Comparison of Land Management Practices on Common Wood Nymph Butterfly Populations

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Table of Contents

Abstract	iii
Introduction	1
Materials and Methods	2
Results	4
Discussion and Conclusions	5
Acknowledgements	9
References	9
Tables and Figures	11

ABSTRACT

Comparison of Land Management Practices on Common Wood Nymph Butterfly Populations. TARA R. SCHWASS (Western Illinois University, Macomb, IL 61455) ROD WALTON (Fermi National Accelerator Laboratory, Batavia, IL 60510).

Diversity of habitat and variety of wildlife has been increasing through restoration and land management techniques at Fermi National Accelerator Laboratory (Fermilab). These land management techniques are crucial to restoring and sustaining the natural habitats and native species of the area. This study examined the effects of land management techniques on the burned restored prairie, unburned restored prairie and mowed non-native grasslands and how these techniques affected local butterfly populations of *Cercyonis pegala*, the common wood nymph. Originally native to the prairie, the common wood nymph now occupies a wide range of habitat that includes not only prairie but also non-native grasslands, open woodlands, fields, marshes, savanna, and road sides. Transect counts were used to survey the abundance of wood nymphs for each of the five sites studied. A similar study performed last year included two of the same sites studied this year. Results were analyzed using a *t*-test, Mann-Whitney *U*-test, Spearman correlation, and Pearson correlation. Our results indicated the prairie had significantly more butterflies than the non-native grasslands and also weather variables did not significantly affect butterfly counts. Our results differed greatly from the study performed last year where non-native grasslands had more butterflies than the native prairie site. These varying results are likely due to the timing of the land management techniques at the sites. However, other possible explanations for the results may be vegetation differences in growth, abundance, and density, and/or butterfly behavior. A continuation of this study should include the same sites after a new season of burning and mowing to examine long-term effects of land management techniques and also to gain a better understanding of butterfly ecology at Fermilab.

INTRODUCTION

Illinois prairies are virtually non-existent today. Since 1975, Fermilab has had an ongoing prairie restoration project that aims to bring back native plant and animal habitats of the prairie. The Ecological Land Management (ELM) Committee oversees and facilitates the restoration of available tracts of land [1]. One of the committee's responsibilities is to create a "roadmap" for the prairie restoration effort [1]. The committee's long-range plan for the prairie restoration includes management activities such as soil preparation and seeding, selective overseeding, plant surveys and periodic burning [2]. These techniques keep unwanted weeds and plants out of the prairie. In addition to prairie, Fermilab manages non-native grassland areas by mowing and applying herbicides [1]. Fermilab's 6,800 acres, 1,200 of which are prairie, offer a diverse amount of habitat and wildlife [3]. Over 54 species of butterflies have been observed at Fermilab [4], however, contributions of ecological studies on native prairie butterflies, especially individual species such as the wood nymph, have been scarce.

For this study, we investigated the common wood nymph of the family Nymphalidae (brush-footed butterflies) and subfamily Satyrinae (satyrs and wood nymphs), a native butterfly species of the prairie in North America [5]. The habitat the wood nymph occupies today ranges from meadows, fields, marshes, roadsides, open woodlands, savannas and prairies from central Canada to central California, Texas, and central Florida [5]. It is absent from the Pacific Northwest coast and much of the Gulf region [5]. The common wood nymph is highly variable in several characteristics, ranging from light brown to deep chocolate brown in color, with two larger yellow-ringed eyespots on the forewing and smaller variable numbers of eyespots on the hind wing [5]. Females tend to be larger, lighter in color, and have larger eyespots than males [5]. Southern and coastal butterflies are larger and have a yellow or yellow-orange patch on the outer part of the forewing, while inland butterflies are smaller and have the yellow forewing patch reduced or absent [6]. Their wingspan ranges from 1 3/4 to 3 inches and they tend to fly erratically with little speed [5, 6]. Females lay lemon yellow-color, keg-shaped eggs singly on host plant leaves in late summer [5, 6]. Shortly after hatching, the caterpillar overwinters emerging generally in June to mate and lay their eggs before dying [5]. The chrysalis is green and plump and the caterpillar is a grass-green color with four lengthwise yellow lines, fine fuzzy pile, and two reddish tails [5]. Wood nymphs at Fermilab have one brood from June to August with females emerging later than males.

For this study natural areas with native prairie and non-native grasslands were monitored to determine the effects of land management techniques on wood nymph butterfly populations. A similar study performed last year at Fermilab indicated the wood nymph was more commonly found in mowed non-native grassland areas rather than the prairie areas [7]. We expected similar results for our study. We are interested in why the wood nymphs persist or do not persist in a given area and the factors, including present land management techniques, in these areas contributing to their abundance or scarcity at Fermilab sites. By answering these questions, much can be learned about the wood nymphs and their habitat preferences. These studies can contribute to an understanding of the population ecology of butterflies and also land management information and conservation.

MATERIALS AND METHODS

Data were collected at five different sites at Fermi National Accelerator Laboratory for 15 days over a 27-day period starting at the end of June 2007 and continuing into July 2007. This study revisited two of the previous sites from last year's study in addition to three new locations. These locations were chosen based on recent history of management techniques. The prairie areas are burned approximately every two years whereas the two non-native grassland sites are managed by mowing every other year [8]. The native prairie sites included prairie site 1 (P1) in ELM-25 last burned in the fall of 2005 (unburned prairie), prairie site 2 (P2) in the northeast quadrant of ELM-1 last burned spring 2007, and prairie site 3 (P3) in the southwest quadrant of ELM-1 last burned in spring 2006 (both unburned prairie) [8]. The non-native grasslands, site 1 (N1) in ELM-9 and site 2 (N2) in ELM-11, were last mowed in late summer 2005 (unburned non-native grasslands) [8]. A site map can be found in Figure 1. P1 and N1 are the sites that were monitored in last year's study.

Vegetation assessments for each site are shown in Table 1. A transect walk commonly called a "Pollard walk," based on the transect count method used in the Butterfly Monitoring Scheme, was used at each site to count the number of wood nymphs over an approximate length of time [9]. The walks were approximately 15 minutes (but no longer) and walked at a uniform pace in a "horseshoe" shape or "U-shape." For each walk butterflies within 6 meters (20 feet) of each side of the monitor were counted. The length of each transect varied from site to site depending on size and conditions. However, each transect length was kept consistent throughout data collection. Using a meter tape or range finder, the transect lengths were measured after the transect had been walked consistently and a path determined. The P1 transect route was broken up into three five-minute intervals with lengths of approximately 190 meters, 190 meters, and 200 meters respectively. The P3 transect route was broken up into two seven and a half-minute intervals with lengths of approximately 250 meters each interval. The P2 transect route was also broken up into three five-minute intervals with lengths of approximately 200 meters each interval. The N1 transect route was two seven and a half-minute intervals of approximately 275 meters each interval. N2 had a transect route with two seven and a half-minute intervals of approximately 280 meters each interval.

Ideal conditions for monitoring butterflies are between the hours of 10:00 A.M. and 3:30 P.M. on days of less than 50 percent cloud cover and light to moderate winds [10]. However, all the walks were completed between the hours of approximately 10:00 A.M. and 1:00 P.M. The sequencing of the walks was changed daily so as not to introduce bias into the study. For the sake of time, due to the wood nymphs' short life cycle, data were collected every possible day whether or not conditions were optimal, the only exception being if it rained which interferes with butterfly flight. Time of day, temperature, relative humidity, cloud cover, average and peak wind speed, and length of time to complete each walk were recorded.

For statistical analysis, count data per hour data were calculated and graphed. Then data were analyzed using a *t*-test, Mann-Whitney *U* test, Spearman correlation, and Pearson correlation.

RESULTS

Figure 2 shows the estimated counts per hour. This graph shows a strong trend of rising and then tapering out at P1. N1 starts out with very low numbers and seems to increase at the end of collection. N2, P2, and P3 had consistently low counts throughout the data collection time period. The highest one-day count estimated per hour was 148 wood nymphs at P1.

The *t*-test, Mann-Whitney *U* test, Spearman correlation, and Pearson correlation were not performed for the data for N2, P2, and P3 since the counts were consistently low. Therefore only P1 and N1 were included in analysis. The *t*-test showed there were significantly more butterflies in P1 than N1 ($t = 3.742$, $df = 17$, $p = 0.002$). The Mann-Whitney *U* test, run as confirmation of the *t*-test, also showed there were significantly more butterflies in P1 than N1 ($U = 34.5$, $p =$

0.002). The Spearman correlation and Pearson correlation indicated the variables of relative humidity, temperature, cloud cover, time of day, average wind speed and peak wind speed, did not significantly affect butterfly counts.

Vegetation analysis showed that P1 had the most numerous and diverse vegetation compared to the other sites studied. P1 contains native big blue stem grass, cord grass, and switch grass while N1 consisted primarily of non-native Hungarian brome, orchard grass, Kentucky and Canada blue grass. P1 seemed to have more flowering plants compared to N1, which had more grasses. However, both sites did have some of the same plants. Examples include crown vetch, black raspberries, timothy grass, and Queen Anne's lace. P2, though mainly prairie, had an edge of Hungarian brome around the outside of the site and patches of dogwood scattered within. P2 also had an abundance of sawtooth sunflower and crown vetch. P3 was composed of sedges, scattered clusters of dogwood, cord grass, and switch grass. P3 was also characterized as a "wet-prairie" because swamp milkweed was found. N2 consisted mainly of Hungarian brome, patches of Canada thistle, black raspberries, and crown vetch. A more detailed vegetation list for each site can be found in Table 1.

DISCUSSION AND CONCLUSIONS

The results show P1 had significantly more wood nymphs than N1 ($U = 34.5$, $p = 0.002$). This indicates a clear difference between the populations at the sites studied. Spearman correlations and Pearson correlations show that the variables of relative humidity, temperature, cloud cover, time of day, average wind speed, and peak wind speed, did not significantly affect butterfly counts. This is likely because conditions were favorable for observing butterflies when data were collected. There was not enough variation in the variables to observe a significant change in butterfly behavior.

In Figure 2, the trend in P2 may represent a rise and fall in the population of wood nymphs. Generally, the numbers will increase at some point as the butterflies emerge, then decrease as their life cycle comes to an end. Discrepancies in the trend may be due to simply not seeing the butterflies and/or unfavorable conditions that may have had a minimal impact on the counts but were not significant to affect overall statistics. Another possibility is that we saw the peak in males followed by the peak in females, because females emerge later than males. The trend for N2 seemed to be steadily increasing. Due to time we no longer were able to keep collecting data to see a possible peak and then fall in the population at N1. P2, P3, and N2 had consistently low counts with no peaks therefore we may conclude there is low abundance in those areas.

Table 2 shows the most recent land management techniques and total counts. P1, last burned in fall 2005, and N1 and N2, last mowed in fall 2005, would seemingly have the greatest population because of the time since management. However, N2 showed very small counts compared to P1 and N1. It is curious to note that although N2 was mowed at the exact same time as N1 and had similar vegetation to N1, there was only a small wood nymph population at N2. P2, last burned in spring 2007, would be expected to have the lowest number of wood nymphs overall and P3, last burned in spring 2006, would still expect low counts but more than P2. P2, as expected, had the lowest number of wood nymphs for the prairie sites, however, had more overall than N2. The overall ranking from lowest abundance to highest abundance was N2, P2, P3, N1, and P1.

This year’s study and the previous study from 2006 have very different results. The previous study found that N1 had significantly higher counts than P1. Last year’s study suggested a few possibilities for higher count in N1. One is the frequency of the land management techniques. P1 had been burned more recently last year than this year. This may have affected observations in P1 since the burn would be expected to kill off the wood nymphs. Another possible explanation for the differences is that P1's vegetation was taller and thicker while N1's vegetation was short last year. This may have made wood nymphs more difficult to spot in P1 than N1. In contrast, this year's study found significantly higher counts in P1 and significantly lower counts in N1. It may be inferred that P1 is higher this year because it has been two years since it was last burned, therefore allowing the wood nymphs time to repopulate. However, there is no obvious reason the population at N1 is much lower this year than last year. N1 was mowed in 2005, which seemingly had no effect on counts last year, but this year's counts at N1 were lower than last year's despite no new land management techniques being used. It may be that the butterfly population had just started emerging as data collection was coming to a close.

Differences in vegetation such as diversity, density, and height, may also account for the differences in populations between sites. Diversity of plants can support the abundance and diversity of many organisms. However, some organisms depend on a certain density of plants in an area [11]. P1 had the most abundant and diverse amount of vegetation. N1 was composed mainly of non-native grasses. Wood nymph larvae feed on numerous grasses but much is not known about the wood nymph's plant preferences. In general, we can only say qualitatively from our study that the vegetation in our sites does not have an effect on the butterfly population preferences because of the change in results over the past two years. The other prairie sites compared to P1 were not as diverse in vegetation. Their low counts could be due not only to vegetation but also to recent burning.

Studies show that population synchrony breaks down beyond 600 m and local populations fluctuate independently of one another [12] as can be seen in our two sites. If asynchrony does occur on a local scale, other populations of butterflies in one area may re-colonize another area [12]. The probability of occupancy of an area increases with habitat size and distance from the nearest occupied habitat [13]. Therefore it is possible that wood nymphs from adjacent areas on site may have traveled to occupy P1.

Next year's study should replicate all the sites used in this study using the same methods and techniques to observe changes after a new season of mowing and burning. It will also be interesting to observe other prairie sites to see how long it takes for the butterflies to repopulate after burning. It will also be interesting to see if N2 ends up with a wood nymph population again.

For this study we may indicate that burning has a negative effect on the wood nymph butterfly. However, burning is crucial for the control of invasive plant species in the prairie at Fermilab. We may also indicate that mowing and herbicides have an effect on butterfly populations, but these are also necessary for controlling weeds and invasive species. Recommendations for land management techniques for the ELM committee are not much different than what is already in place until further research can be done. However, "patchy" burning rather than complete burns may allow more species, especially butterflies in their larval stage, to survive a burn. This may allow populations of butterflies to bounce back faster after a burning. Another suggestion is that adjacent areas should not be managed in the same year. Frequency and site order of land management techniques should be rotated consistently in order to maintain an overall butterfly population at Fermilab.

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TABLES AND FIGURES

Table 1: Vegetation Analysis [14]	
Scientific Name	Common Name
P1 (unburned prairie)	
Andropogon gerardi	Big Blue Stem
Phalaris arundinacea	Reed Canary Grass*
Helianthus grosseserratus	Sawtooth Sunflower
Silphium laciniatum	Compass Plant
Penstemon digitalis	Foxglove Beard Tongue
Tradescantia ohiensis	Common Spiderwort
Solidago sp.	Goldenrods
Zizia aurea	Golden Alexander
Bromus inermis	Hungarian Brome*
Melilotus alba	White Sweet Clover*
Coronilla varia	Crown Vetch*
Silphium integrifolium	Rosinweed
Baptisia leucantha	White Wild Indigo
Apocynum cannabinum	Indian Hemp/Dogbane
Thalictrum dasycarpum	Purple Meadow Rue
Panicum virgatum	Switch Grass
Silphium terebinthinaceum	Prairie Dock
Asclepias syriaca	Common Milkweed
Eryngium yuccifolium	Rattlesnake Master
Rubus occidentalis	Black Raspberries
Rudbeckia hirta	Black-eyed Susan
Amorpha canescens	Lead Plant
Coreopsis palmata	Stiff Coreopsis
Pycnanthemum virginianum	Common Mountain Mint
Phleum pratense	Timothy Grass*
Dodecatheon meadia	Shooting Star
Quercus macrocarpa	Bur Oak
Spartina pectinata	Prairie Cord Grass
Heracleum maximum	Cow Parsnip
Daucus carota	Queen Anne's Lace/Wild Carrot
Ratibida pinnata	Yellow Coneflower/Gray-headed Coneflower
Monarda fistulosa	Wild Bergamot
Parthenium integrifolium	Wild Quinine
Desmodium canadense	Showy Tick Trefoil
P2 (burned prairie)	

Bromus inermis	Hungarian Brome*
Silphium laciniatum	Compass Plant
Silphium integrifolium	Rosinweed
Apocynum cannabinum	Indian Hemp/Dogbane
Cornus racemosa	Gray-headed Dogwood
Helianthus grosseserratus	Sawtooth Sunflower
Coreopsis palmata	Stiff Coreopsis
Silphium terebinthinaceum	Prairie Dock
Penstemon digitalis	Foxglove Beard Tongue
Achillea millefolium	Yarrow/Milfoil
Andropogon gerardi	Big Blue Stem
Coronilla varia	Crown Vetch*
Thalictrum dasycarpum	Purple Meadow Rue
Ratibida pinnata	Yellow Coneflower/ Gray-headed Coneflower
Rubus occidentalis	Black Raspberries
P3 (unburned prairie)	
Cyperus sp.	Sedges
Penstemon digitalis	Foxglove Beard Tongue
Solidago sp.	Goldenrod
Silphium laciniatum	Compass Plant
Hordeum jubatum	Foxtail Barley
Apocynum cannabinum	Indian Hemp/ Dogbane
Erigeron strigosus	Daisy Fleabane
Spartina pectinata	Prairie Cord grass
Panicum virgatum	Switch Grass
Oenothera biennis	Evening Primrose
Helianthus grosseserratus	Sawtooth Sunflower
Silphium integrifolium	Rosinweed
Asclepias incarnata	Swamp Milkweed
Coronilla varia	Crown Vetch*
Ratibida pinnata	Yellow Coneflower/ Gray-headed Coneflower
Cornus racemosa	Gray-headed Dogwood
N1 (un-mowed non-native grassland)	
Dactylis glomerata	Orchard Grass*
Bromus inermis	Hungarian Brome*
Phleum pratense	Timothy Grass*
Trifolium pratense	Meadow Clover*
Cirsium arvense	Canada Thistle*
Tragopogon pratensis	Common Goat's Beard*
Poa pratensis	Kentucky Blue Grass
Poa compressa	Canada Blue Grass

Cornus racemosa	Gray-headed Dogwood
Rosa multiflora	Multiflora Rose*
Rhamnus cathartica	Common Buckthorn
Cichorium intybus	Chicory *
Phalaris arundinacea	Reed Canary grass
Vitis riparia	Wild Grape
Erigeron strigosus	Daisy Fleabane
Datura stramonium	Jimson Weed*
Agropyron repens	Quack Grass*
Daucus carota	Queen Anne's Lace/ Wild Carrot
Ambrosia artemisiifolia	Ragweed
Coronilla varia	Crown Vetch*
Rubus occidentalis	Black Raspberries
N2 (un-mowed non-native grassland)	
Plantago major	Common Plantain*
Chrysanthemum leucanthemum	Ox-eye Daisy*
Asclepias syriaca	Common Milkweed
Coronilla varia	Crown Vetch*
Trifolium pratense	Meadow Clover*
Cornus racemosa	Gray-headed Dogwood
Cirsium arvense	Canada Thistle*
Bromus inermis	Hungarian Brome*
Rubus occidentalis	Black Raspberries
* Non-native	

Table 1: Qualitative vegetation assessment [14].

Table 2: Land Management, Total Count, and Average Number of Butterflies per Hour				
Site	Burned	Mowed	Total Count	Average Number of Butterflies per Hour
P1	Fall 2005	-------	876	58.4
P2	Spring 2007	-------	41.8	3.2
P3	Spring 2006	-------	47.6	3.7
N1	-------	Fall 2005	286.9	20.5
N2	-------	Fall 2005	28.6	2.4

Table 2: Land management, total count, and average number of butterflies per hour.

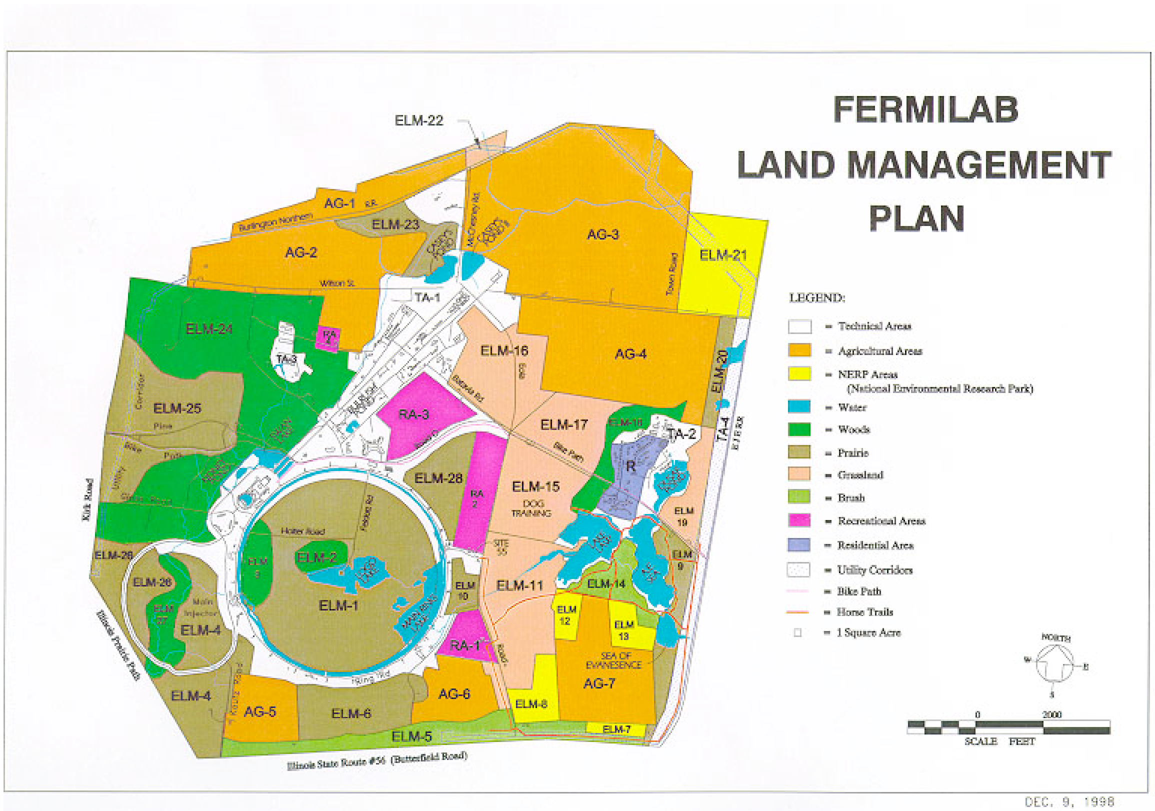

Figure 1: Land management plan map.

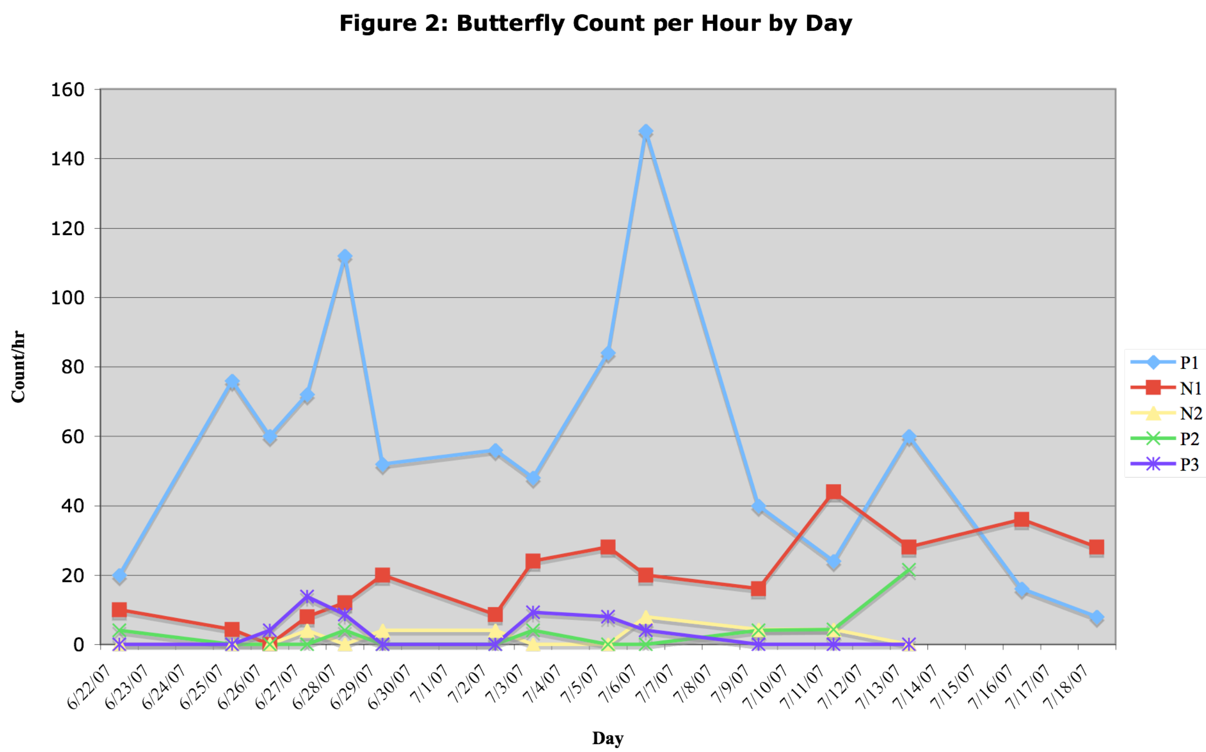

Figure 2: Butterfly count per hour over 27-day period.