

Survey of Karner blue butterflies at Allegan State Game Area by John Lerg

Introduction

The Karner blue butterfly (*Lycaeides melissa samuelis*) is a federally endangered butterfly that occurs in habitats supported within oak savanna in Michigan. The US Fish and Wildlife Service has commissioned a Karner Blue Butterfly Recovery Plan (USFWS 2003) which identifies an approach for recovering this butterfly that focuses on perpetuation of metapopulations in historic areas of occurrence of the butterfly. The plan is dependent upon the maintenance of habitat within historic areas to perpetuate these metapopulations.

To meet objectives of the Recovery Plan, there is a need to be able to recognize and quantify habitat for this butterfly. Similarly, there is a need to estimate butterfly numbers within selected habitats to help in habitat characterization. Finally, survey protocols need to be evaluated for their application to local habitat patches (or habitat sites) and butterfly populations.

Estimates of total butterfly numbers for the full duration of a flight period within a habitat patch have been attempted in a number of ways including using mark-release-recapture sampling, transect sampling with expansion to the area of the habitat patch, and total counts on the flight peak date and multiplying by a previously established factor. All of these methods involve direct measurement of butterfly populations.

An objective of this pilot effort is to begin to establish a basis for indirectly estimating butterfly population levels through assessment of the quantity and robustness of the associated habitat. Direct measurement of the butterfly is seen as an intermediary step in establishing this indirect population measurement and as a means to periodically validate the indirect population quantification.

This paper reports on a pilot effort to evaluate the effectiveness of using an expansion of Pollard-Yates Transects in estimating butterfly populations at selected sites. This effort also explores the effectiveness of visually characterized habitat as a predictor of butterfly density. Finally, this effort combines the information on butterfly densities by habitat patch with information on visually characterized habitat throughout metapopulation areas to suggest a means for estimating butterfly numbers within entire metapopulation areas.

Study Area

Allegan State Game Area, a state-owned property in southwest Michigan managed Department of Natural Resources, was chosen as the study site for this pilot effort. This Game Area hosts 2 of the 8 areas of historic butterfly occurrence in Michigan where the Recovery Plan recommends that metapopulations be perpetuated. Both butterflies and habitat on this Game Area have been well studied, and the availability of this information contributed to selection of this Game Area for this effort.

Each of the 2 metapopulation areas managed for the butterfly on the Game Area is roughly 10 square miles in extent and exists south of the Kalamazoo River and east of Swan Creek (Pine Plains Management Unit) and south of the Kalamazoo River and west of Swan Creek (Sand Plains Management Unit). The habitat, and thus the butterfly, occurs in multiple discrete habitat patches or habitat sites scattered within each of the metapopulation areas. The Pine Plains Management Unit is managed to support a metapopulation that has the structural form of a core–satellite metapopulation; the Sand Plains Management Unit is managed to support a metapopulation that has the structural form of a patchy metapopulation (USFWS 2003).

Methods

This pilot effort was focused in 5 selected habitat patches in the Pine Plains Management Unit and 4 selected habitat patches in the Sand Plains Management Unit. Within each Management Unit, habitat patches were selected that had both low and high wild lupine (*Lupinus perennis*) coverage based upon visual characterization. Although lupine coverage was not further quantified for this effort, lupine coverage on this Game Area has been previously reported in another study involving these habitat patches to range from 0.2% to 14.6% (Lawrence 1994). Acreage for each habitat patch was determined, and the Game Area database was queried to establish that each selected habitat patch was known to be occupied by Karner blue butterflies.

Pollard-Yates Transects (Pollard and Yates 1993) were run periodically (every 3 to 8 days) within each of the 9 selected habitat patches throughout the second flight period of the butterfly (29 June to 5 August, 2004). Transects were run only when temperatures were above 70 degrees Fahrenheit, there was no precipitation, and wind speeds were less than 10 mph. Meandering routes for transects were plotted within each of the habitat patches to cover the entire patch, including areas of lupine occurrence, and to avoid double counting of butterflies. These routes were reused when transects were subsequently rerun. The distance covered and the number of butterflies seen was recorded. All transects were run by the author, thereby ensuring greater consistency of sampling application.

Several species of butterflies and skippers were encountered during these transects. The perpendicular distance from the transect line to each butterfly identified as a Karner blue butterfly was recorded. Records were not made of butterflies that could not be positively identified, and no effort was made to depart from the transect line to pursue butterflies for purposes of better identification. This resulted in no records for butterflies that were greater than 4 meters from the transect line.

Transects that resulted in no butterflies seen were recorded as presence/absence surveys and were not included in total transects run. These zero counts occurred only at the beginning or end of the flight period and were taken as evidence of flight end points for individual habitat patches.

A daily population index was developed each time a transect was completed by taking the number of butterflies seen on an individual transect and reflecting this number against the

distance traveled on that transect. This index was recorded as butterflies per 100 meters of transect.

The perpendicular distance from the transect line to each individual Karner blue butterfly identified (n=396) was entered into a histogram, and modeling was used to arrive at an Effective Strip Width (ESW) within which the total number of butterflies present could be estimated. This method follows that in regular use by other researchers and is recommended for the butterfly (King 2000, Buckland and others 1993, Brown and Boyce 1998, Thomas 1983). The ESW is that perpendicular distance on either side of the transect line out to which the number of butterflies seen within that distance equals the number of butterflies seen beyond that distance. The Effective Strip Width determined for this study was 1.5 meters on each side of the transect line. This result agrees closely with that determined by King (2000) (ESW=1.47 meters) in Wisconsin.

Given an effective counting width of 3 meters (one ESW of 1.5 meters on each side of the transect line), the distance traveled on each transect was multiplied by 3 meters to generate a measure of survey area coverage for each transect. The number of butterflies observed on each transect was then reflected against this area of coverage to generate a butterfly density estimate for each day that a transect was run within an individual habitat patch. That density estimate was recorded as butterflies per 100 square meters. Butterfly density was combined with individual habitat patch area to generate a butterfly population estimate for the entire habitat patch for that day.

All daily population estimates by habitat patch were plotted against the days of duration of the second flight of the butterfly to generate a curve intersecting the x-axis at the date of the beginning and the end of the flight. The area under the curve was calculated and equated to the number of butterfly-days occurring within a given habitat patch. Noting that butterflies live an average of 5 days (USFWS 2003), the number of butterfly-days was divided by 5 to arrive at an estimate of the aggregate number of butterflies supported within a given habitat patch during the second flight. This number was further divided by the area of the habitat patch to arrive at a second-flight aggregate density for each patch, recorded as individuals per 100 square meters. This approach to population estimation is an expansion of methods summarized by Southwood (1978) and Krebs (1989).

Results

A total of 45 Pollard-Yates Transects were completed within the 9 selected habitat patches where Karner blue butterflies were seen (Table 1). For the Pine Plains Unit, the aggregate number of butterflies in the 5 selected habitat patches ranged from approximately 200 to approximately 2000 individual butterflies for a total in the 5 habitat patches of nearly 5000 (4827) individual butterflies during the second flight (Table 1). Aggregate butterfly density in these 5 habitat patches ranged from roughly 2 butterflies per 100 square meters to nearly 16 butterflies per 100 square meters. The 3 habitat patches that were judged prior to surveying to have high lupine coverage were found to have an aggregate butterfly density area-weighted average of 9.26 butterflies per 100 square meters. By comparison, the 2 habitat patches that were judged prior to surveying

to have low lupine coverage were found to have an aggregate butterfly density area-weighted average of 3.29 butterflies per 100 square meters.

For the Sand Plains Unit, the aggregate number of butterflies in the 4 selected habitat patches ranged from approximately 100 to approximately 3000 individual butterflies for a total in the 4 habitat patches of over 5000 (5445) individual butterflies during the second flight (Table 1). Aggregate butterfly density in these 4 habitat patches ranged from roughly 0.5 butterflies per 100 square meters to nearly 16 butterflies per 100 square meters. The single habitat patch that was judged prior to surveying to have high lupine occurrence was found to have an aggregate butterfly density of 15.93 butterflies per 100 square meters. By comparison, the 3 habitat patches that were judged prior to surveying to have low lupine occurrence were found to have an aggregate butterfly density area-weighted average of 1.96 butterflies per 100 square meters.

The 9 habitat patches selected for this pilot effort are subsets of much larger numbers of habitat patches within each of the 2 metapopulation areas on the Game Area. Some of these patches are known to be occupied with butterflies whereas information is lacking to provide similar understanding on other habitat patches. Area and lupine coverage were documented for an additional 10 known occupied habitat patches (Table 2). These additional 10 patches were combined with the original 9 patches within metapopulation areas and then grouped by lupine coverage (high or low).

The acreage in these lupine coverage groupings was combined with the expected aggregate butterfly density within each grouping to provide totals that could be summed as estimates of butterflies within each of the 2 metapopulation areas. By this process, the second-flight estimate for the Pine Plains Unit was over 10,000 (10,100) butterflies and over 18,000 (18,369) butterflies for the Sand Plains Unit. These estimates are generated from only the subset of habitat patches where information is available to support this process. Thus, from that consideration, they must be viewed as minimum estimates of metapopulation sizes.

Discussion

This pilot study recognizes a history of management for invertebrates that cues management response to changes in populations of selected invertebrate species as directly measured through surveys. Although this approach is intuitive, it is also intensive, costly, and potentially harmful to the species populations selected as indicators. Maintenance of habitat is often advocated as pivotal to conservation of these target species. Thus, cueing management directly to habitat needs and indirectly to population response may be more efficient and timely. This effort begins to develop that linkage.

In part, this pilot study represents an effort to quantify butterfly numbers at Allegan State Game Area. Previous to this study, a survey using mark-release-recapture methods performed in 1989 resulted in an estimate of 2000 to 3000 butterflies on the Game Area (Lawrence 1994). However, this survey was focused entirely in the Sand Plains Unit as the occurrence of butterflies in the Pine Plains Unit was not known at that time. Additional butterfly subpopulations in the Sand Plains Unit were also subsequently

discovered as a result of surveying additional habitat patches. Because these patches existed at least as early as 1989, this estimate of butterflies in the Sand Plains Unit is conservative.

Subsequent to Federal listing in 1992 (USFWS 1992), additional effort was expended in surveying for the Karner blue butterfly throughout its range in Michigan. At the time of listing, the butterfly was known from 6 counties whereas as a result of additional survey effort, it is currently known from 11 counties (Wilsmann 1994). Similarly, additional survey effort at Allegan State Game Area during that period resulted in discovery of several additional subpopulations and a relatively complete understanding of butterfly distribution on the Game Area.

In 1998, another effort was made to quantify butterfly numbers on Allegan State Game Area. In that effort, the Michigan Natural Features Inventory conducted total counts of all butterflies in known occupied habitat patches in both Management Units during 13-15 July approximating the peak of the second flight (M. Rabe, personal comm.). A total of 2,332 individual butterflies were counted with a majority occurring in habitat patches in the Sand Plains Management Unit. Expanding this total by a factor of 3 (Schweitzer 1994, USFWS 2003) provides a conservative estimate of approximately 7,000 butterflies for the 2 Management Units combined during the second flight in 1998.

Transect sampling was selected for this pilot effort because the method can be effectively applied in the field with limited resources, and it is a method accepted by other practitioners. However, expansion of transect results to population estimates covering a protracted flight period has been problematic. The method of using transect results to support population estimates for a single day and the use of such transect results repeated for selected dates throughout the flight period as points to define a curve that characterizes butterfly abundance throughout the flight is applied here. This method allows greater flexibility in selecting sample dates, can be customized to the attributes of the organism being studied, and is useful in characterizing population attributes in addition to population size.

The Recovery Plan recommends conservation of this butterfly through management of metapopulations (USFWS 2003). The plan offers a minimum viable metapopulation template that includes at least 3000 butterflies included in subpopulations within the metapopulation area with significant monitoring requirements to demonstrate adherence to template provisions. The plan also offers a large viable metapopulation template that involves considerably less monitoring but includes at least 6000 butterflies included in interacting subpopulations distributed over at least 640 acres of habitat within the metapopulation area. The results of this pilot effort suggest that 6000 butterflies can be supported on considerably less than 640 acres of habitat. Recent efforts by the US Fish and Wildlife Service to define occupied habitat amplify the significance of this apparent disconnect.

An assumption in managing for metapopulations is that they are sufficiently independent of each other that they evolve with unique attributes. The isolation necessary to

accommodate this evolution and uniqueness is typically a function of physical distance and barriers. For the 2 metapopulations at the Game Area, the distance between the approximate centers of the metapopulations is approximately 6 miles (10 kilometers). The distance between the closest subpopulations of these respective metapopulations is approximately 4 miles (6.5 kilometers).

Swan Creek, separating these metapopulations, is assumed to be a functional barrier. Although the Creek itself is not large, it exists within a riverine corridor whose bottom is variously 3 to 10 meters (10 to 30 feet) below escarpment tops on either side of the corridor and more than 1 kilometer wide in many places. Thus, the corridor occurs as a wide, deep trench on the landscape that is fully forested with lowland hardwoods. This combination of distance and a stream corridor acting as a physical barrier are assumed to have functionally precluded butterfly migration between metapopulations, thereby facilitating independence.

Given this presumed independence, a review of the data was conducted to search for unique attributes. Subpopulation numbers (n=4) in the Sand Plains Management Unit seem to have peaked a couple days earlier than subpopulation numbers (n=5) in the Pine Plains Management Unit. However, small sample sizes precluded the opportunity to consider significance (Table 1). Additionally, the second flight appeared to be more protracted and butterfly appearance more distributed through the flight in the Sand Plains Management Unit than in the Pine Plains Management Unit. Again, however, small sample sizes may have precluded discovery of significance (Kolmogorov-Smirnov Test).

This pilot effort was effective in highlighting the robustness of this process in assessing butterfly populations and in estimating the need for resources in expanding this effort in 2005. The effort also offered a data set with which to better understand the attributes of populations. Preliminary results from the limited set of habitat patches on which this effort was focused suggest that the habitat patches, in their aggregate, are sufficiently robust to support desired populations. Although management will be needed to maintain them in a condition that supports the butterfly, management for corridors to allow butterfly interaction between subpopulations should receive priority to attain similar robustness.

Acknowledgement

I thank Maria Albright, Wildlife Technician at Allegan State Game Area, for her efforts in retrieving and compiling data from the Game Area database. The study design was improved through comments offered by Jennifer Fetting. The manuscript benefited greatly from review by Matthew Herbert and Todd Hogrefe. This study is a contribution of Federal Aid in Wildlife Restoration, Michigan Planning Grant, E-3-HCP.

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John Lerg (LergJ@Michigan.gov)
Department of Natural Resources
Natural Heritage Unit
PO Box 30180
Lansing, Michigan 4890

Table 1. Karner blue butterfly survey results for Allegan State Game Area, 2004.

Habitat Patch	Area (Acreage)	Aggregate Butterfly Estimate For Patch	Population Peak (Date)	Aggregate Butterfly Density (Indiv/100 sq meters)	Lupine Cover.
Pine Plains Management Unit					
North Opening	0.4	197	89 (7/12)	12.18	High
Middle Opening	2.9	1858	1238 (7/12)	15.84	High
South Opening	5.5	1241	476 (7/12)	5.58	High
42 nd NE Opening	5.2	509	413 (7/12)	2.47	Low
Monroe Opening	6.4	1022	627 (7/15)	3.94	Low
Sand Plains Management Unit					
Circle Opening	1.6	1031	500 (7/12)	15.93	High
Annex Opening	7.9	834	304 (7/7)	2.61	Low
49 th NE Opening	41.7	3444	1502 (7/12)	2.04	Low
Natural Area E	6.1	136	54 (7/7)	0.55	Low

Table 2. Known occupied Karner blue butterfly habitat at Allegan State Game Area.

Habitat Patch	Area (Acreage)	Lupine Coverage
Pine Plains Management Unit		
North Opening	0.4	High
Middle Opening	2.9	High
South Opening	5.5	High
42 nd Northeast Opening	5.2	Low
Monroe Opening	6.4	Low
Power Line Opening	11.3	Low
Monroe West Opening	4.2	Low
40 th Pipe Opening	15.3	Low
40 th South Opening	1.4	Low
Staging Southeast Opening	7.3	Low
Sand Plains Management Unit		
Circle Opening	1.6	High
Pipeline 1 Opening	15.5	High
Horseman's 2 Opening	1.8	High
126 th Southeast Opening	6.6	Low
Annex Opening	7.9	Low
49 th Northeast Opening	41.7	Low
Natural Area East	6.1	Low
Horseman's 3 Opening	9.2	Low
46 th Northeast Opening	6.5	Low