery Availability of Secondary Host Plants

Arrowwood Viburnum *(Viburnum recognitum)* Some native plant nurseries specializing in trees and shrubs have this native shrub for sale. Check the resources section of the Maryland Native Plant Society website at www.mdflora.org. It may also be found at larger mainstream nurseries.

White Ash *(Fraxinus americanus)* Some native plant nurseries specializing in trees and shrubs still have this native tree for sale. Check the resources section of the Maryland Native Plant Society website at www.mdflora.org. Please note: this species is being attacked by ash borers, which cause 100% mortality, so planting is not recommended.

Honeysuckle *(Lonicera spp.)* The easiest method is to dig or collect your own from safe, pesticide-free areas of both non-native invasive Japanese honeysuckle and bush honeysuckle. Our Maryland Coastal Plain native coral honeysuckle *(Lonicera sempervirens)* is available for purchase at most mainstream nurseries, although finding the true species is difficult. Most nurseries carry only cultivars, some of which have no nectar, but in this case it's only the leaves that are needed. To propagate coral honeysuckle, take softwood cuttings in May-June.

Hairy Beardtongue *(Penstemon hirsutus)* This native species over-winters as a basal rosette and is preferred by post-diapausal caterpillars over most of the other choices. Plus, leaves are available in early spring if caterpillars begin feeding before other secondary host species have leafed out. It is easy to grow from seed with only a one-month cold-moist stratification. Seeds need light to germinate; sow seeds on soil surface and do not cover with soil. Plants can also be found at native plant nurseries and some large mainstream nurseries.

Foxglove Beardtongue *(Penstemon digitalis)* This native species also over-winters as a basal rosette and is a preferred species. It is easy to grow from seed, but division of established plants is recommended. Detailed instructions on dividing plants can be found at the American Penstemon Society's website at http://apsdev.org/propagation/division.html This species is widely available in the nursery trade.

Lousewort or Wood Betony *(Pedicularis canadensis)* This native species is generally found growing at higher elevations and is difficult to find at nurseries on Maryland's Piedmont or Coastal Plain. This species has semi-evergreen leaves in the basal rosette, so would be a good early spring food source for larvae. Once the plant is established, it spreads by rhizomes, which can be easily divided. Some native plant nurseries in the Great Lakes region sell this species: www.bluestemfarm.com www.hiddensavanna.com and http://www.prairiemoon.com

Blue Toadflax *(Nuttalanthus canadensis)* This native species likes well-drained sandy soil and would grow best in Coastal Plain areas. Environmental Concern in St. Michael's, Maryland sells this species, although availability is limited. See: http://www.wetland.org/nursery. Also, check this Norfolk, VA dune restoration website for a listing of east coast nurseries that sell this species. See: http://www.norfolk.gov/es/pdf/Dune_Restoration_guide.pdf.

Narrow-leaved Plantain *(Plantago lanceaolata)* This non-native invasive species over-winters as a basal rosette and (along with Hairy beardtongue) is preferred by post-diapausal caterpillars over most of the other choices. The easiest method is to dig plants from safe, pesticide-free areas. This species should not be propagated or planted in wild areas.

Propagation and/or Nursery Availability of Nectar Plants that Bloom During Adult Flight Period

Common Milkweed *(Asclepias syriaca)* Seeds: Cold-moist stratify seeds for one month. Native.

Butterfly Weed *(Asclepias tuberosa)* Seeds: Cold-moist stratify seeds for one month. Buy pesticide-free plants from native plant nurseries and large mainstream nurseries. Native.

Dogbane or Indian Hemp *(Apocynum cannabinum)* Seeds: Cold-moist stratify seeds for one month. Spreads by rhizomes; root cuttings may be taken in spring or fall. Native.

Ox-eye Daisy *(Chrysanthemum leucanthemum)* Seeds: available from many online seed nurseries. One is www.americanmeadows.com. After the last spring frost, sow seed directly on ground where you want them to grow and cover lightly with soil. This plant is non-native and can be aggressive.

Daisy Fleabane *(Erigeron annuus)* Seeds: no known commercial seed sources; collect seed from wild patches. After last spring frost, sow seed directly on ground where you want them to grow and cover lightly with soil. Native annual or biennial. Can be aggressive in disturbed soil.

Lance-leaved Coreopsis *(Coreopsis lanceolata)* Seeds: easy to propagate and available from many online seed nurseries. Plants are widely available at mainstream nurseries. Note: there are numerous cultivars, some of which do not produce nectar. Purchase the true species. Native, but in Maryland it is generally found as a cultivated escapee.

Mountain Mint *(Pynanthemum spp.)* *P. incanum, P. muticum* and *P. virginianum* are most easily grown from stem cuttings (spring or summer). Seeds: cold-moist stratify for one month. Plants available at many native plant nurseries and some mainstream nurseries. Native.

Wild Blackberry *(Rubus spp.)* Purchase from nurseries or layer canes from wild bushes. Native.

APPENDIX VI
DEER FENCING AND MATERIALS

4' welded wire fencing with 2" x 4" holes. Fence posts are 6' tall. You can replicate this design using 5' fencing with 6' poles. Photo by Rob Gibbs, M-NCPPC.

Double electric fence operated by a battery powered charger. Metal threads in the rope provide the charge. Photo by Noah Rawe, Maryland Forest Service.

“Roofed” deer exclosure made from 24" vinyl green lawn fence and staked in the ground with 3/8" x 48" rebar pins. Exclosure is held together using crab pot rings (cable ties would also work but are more cumbersome to deal with. Exclosure has an approximate 32" diameter with a height of 24" and is covered with another section of lawn fence measuring 24" by 30". One roll of lawn fence will provide enough material for 4 exclosures. Photo by Jen Frye, Maryland NHP.

Welded wire deer fence, 10' x 10' x 8' high, with metal stakes and an open top. Photo by Ruth Eisenhour, Harford Glen Environmental Education Center.

APPENDIX IV
GLOSSARY OF TERMS
(as used in this conservation and management plan)

action items – tasks that will be undertaken in a given time frame by the Baltimore Checkerspot Recovery Team (BCRT) in support of larger goals and objectives outlined in the Baltimore Checkerspot Conservation and Management Plan.

adult sighting – when surveying, this refers to the sighting of an adult butterfly or butterflies, without recording or observing evidence of a breeding colony or other life stages (eggs, larvae or pupae).

ArcMap GIS – mapping software produced by the Environmental Systems Research Institute, Inc. (Esri©) that allows for the visual display and analysis of spatial data. The software can be used to mark the locations of species, habitats and other features on the landscape.

basal rosette – a circular arrangement of leaves around the base of a plant stem, usually at or near the surface of the ground.

Braconidae – a large family of parasitoid wasps that typically attack herbivorous insects.

buffer – a specified linear distance around an object or area.

cambium – a layer of tissue just under the bark of woody plants that is responsible for the secondary growth of roots and stems.

Climate Envelope Model (CEM) – a computer model that uses climate-related information to predict the distribution of a species by inferring its environmental requirements (temperature, rainfall, etc.) from localities where it is currently known to occur.

climate space - an area of land which has a suitable climate for a particular species, independent of habitat.

Climate Change Vulnerability Index (CCVI) – a NatureServe model designed to determine the vulnerability of a plant or animal species to the predicted impacts of climate change by considering the magnitude of change predicted to occur within the range of a given species and measuring that against the physiological characteristics (if known) and ecological requirements of that species.

coldframe – a protected plant bed with a transparent roof, typically built low to the ground and used to protect plants from adverse weather conditions while they slowly acclimate to outdoor conditions prior to transplanting.

cold-moist stratification – the process of pretreating seeds with low temperatures and moisture to mimic natural winter conditions. This technique is used to break down seed germination inhibitors in the seed in a relatively short period of time to speed up and ensure seed germination.

connectivity – refers to the physical or geographic distance between two habitats or populations of individuals as well as the degree to which the landscape facilitates or impedes the movement of individuals between those habitats or populations.

conservation easement – a land protection agreement between a private landowner and a government agency or land trust for the purposes of conserving natural resources in perpetuity. The landowner typically limits the right to develop and subdivide the land, while the agency or land trust accepting the easement agrees to monitor it in perpetuity to ensure compliance with the terms of the easement.

conservation status – a rank that indicates how rare or common, or how stable or imperiled a given species is. NatureServe and Natural Heritage Programs (NHPs) across the country use a suite of factors to assess species ranks, including the distribution of the species, the number of known populations or occurrences, and the population trend, all of which help to determine the risks of extirpation or extinction. Conservation status ranks are based on a one to five scale, ranging from critically imperiled (1) to demonstrably secure (5). Status is assessed and documented at the global (G), national (N), and state/province (S) level.

deleterious gene – a gene that generally results in a trait that decreases an individual's fitness in a particular environment.

diapause – a period of inactivity or dormancy in which an organism's growth and development is suspended and physiological systems are slowed, usually in response to adverse environmental conditions, such as the onset of winter.

dispersal corridor – an area of habitat connecting wildlife populations that would otherwise be separated by (usually) human developments, permitting individuals of otherwise separated populations the opportunity to interact and interbreed, negating the impacts of inbreeding depression by increasing gene flow, and potentially facilitating the expansion of individuals into new territories.

eclose – to emerge from a chrysalis or pupa, or to hatch from an egg.

enclosure – a barrier that seals off an area for the purpose of keeping something within it, such as a butterfly house where the butterflies cannot leave the area on their own.

exclosure – a barrier, such as a fence, typically designed for the purpose of keeping unwanted animals out of a given area.

extirpation – to become eliminated or to disappear from a given site or region.

fitness – the capacity of an organism to survive and reproduce.

gene – a unit of heredity made up of a segment of DNA, determining distinct characteristics that can be passed from parent to offspring.

gene flow – the transfer of genes between populations.

genotype – describes the genetic makeup of an individual.

host plant – the food plant required for the growth and development of a butterfly larvae (caterpillar). While many Lepidopteran species can feed on a number of different host plants, others are limited to one or a few specific species of host plant.

Ichneumonidae – a family of parasitoid wasps typically characterized by an elongated abdomen.

inbreeding depression – reductions in fitness as a consequence of matings between related individuals.

iridoid glycosides – a class of organic compounds usually found in plants that provide a chemical defense against herbivorous insects.

isolation effects – in the context of this plan, a presumed lack of genetic diversity and decreased fitness in a population of organisms due to geographic isolation and subsequent inbreeding.

larva – the caterpillar stage in the life cycle of a butterfly, characterized by feeding and growth.

Lepidoptera – the order of insects that includes the butterflies and moths.

managed hunt – an organized bow or firearm hunt with the goal of reducing deer density in a particular area.

managed lands – a term often applied to protected public lands that are managed or maintained for specific purposes, such as the protection of natural resources or the enhancement of wildlife habitat. Parks, wildlife management areas and wildlife refuges are all examples of managed lands.

Maximum Entropy (MAXENT) Model – a type of Climate Envelope Model (CEM) used to predict the distribution of a species by inferring its environmental requirements (temperature, rainfall, etc.) from localities where it is currently known to occur.

metapopulation – a group of spatially separated populations (or sub-populations) of the same species that are capable of interacting and interbreeding with one another over time. Typically, species that exhibit metapopulation dynamics occur within a number of habitat patches, with the result that sub-populations in some patches may go extinct while other patches may be colonized and form new sub-populations, so that not every patch is occupied at any given time. Richard Levins, who coined this term in 1970, defined a metapopulation as “a population of populations.”

NatureServe – a non-profit conservation organization whose mission is “to provide the scientific basis for effective conservation action.” NatureServe works with Natural Heritage Programs (NHPs) across the country to provide accurate, up-to-date information about rare and endangered species and ecosystems.

NHP Vegetation Plot Database – a database containing information on plant species composition and structure. Typically, this data is collected and maintained by state Natural Heritage Program (NHP) biologists who sample the vegetation using plots within a delimited area. Vegetation sampling is conducted across various regions of the state in order to classify the different types of plant communities that occur.

node – in plants, it is the area of the stem from which the leaves grow.

non-native invasive – any number of introduced plants inhabiting an area where they are non-indigenous or non-native. Non-native invasives (also called NNIs) are extremely adaptable and aggressive, and typically thrive in areas outside their natural range, often displacing native plants.

novel host – a new host plant only recently utilized by a species of butterfly larvae.

Nymphalidae – the family of brush-footed butterflies, known for having a reduced pair of fore legs.

outbreeding depression – a loss of fitness in an individual or population as a result of cross-breeding between individuals from highly differentiated populations. Outbreeding depression occurs when there is a break down in the genetic make-up that normally allows an individual or population to be locally adapted to their environment. Outbreeding depression is rarely documented. A common example to help understand the concept is as follows: for a given species, you might have two populations, one which produces a large body size and another which produces a small body size. Mating of individuals between these two populations may produce offspring with an intermediate body size, which may not be adaptive in either population.

parasitoid – an invertebrate, usually a wasp, fly or nematode, that completes a significant portion of its development within the body of host animal, ultimately consuming or killing it.

plugs – young, first-year plants that are grown in individual trays.

population viability - the ability of a population to persist over time and avoid extirpation or extinction. Population viability is affected by birth, death and growth rates of individuals within a population, and can be influenced by both environmental and genetic factors.

post-diapausal – refers to the state of an organism that has resumed activity after being in a diapausal state.

pre-diapausal – refers to the state of an organism that is active and has not yet entered diapause.

primary host plant – the main host plant of a butterfly larvae (caterpillar) which is required for growth and development and is particularly crucial in the early stages of development.

regional host – refers to food plant required by a butterfly larvae (caterpillar) in a given region, as it is not uncommon for a given species to use different host plants in different parts of its range.

rooting hormone – a natural or synthetic compound that stimulates cuttings to produce roots, hastening the vegetative propagation of new plants.

secondary host plant – butterfly larvae (caterpillar) host plants that be used in the later stages of a caterpillar's life cycle if the primary host plant is not available.

sedentary – in term of insects, having a low dispersal capability or inclination.

seed dormancy – a condition or state in which a seed does not germinate.

source population – in this context, reproductively successful populations of a given species that produce enough offspring to both sustain the original population and emigrate to new areas to give rise to new populations.

succession – the change in the species structure and composition of an ecological community over time.

suitable habitat – defined by NatureServe as "habitat capable of supporting reproduction or used regularly for feeding or other essential life history functions, [or more generally] a habitat in which you would expect to find the species."

Tachinidae – a large family of flies with worldwide distribution that are large, covered with stiff hairs, and known for being parasitoids of other arthropods.

track – in Natural Heritage Program (NHP) terms it means to keep track of a species or maintain awareness of how a species is faring in the state. Tracking involves periodically reviewing and recording data on the distribution, conservation status and population trend of a given species.

unsuitable habitat – defined by NatureServe as "habitat through which the species may successfully disperse but that cannot support reproduction or long-term survival."

water table – the level at which the ground is saturated with water.