# Keeping up with the Karners: habitat, population growth and persistence of a local federally endangered species

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**May 4, 2012**

Complex and multi-stakeholder models for land and species conservation often produce varying opinions on management strategies, especially when developed to accommodate mixed, and sometimes-incompatible land usage. Management can be further complicated by legislation meant to preserve endangered species, producing varying methods of quantifying population viability through time and space. However, even in areas with minimal development, species distribution will be intrinsically varied. Qualitative differences in habitat patches create distinct and often dissimilar differences in population structure between subpopulations, which is crucial to understanding theories such as risk spreading, the "rescue effect", and the effects of local extinctions and colonizations, as strategies to maintain species persistence (Possingham et. al., 1994).

To inform management, conservation scientists must understand the host of variables influencing endangered species population fluctuations and persistence. To date, two population models have risen to the forefront of insect population monitoring and theory; the habitat-based paradigm and the metapopulation paradigm (Gutiérrez et. al., 1999). The habitat-based method of analysis is based on findings that populations are often lost after degradation or alteration to habitats, which was observed dramatically in the case of many butterfly species that were lost even after subtle environmental changes (Gutiérrez et. al., 1999). Sufficient access to a necessary quality and quantity of resources for larvae and adults, appropriate microclimatic conditions, and synchrony between host plant and insect are substantial factors influencing population persistence in habitat-focused analysis. The metapopulation paradigm, in contrast, is based on a model of assessing a population in a fragmented landscape where local populations are connected by migration, with populated patches varying through space and time based on local extinction and colonization events (Bravo et. al, 2007).

Both habitat and metapopulation analysis are important in predicting long term survival and designing management plans.To fully understand the a species' population dynamics and create an effective management plan that facilitates long-term viability, both temporal and spatial fluctuations in habitat degradation, as well as corresponding population estimates must be examined to predict future persistence (Vulleumier et. al., 2007).

To address these ideas we examined the federally endangered Karner Blue Butterfly. In the case of the Karner Blue, research is often focused on availability of the only larval food source, Wild Blue Lupine (Grundel and Pavlovic, 2007). However, narrow assessments of populations based on host plant availability overlook many other aspects of colonization and prevalence, including connectivity between patches, and the likelihood of occupation in surrounding patches (Grundel and Pavlovic, 2007). Furthermore, studies have shown that the range of the Karner Blue Butterfly is considerably restricted compared to its host plant, suggesti

Conservation from the 2006-2011 to determine predictive factors of temporal variation in population was auctioned by the County of Saratoga and purchased by the Town of Wilton (History of Organization). Wilton allocated 3000 acres for a butterfly preserve and recreation area, ultimately creating Wilton Wildlife Preserve and Park (Wilton Wildlife Preserve and Park, 2011). The Nature Conservancy and New York Department of Environmental Conservation have been conducting Karner blue monitoring  and habitat restoration in the Wilton site since the 1980s (Wilton Wildlife Preserve and Park, 2011). The area is also protected habitat other species, including the Blandings Turtle, Spadefoot toad, and Hognose snake.

The data we utilized to address our research goals was collected at the following sites: CSN, CSS, ERN, ERS, ERR, ERSP, FX12, FX3, JKD, ODG, OPD (Figure 1). These sites are actively managed using techniques such as mowing, tree and stump removal, planting of nectar plants and lupine, and localized use of herbicide. Controlled burning is not used at this time.  The Nature Conservancy and NY-DEC assesses the quality of each habitat based on a number of factors: habitat size, lupine density, lupine stems, nectar density, overstory frequency, shade frequency and grass frequency (Bried et al. 2005).

## Methods and Results

### I. Population Growth: contrasting observed and expected

single habitat variable presents a more complete and consistent paradigm for establishing stable Karner populations.

**Acknowledgments**
We would like to sincerely thank Josh Ness for his time, patience and wisdom regarding this project, Karen Kellogg for her life support, Chris Zimmerman (TNC) and Kathy O'Brien (NY-DEC) for allowing us to utilize this data set, Monica Raveret-Richter for data support and Wilton Wildlife Preserve and Park. Thank you to the ES Kapstone Krew for an amazing year! And finally, we would like to thank Mr. Pollard and Mr. Yates for their endless dedication to counting butterflies.

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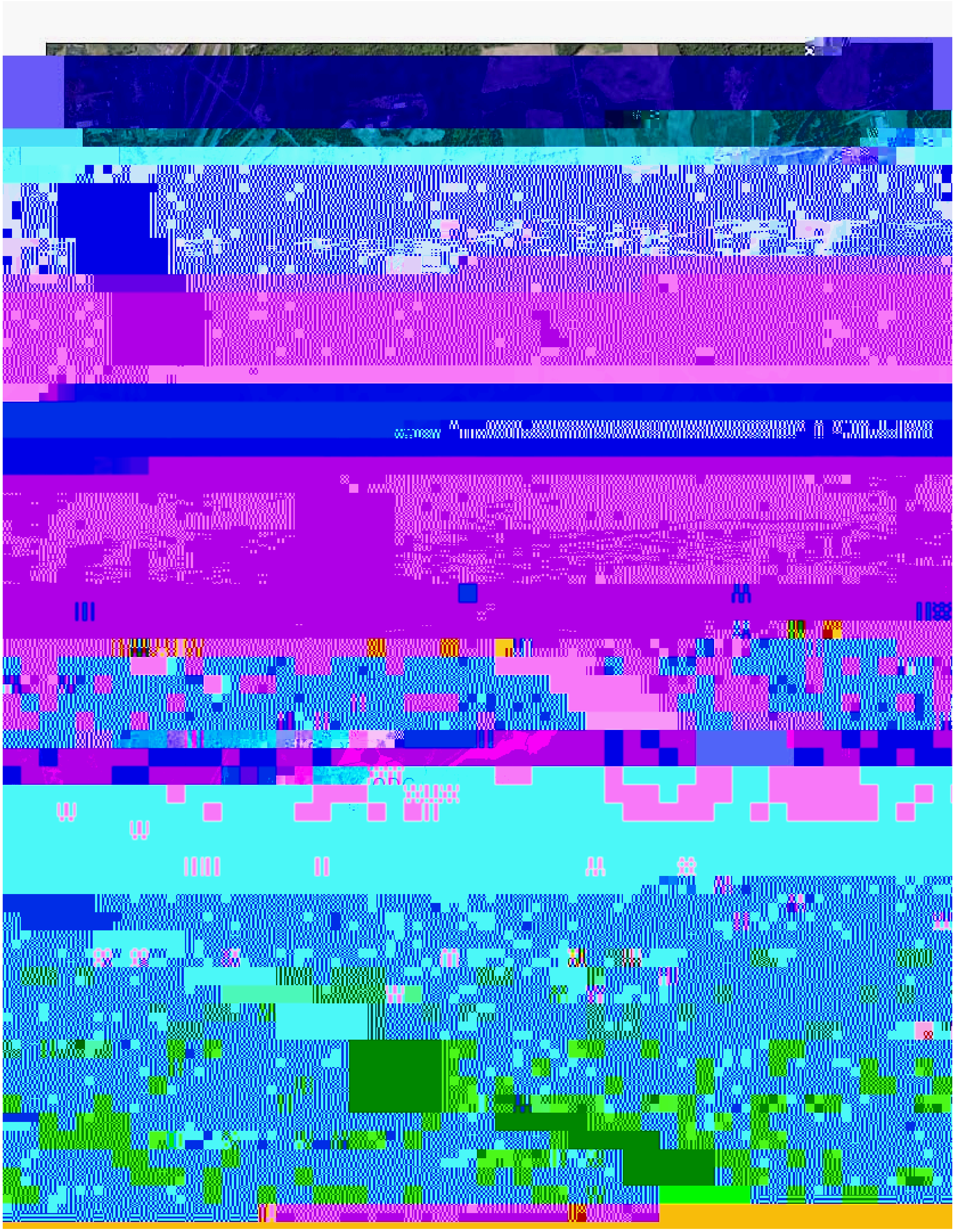

Figure 1 The distance monitoring sites used for distance sampling from 2006-2011.

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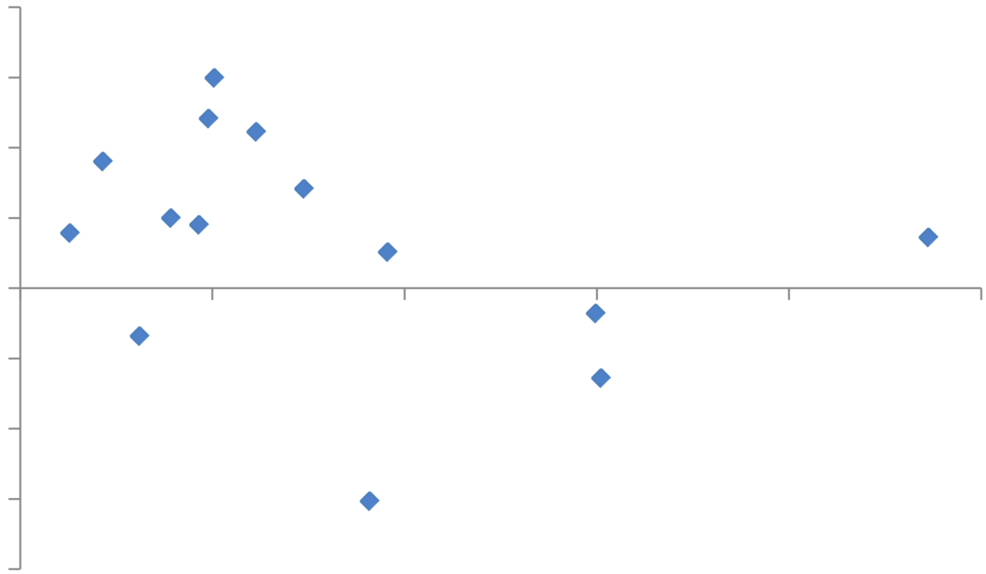

Figure 4 Population size influence on population change for pooled summer and winter lambda

Figure 5 Population size influence on population change varies between Summer and Winter time-steps across the metapopulation.

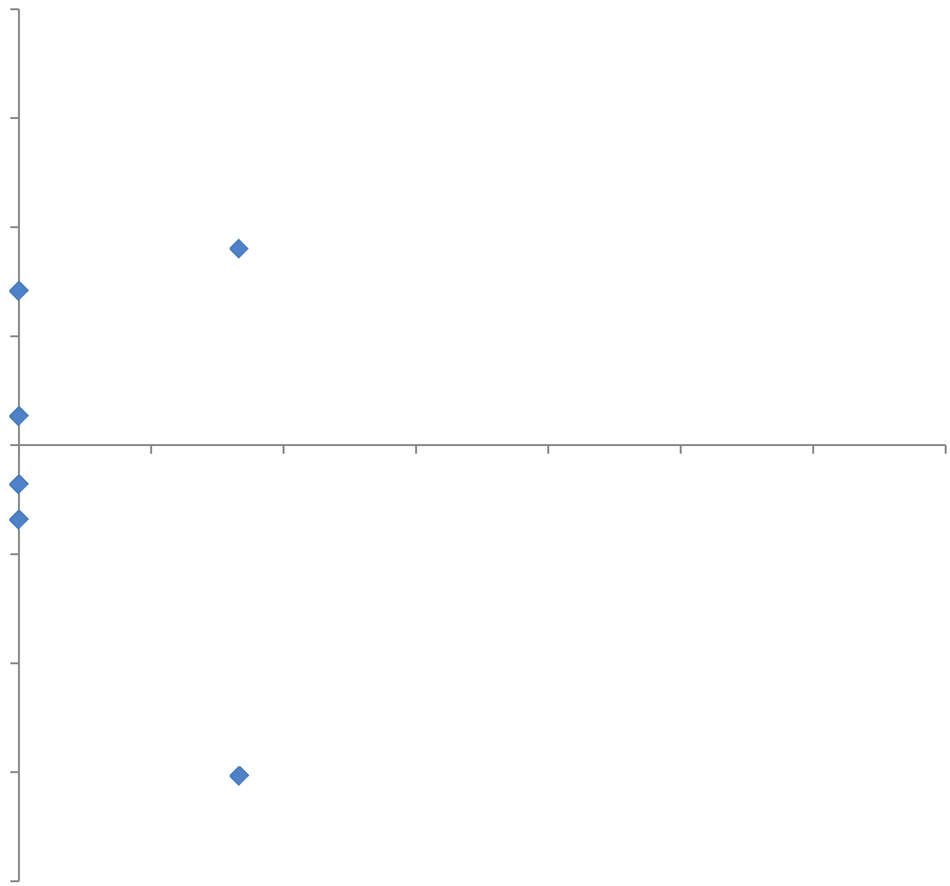

Figure 6 Influence of shade within three lupine abundance categories on population fluctuation. Low (9000-12000), Medium (26000-94000), High (110000-450000) as measured in stems per transect.

**Table 1 Linear Regression Summary of Habitat Indicators**

| Test | Variable 1 | Variable 2 | Equation | F Stat | $R^2$ |
|---|---|---|---|---|---|
| Linear Regression | Grass Frequency | Lambda | y = 1.99x + 1.38 | 0.076 | 0.0034 |
| Linear Regression | Lupine Abundance | Lambda | y = 3.31^-8 + 0.46 | 0.108 | 0.005 |
| Linear Regression | Lupine Density | Lambda | y = 1.3^-6 + 0.40 | 0.125 | 0.0006 |
| Linear Regression | Nectar Density | Lambda | y = 1.04x -0.33 | 1.09 | 0.0462 |
| Linear Regression | Shade Frequency | Lambda | y = 1.08x + 0.168 | 2.93 | 0.117 |
| Linear Regression | Overstory | Lambda | y = 1.91x +0.08 | 3.83 | 0.148 |
| Linear Regression | Habitat Size | Lambda | y = 0.008x + 0.45 | 0.076 | 0.003 |

Table 2 Categorization of performance based on site.

| Site | Year | Performance | Site | Year | Performance |
|---|---|---|---|---|---|
| CSN | 2009 | over | CSN | 2007 | under |
| CSS | 2009 | over | CSN | 2010 | under |
| CSS | 2010 | over | CSN | 2010 | under |
| ERR | 2009 | over | CSS | 2009 | under |
| ERSP | 2009 | over | ERN | 2010 | under |
| ERSP | 2009 | over | ERS | 2010 | under |
| FX1+2 | 2010 | over | ERR | 2009 | under |
| FX3 | 2010 | over | ERR | 2010 | under |
| ODG | 2009 | over | ERR | 2007 | under |
| ODG | 2009 | over | ERSP | 2010 | under |
| ODG | 2010 | over | JNK | 2010 | under |
| OPD | 2010 | over | | | |

**Table 3 T-Tests of habitat variables based on performance**

| Test | Variable 1 | Variable 2 | Mean Over performing sites | Mean Under performing sites | n | DF | p Value | t Stat |
|---|---|---|---|---|---|---|---|---|
| Two-Sample Assuming Unequal Variances | Habitat Size | Lambda | 5.411626 | 1.750738 | 12,11 | 11 | 0.0425 | 1.8924 |
| Two-Sample Assuming Equal Variances | Nectar Density | Lambda | 0.816835 | 0.683844 | 12, 11 | 21 | 0.0169 | 2.2707 |
| Two-Sample Assuming Equal Variances | Shade Frequency | Lambda | 0.386468 | 0.131169 | 12,11 | 21 | 0.0023 | 3.1545 |
| Two-Sample Assuming Equal Variances | Overstory | Lambda | 0.265971 | 0.10868 | 12,11 | 21 | 0.0033 | 3.0028 |
| Two-Sample Assuming Equal Variances | Lupine Density | Lambda | 45915.35 | 26229.25 | 12,11 | 21 | 0.1371 | 1.1225 |
| Two-Sample Assuming Unequal Variances | Lupine Abundance | Lambda | 1210594.2 | 118356.6 | 12,11 | 11 | 0.0427 | 1.8899 |
| Two-Sample Assuming Equal Variances | Grass Frequency | Lambda | 0.410416 | 0.223053 | 12,11 | 21 | 0.0161 | 2.2920 |