Thorne's Hairstreak (*Callophrys [Mitoura] thornei*) Monitoring Plan
First annual report, covering 2009

Matthew Forister (PI, University of Nevada, Reno; mforister@unr.edu)
Amy Lucas (Graduate Student, University of Nevada, Reno)

This report covers activities performed during our first year of work and outlines activities for our second year. These activities are summarized with reference to our objectives for the first year, as well the objectives that we are preparing to meet in the coming year. Those objectives are as follows:

First year objectives:

(1) Map Tecate cypress stands on Otay Mountain.
(2) Create a sampling scheme to be implemented in 2010.

Second year objectives:

(3) Conduct occupancy surveys for Thorne's hairstreak (TH) adults and juveniles.
(4) Characterize habitat associated with TH presence.
(5) Age trees (by coring) in sampled stands of Tecate cypress.
(6) Conduct larval and adult experiments to assess the importance of tree age for TH.

Summary of completed activities and outline of activities for the next year:

Map of Tecate cypress stands created in 2009

During approximately 80 days in the field in Spring and Summer of 2009, two people (Lucas and field assistant) systematically searched Otay Mountain for stands of Tecate cypress. The focus of the search was larger stands (groups of 20 or more trees greater than 1 meter in height), though smaller stands were also included whenever they were encountered. The search included both stands accessible from the major roads (the Otay Mountain Truck Trail and the Minnewawa Truck Trail) as well as stands that were only accessible following extensive hikes away from the roads. Once located, stands were mapped using a handheld GPS unit. Map data was processed in collaboration with the FWS office in Carlsbad, California.

Lucas and her field assistant were successful in this first year activity (see Fig. 1 for a reproduction of the map that was produced; this map can also be downloaded at http://web.me.com/mforister/GreatBasinBugLab/TH.html). Although no mapping endeavor of this type can claim to include all focal stands, we believe that this map covers the majority of the Tecate cypress stands on Otay mountain. Even if more stands are discovered in the coming years, we have a solid foundation for beginning our study of TH (see section below on the design of our sampling map). Finally, the geographical data files resulting from this work are being stored in both the FWS office in Carlsbad as well as the Forister lab at the University of Nevada, Reno. Files have also been transferred to SANDAG offices.

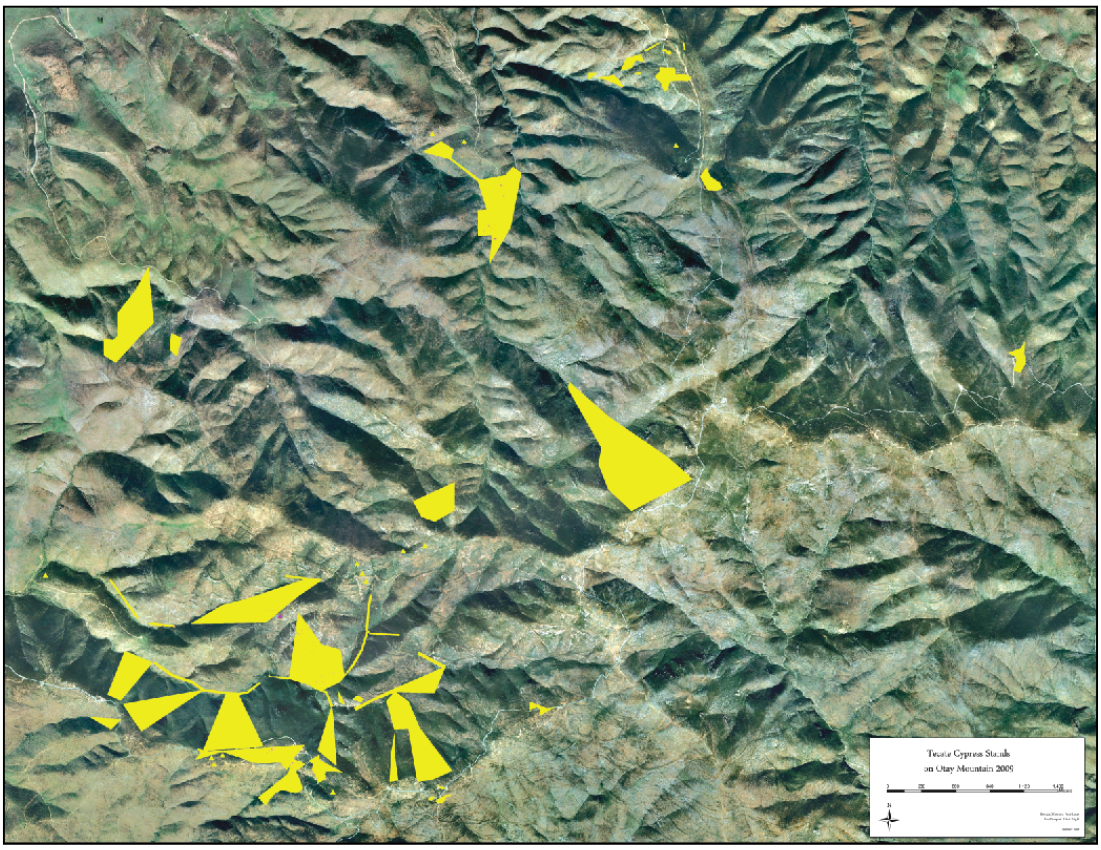


Figure 1. Otay mountain with Tecate Cypress stands (in yellow) mapped in 2009.

Sampling, design created in 2009 and plan for data collection in 2010

Using the map of Tecate cypress generated in our first field season, we have created a sampling design which includes points to be visited at regular intervals during TH monitoring (these are also the points where vegetation and abiotic conditions will be characterized, as discussed below). Our sampling scheme was produced with specific goals and within certain logistical constraints. Our primary goal is to inform the management and conservation of TH, and our primary constraint is simply the number of people involved in this project (the field crew consists of Lucas and a field assistant). In Table 1, we provide a brief review of threats to TH, associated management actions and relevant results to be produced by this project (across all years).

For all of the "data and results" mentioned in Table 1, the key is the characterization of TH habitat, both within and among patches. The butterfly does not appear to be host-plant limited (i.e. based on preliminary observations and results published by others, only a small fraction of available host patches are occupied by TH). This raises the likely possibility that other factors, abiotic or biotic, influence the local distribution and abundance of TH. To characterize TH habitat and identify these other factors (beyond the presence of the host plant) that might influence TH presence, we will implement a point-sampling scheme as described in the original TH monitoring plan (part of the San Diego Multiple Species Conservation Plan [MSCP], which should be referenced for details beyond those summarized here).

Table 1. Summary of threats, potential management actions and relevant data.

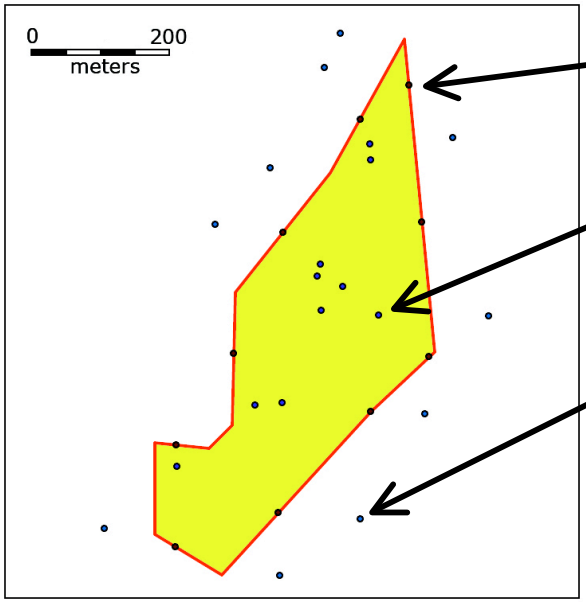
Possible threats to TH	Management actions	Relevant data and results
Destruction of Tecate cypress stands by wildfire resulting in direct TH mortality and reduced availability of larval hosts.	Associated management actions could include: (1) protection of specific stands during a wildfire; (2) propagation and release of TH into new stands post fire; and (3) restoration of cypress stands.	Data to inform these management actions would consist of a characterization of optimal TH habitat, both within and among patches.
Reduction in availability of nectar resources associated with wildfire and/or the invasion of exotic plants.	Associated management actions could involve the restoration of specific nectar resources and/or targeted actions to halt the spread of exotics.	Data to inform these management actions would include a knowledge of nectar sources associated with persistent TH populations (i.e. occupied patches).
Shifting abiotic conditions associated with a changing regional/global climate.	Management actions in response to these abiotic threats could include propagation and introduction of TH into climatically suitable patches.	Data to inform these management actions consists of a knowledge of abiotic conditions associated with TH habitat.
Biotic threats might include elevated levels of predators and/or parasitoids.	Controlling or mitigating natural enemies would be extremely difficult; at present, we would consider the identification of this threat as a low priority.	Parasitoid presence can be measured by rearing field-collected larvae. We will consider this in the event that sufficiently high numbers of larvae are detected in the field.

In brief, each patch of Tecate cypress will contain and be surrounded by systematically and randomly placed sampling points (each 10m in diameter) that are visited at least twice during the flight season of TH. See Fig. 2 for an example of the sampling design for one patch and Table 2 for a summary of biotic and abiotic variables measured at each point. Note that no sampling scheme can hope to measure all relevant variables. Based on our own knowledge of *Mitoura* butterflies and our experience in the field this previous season, we have selected a subset of variables that we expect to be informative and that are logistically feasible to measure in the field. Data collected from these points will be used in multivariate analyses (e.g. structural equation modeling) to investigate correlations between biotic and abiotic variables and the presence and abundance of TH adults and juveniles. These multivariate analyses will address a number of questions, primarily including (but not limited to) the following:

(1) **What characterizes patches of cypress that are occupied by TH?** This characterization can be made both in terms of the specific variables measured, summarized at a patch-scale, as well as in terms of certain variables, such as isolation and patch geometry, that can be derived from geographic data.

(2) **Within patches, what configurations of biotic and abiotic variables best predict TH presence and abundance?** This question, involving analyses at a within-patch scale, is complimentary to the first question in characterizing TH habitat, but provides more detailed information to be potentially used in

management activities such as habitat restoration. Also note that analyses at this scale are also based on observed variables and geographically-derived variables. For the latter, we will, for example, ask if butterflies are found more often in the interior or perimeter of patches.



Perimeter points placed systematically every 200m along the perimeter from a random starting point.

Interior points placed randomly within the interior (not overlapping 5m from the edge). The number of these points is equal (when possible) to or less than the number of perimeter points.

Exterior points placed randomly within a 100m buffer around the patch (not overlapping 5m from the edge). The number of points is equal (when possible) to or less than the number of perimeter points.

Figure 2. Exemplar patch illustrating the placement of sampling points within and around a patch of Tecate cypress (in yellow).

Challenges anticipated in 2010, our first full field season:

Working with rare animals always raises the possibility that few or no individuals will be observed. Given an appropriately designed sampling scheme, as outlined above and in more detail in the TH MSCP monitoring plan, the absence of individuals is valuable information that can be incorporated into long term data collection.

It should be noted that the sampling scheme as illustrated in Fig. 2 is a slight modification of the sampling scheme as originally described in the TH MSCP monitoring plan. The original monitoring plan was designed for a much larger field crew than we have, thus we have simplified primarily by reducing the number of points sampled per patch to a number that we believe will be logistically feasible. We will, however, be going into the field this season armed with alternate sampling schemes (that have both increased and decreased numbers of points per patch). In the event that sampling happens at a more rapid pace or even slower pace than we envision, we will be able to seamlessly adopt the back-up sampling schemes. All sampling schemes will provide adequate data to address the questions and objectives listed above.

Table 2. Summary of data collected at each sampling point (see TH MSCP monitoring plan for more details).
Biotic
Number and activity (nectaring, lekking, etc.) of TH adults
Number of larvae sampled with a beating sheet
Abundance of Tecate cypress, and average crown density
Average age, height and diameter of cypress trees
Abundance and identity of nectar sources
Phenology of nectar sources
Abiotic
Ambient temperature, wind speed, and cloud cover
Average slope and aspect

Other activities in the first and second years

Also in this first year we have established protocols for handling adult butterflies, obtaining eggs in flight cages, and rearing larvae on cut cypress branches (2 individuals were successfully reared). These protocols will be used in the coming year to address objective 6 above. Specifically, we will use caged adults to ask if females have a preference when ovipositing for trees (and foliage) of different ages. This will include four treatments: young and old foliage from both young and mature cypress individuals. Following adult experiments, larvae will be reared on the same suite of foliage types. We recognize that other researchers (led by Kathy Williams, San Diego State Univ.) have addressed this question of foliage age with TH. In particular, Williams has observed TH eggs and larvae on both young and mature cypress trees in the wild. However, we believe that there is still work to be done, for a number of reasons. In particular, the presence of eggs on a particular foliage type in the wild does not necessarily mean that the foliage in question is optimal for larval development (a maladaptive disconnect between adult oviposition preference and larval performance is frequently observed in butterflies). Our previous experience with *Mitoura* butterflies in Northern California has shown that large numbers of caterpillars (at least 30-50 per treatment) must be reared to pupation to detect important differences in performance on foliage of differing quality. This number of caterpillars should be feasible, as individual (wild-caught) *Mitoura* females can lay 30 – 100 eggs in captivity.