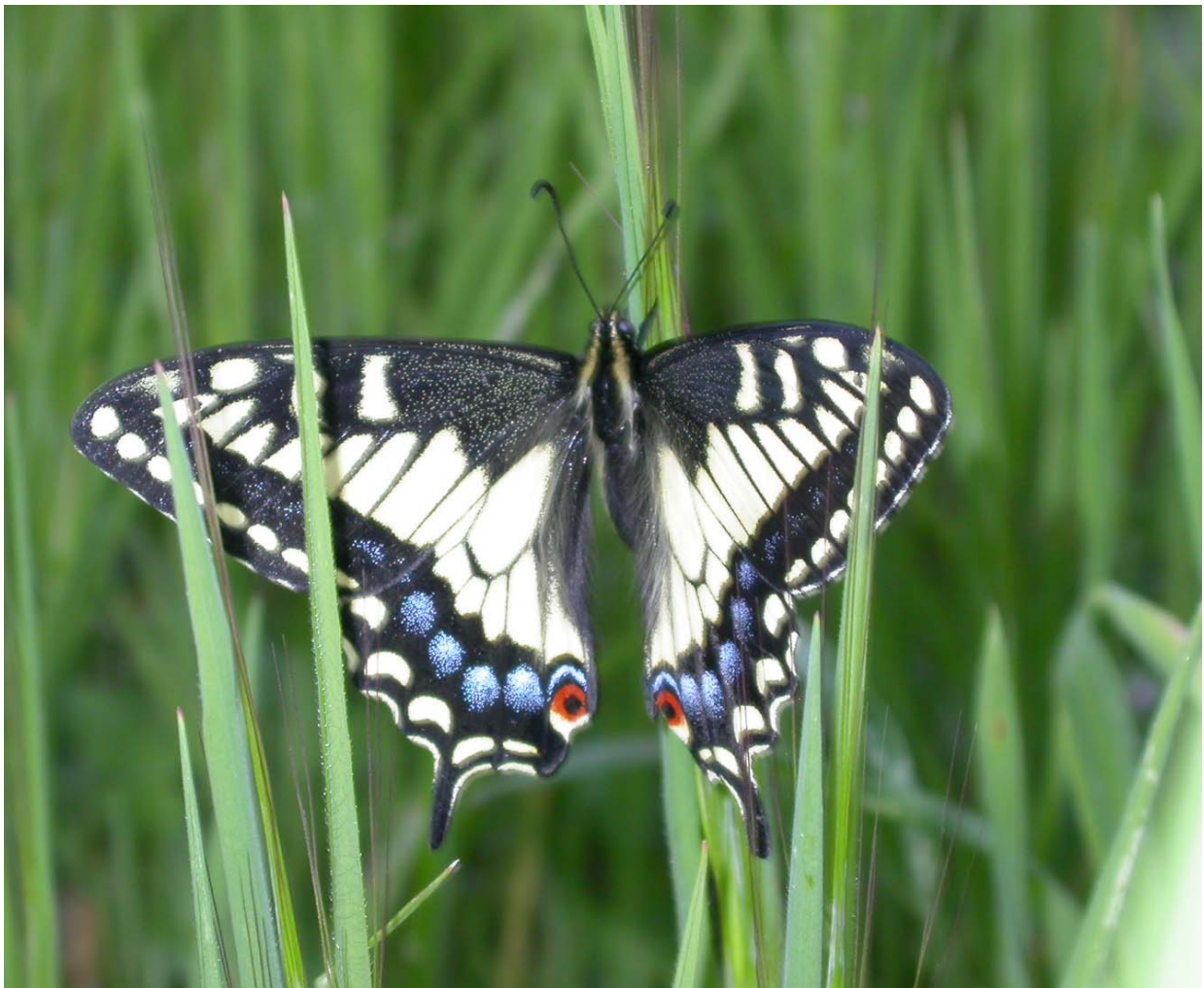




Lepidoptera (Butterfly and Moth) Inventory

John Muir National Historic Site – 2003-2006

Natural Resource Report NPS/SFAN/NRTR—2008/084



ON THE COVER

Anise Swallowtail in grass on Mount Wanda, John Muir National Historic Site
NPS photo

Lepidoptera (Butterfly and Moth) Inventory

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Natural Resource Report NPS/SFAN/NRTR—2008/084

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Introduction

John Muir National Historic Site represents an island of protected parkland in the midst of an urbanizing landscape. The park contains over 280 native and non-native vascular plants and unique vegetation communities including chaparral and oak woodlands representative of what the region may have looked like at the time of John Muir in the mid- to late-1800s (Jepsen and Murdock 2002). The diversity and abundance of nectar and host plants suggests that Mt. Wanda may also be home to a rich array of Lepidoptera (butterflies and moths). Lepidoptera represent a taxonomic group that is largely understudied. The goal of this inventory was to identify as many moth and butterfly species as possible within the limited parameters of time, equipment and expertise available at John Muir National Historical Site (JOMU).

The San Francisco Bay Area Network (SFAN) Inventory and Monitoring (I&M) Program initiated several inventories by 2003, with a focus on vertebrates and vascular plants. Prior to this study, a bee inventory was the only other invertebrate inventory underway for JOMU (Griswold *et al.* 2005). An inventory of Lepidoptera fell within the scope and goals of I&M, but did not receive funding from the program other than the time of the Natural Resource Specialist. Similar to all I&M inventories, the data collected in this inventory will be entered as evidence into the NPS online inventory database, NPSpecies.

There is some concern that the lack of grazing on Mt. Wanda is increasing the biomass of non-native grasses, resulting in a decrease of native flowering plant abundance through shading and competition, which may impact the insects that use these species as host and nectar or pollen sources. This concern was presented by Dr. Gordon Frankie, a professor at UC Berkeley during a 2002 bee inventory (Griswold *et al.* 2005). This survey will serve as a baseline inventory for Lepidoptera which may be used for local and regional studies in the future.

Due to its small size, JOMU is unable to support populations of many large animals. But populations of small animals such as invertebrates may endure even on small patches of intact habitat. Lepidoptera is an ideal group of invertebrates to inventory because the species are relatively well-described, easy to identify, and well-liked by the public. Furthermore, their close association with plants makes them good indicators of the health of vegetation, so they may be a key component of a vital signs monitoring program.

The more that is known of the resource, the better we can protect it, plan long term vital signs monitoring, and encourage research in the park. A Lepidoptera inventory can promote the sharing of resources across parks while providing a catalyst for community involvement and excitement for the resources at JOMU.

The first step in protecting park butterfly and moth populations is to know what is being protected. Identifying Lepidoptera species will allow managers to consult

published material to better understand specific life histories and habitat requirements. This information, combined with the natural history data collected during the project, will allow the park to make informed decisions about how to best manage for the impacts of factors such as increased visitor use, facility construction, and invasions of exotic plants. It will help focus attention on the needs of certain species when managing fire and when developing linkages to nearby natural areas. As the first step in incorporating Lepidoptera into vital signs monitoring programs, it will help keep tabs on the health of butterfly and moth populations as well as the plant populations on which they depend. Finally, it will increase awareness about JOMU Lepidoptera on the part of the academic community, butterfly organizations, and the general public.

Methods

Site Selection

The John Muir National Historic Site is part of the San Francisco Bay Area Network of National Park units (Fig. 1). JOMU encompasses three separate park units including the home of John Muir, the Strentzel/Muir family gravesite and the adjacent Mt. Wanda natural area. These units total approximately 325 acres. Mt Wanda is the most important site for natural resources at JOMU due to the native oak woodlands, bay forests, riparian areas, and grasslands. A vegetation map of Mt. Wanda completed during the Lepidoptera inventory (O'Neil and Egan 2004) was not available for early planning of sampling locations. However, a good understanding of the existing vegetation communities was known at the onset of this inventory and an effort was made to sample in every vegetation type on Mt. Wanda.

Butterflies

Butterflies were collected and identified in a variety of ways throughout the survey. In most instances, butterflies were netted or observed opportunistically during other projects such as setting up or taking down the moth traps, mapping invasive species, surveying the oak communities or collecting plant specimens for the herbarium. Particularly toward the end of the inventory a list of expected species based on the plant inventory (Appendix A) was used to target surveys in the appropriate season, time of day, and location.

Park and I&M staff collected new butterfly species in order to consult with specialists on correct identification. In some cases, no butterflies were collected for a particular species due to the ease of identification in the field or because a specialist was in the field and could positively identify the specimen without harm.

Four butterfly counts were held on Mt. Wanda in June 2003-2006 as part of the Lepidoptera inventory. Volunteers from the North American Butterfly Association (NABA) along with NPS staff hiked all of the various habitat types on Mt. Wanda and identified as many species as possible in a single day. In 2003, only binoculars were used for identification purposes. In 2004-2006, butterflies were netted for identification purposes and then released. Appendix B lists results of these events.

Figure 1. Ecoregions

San Francisco Bay Area Network Inventory and Monitoring Program

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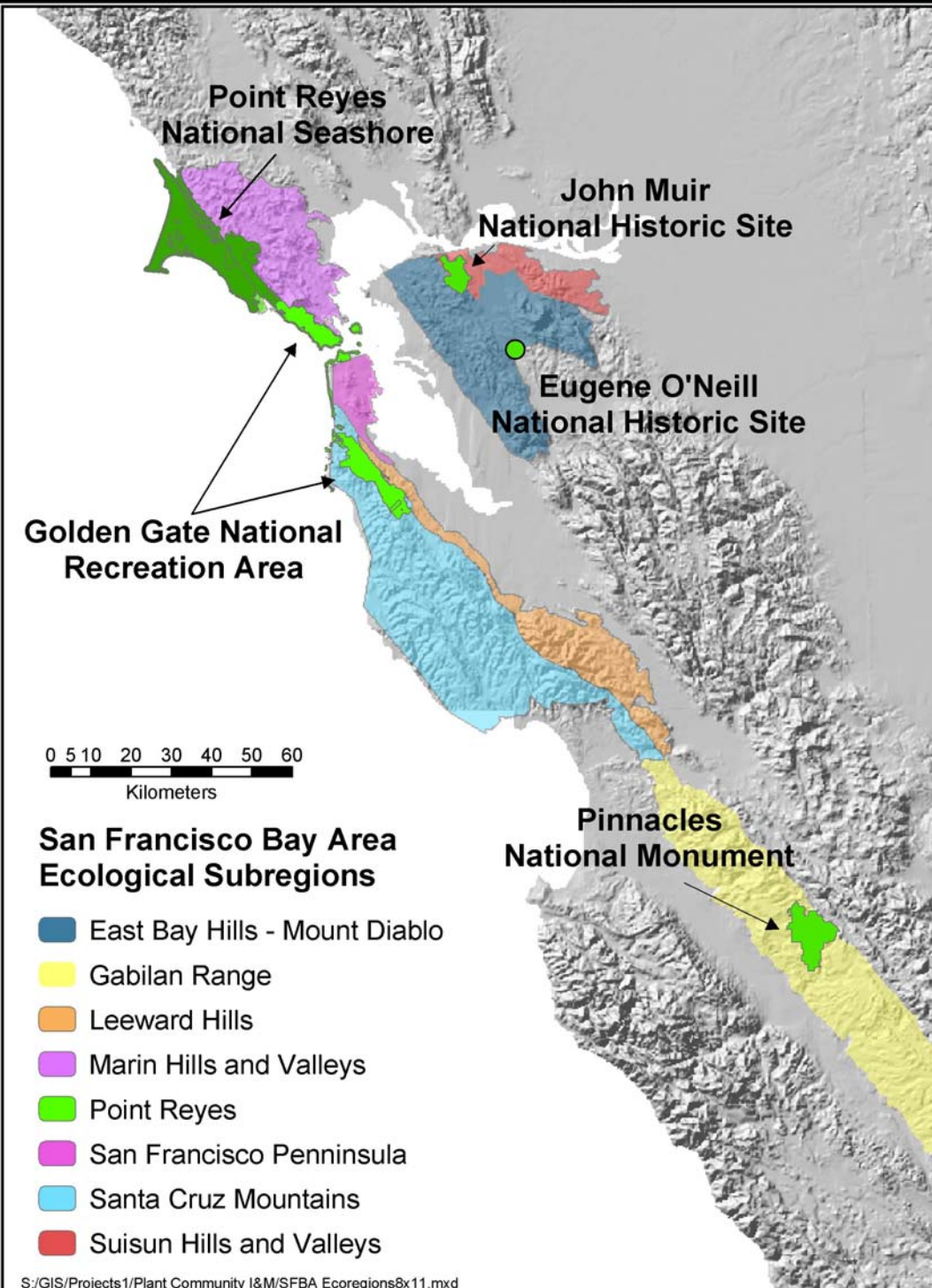


Figure 1. San Francisco Bay Area Ecoregions: Location of John Muir National Historic Site.

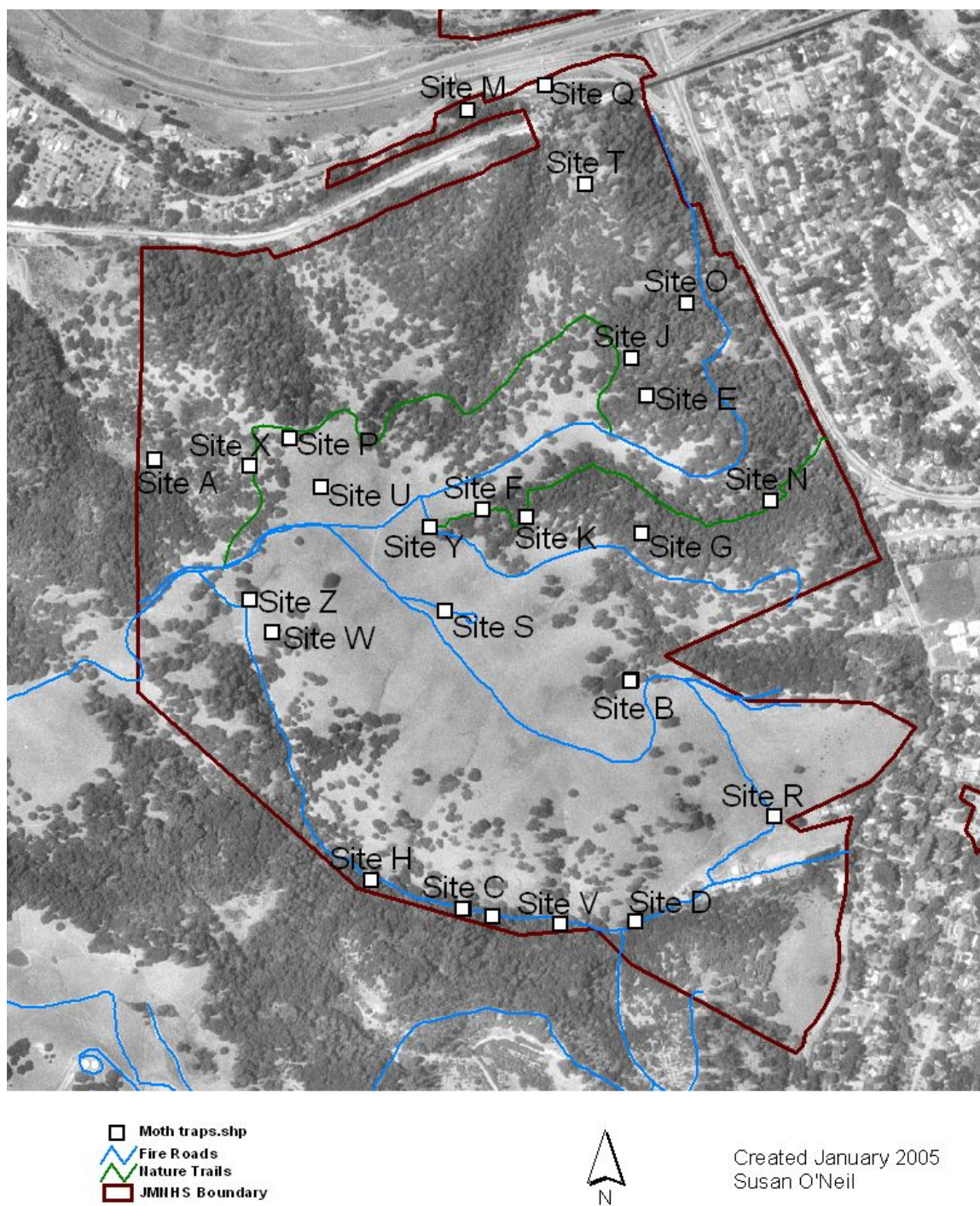


Figure 2. Location of moth trap sites on Mt Wanda.

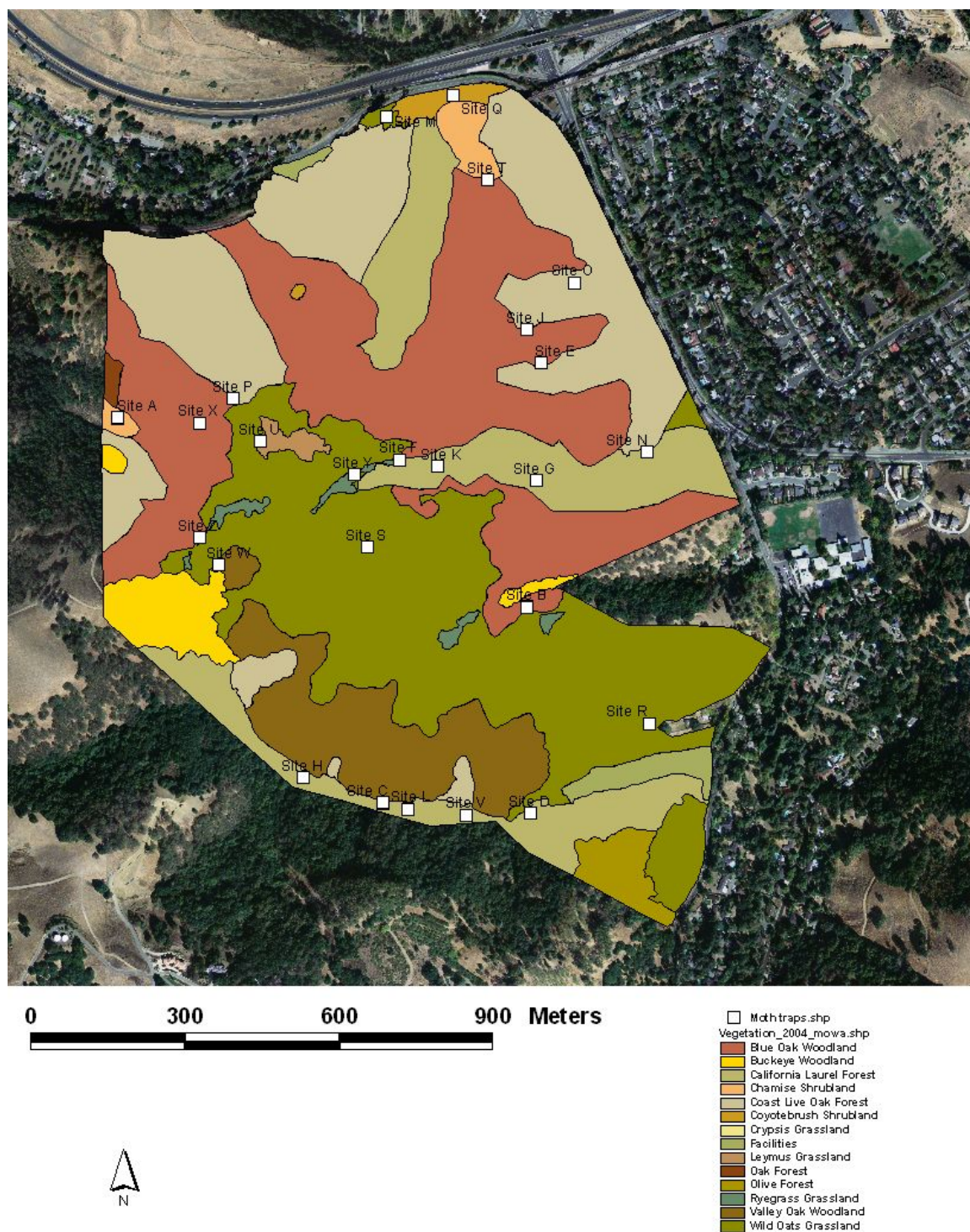


Figure 3. Location of moth trap sites over 2004 vegetation map of Mt. Wanda.

Moths

Except for a few day-fliers that were collected during the butterfly inventory and a few collected from monitored sheets with black lights, moths were collected using light traps. Starting in September 2003, moths were collected for two to three consecutive rain-free nights that coincided with the darkest period (new moon) of each month. Sampling occurred during each month for one full year (Sept. 2003 - Sept. 2004; Table 1).

Table 1. Collection nights for each month and sites of collection for duration of moth inventory. See Appendix D for UTM coordinates, and Figures 2 and 3 for map of sampling sites.

Month, Year	Dates	Collection sites*
September, 2003	25	A, B, C
	26	B, D
October, 2003	23	A, C, E
November, 2003	18	A, B, F
	19	G, H
December, 2003	16	A, H
	17	G, I
	18	J, K
January, 2004	20	D, L, M
	21	N, O
	22	A, P, Q
February, 2004	23	D, N, R
	27	D, M, R
March, 2004	22	A, G, S
	23	T, U
	24	D, V, W
April, 2004	20	D, E, V
	21	A, X
	26	A, I, T
May, 2004	18	B, D, G
	19	A, T
	20	A, T, V
June, 2004	14	A, T, U
	15	A, C, V
July, 2004	19	B, J, Y
	20	A, D, T
August, 2004	15	B, E
	16	D, V, Z
	17	A, G, M
September, 2004	13	D
	14	A, B, G
	15	O, Q
Total number of collections:		83

The light traps used for collecting moths were Universal Black Light Traps (BioQuip Products, Inc.) consisting of: 3.5 gallon polypropylene bucket 10.5 in. high; 12 in. diameter smooth surfaced, lightweight funnel fit to the lip of the bucket; aluminum lid; rain drain; 4-way bungee cord assembly; 22-watt Circline black light tube mounted on top of vanes under the trap's lid. Traps were powered by a 12-volt DC gel cell battery using photoelectric switches so that the light was on only between dusk and dawn (see Figure 4).



Figure 4. Light trap setup used for collecting moths.

Each bucket contained small jar filled with Ethyl Acetate. A cotton wick was used to draw the chemical slowly into the environment of the bucket thus killing the moths inside. After each night of collecting, the traps were brought back to the office for recharging the batteries and refilling the ethyl acetate. The funnel was kept as clean as possible to keep the surface smooth so that moths would slide into the bucket.

Sampling buckets were set up in most vegetation types on Mount Wanda (Figures 2 and 3). The sites were chosen to facilitate access to Mt. Wanda at the time of collection (roads and trails get very slippery during winter with vehicle access impossible at times). During each collection period at least one of the chaparral areas (Site A or T) was sampled due to the unique species expected in those areas. Locations with stands of *Ptelea crenulata* (hop tree) were often selected due to the relative scarcity of this plant on Mt. Wanda.

The specimens from each trap were collected the following morning and stored in sealed plastic bags in a freezer. Moths were then processed to prepare for identification and storage. Each bag of moths (representing one collection site for each night) was sorted, pinned and labeled. As many moths as possible were dried on spreading boards to improve the ability for identifiers to see characteristics. Most specimens were pinned using a Number 2 pin. The micro-moths were pinned using a much smaller diameter minuten pin connected to the Number 2 pins using a strip of foam. In the case of hundreds of the same moth in one trap, several specimens were pinned and the rest were disposed of.

Biological science technicians at Point Reyes National Seashore, Geoff Smick and Amelia Ryan, assisted with pinning some of the moths collected in late-winter/spring of 2004 and developed the labeling system for the study.

Data for each specimen (location, date, collector, UTM and collection type) was entered into Microsoft Access. The data was then exported into Microsoft Word where a format was created for entomological labels. The labels were printed on archival quality entomological paper.

Students at Dominican University, Lisa Lima and Lawrence Hepworth, assisted in finishing the labeling of all specimens. NPS intern, Melissa Plemons, undertook the tremendous task of sorting all of the pinned moth specimens into morphotypes. The specimens were transferred to Dr. Jerry Powell at UC Berkeley for identification. Dr. Powell and Peter Jump completed the identifications and worked with Paul Johnson in developing a spreadsheet of species. The spreadsheet will serve as the definitive species list until further work is done on the specimens identified above the species level. The database used to create the labels is inappropriate for long-term data storage. The amount of work needed to combine the species identifications with the thousands of database entries is not appropriate at this time.

The JOMU site is not equipped to accession these specimens into the museum. During this study there were several ant attacks on the collection as it was being processed. The specimens will remain in the PINN museum until other arrangements are made. A few important specimens will be deposited at the Essig Museum of Entomology at the University of California, Berkeley.

Results

Butterflies

Through opportunistic and directed sampling on Mt. Wanda, 35 species of butterflies have been identified. The 35 species represent 27 genera and five families. An additional species, fiery skipper, was documented elsewhere at JOMU. Table 2 lists all species of butterfly recorded on Mt Wanda organized alphabetically by family and scientific name:

Table 2. Butterflies documented on Mt. Wanda during Lepidoptera inventory.

Family	Scientific Name	Common Name	Specimen collected?
Hesperiidae	<i>Erynnis propertius</i>	Propertius duskywing	X
	<i>Erynnis tristis</i>	Mournful duskywing	X
	<i>Ochlodes agricola</i>	Rural skipper	X
	<i>Ochlodes sylvanoides</i>	Woodland skipper	X
	<i>Poanes melane</i>	Umber skipper	
	<i>Pyrgus communis</i>	Common checkered skipper	X
Lycaenidae	<i>Callophrys augustinus</i>	Brown elfin	
	<i>Celastrina ladon</i>	Spring azure	
	<i>Glaucopsyche lygdamus</i>	Silvery blue	X
	<i>Lycaena xanthoides</i>	Great copper	
	<i>Plebejus acmon</i>	Acmon blue	X
	<i>Strymon melinus</i>	Gray hairstreak	
Nymphalidae	<i>Adelpha bredowii</i>	California sister	X
	<i>Cercyonis sthenele</i>	Great Basin wood nymph	X
	<i>Chlosyne palla</i>	Northern checkerspot	X
	<i>Coenonympha tullia</i>	Common ringlet	X
	<i>Danaus plexippus</i>	Monarch	X
	<i>Euphydryas chalcedona</i>	Variable checkerspot	X
	<i>Junonia coenia</i>	Common buckeye	X
	<i>Limenitis lorquini</i>	Lorquin's admiral	X
	<i>Nymphalis antiopa</i>	Mourning cloak	X
	<i>Phyciodes mylitta</i>	Mylitta crescent	X
	<i>Vanessa annabella</i>	West Coast lady	X
	<i>Vanessa atalanta</i>	Red admiral	X
	<i>Vanessa cardui</i>	Painted lady	X
	<i>Vanessa virginiensis</i>	American lady	X
	<i>Battus philenor</i>	Pipevine swallowtail	X
Papilionidae	<i>Papilio eurymedon</i>	Pale swallowtail	
	<i>Papilio multicaudata</i>	Two-tailed swallowtail	X
	<i>Papilio rutulus</i>	Western tiger swallowtail	
	<i>Papilio zelicaon</i>	Anise swallowtail	X
Pieridae	<i>Anthocharis sara</i>	Sara orange-tip	X
	<i>Colias eurytheme</i>	Orange sulfur	X
	<i>Euchloe ausonides</i>	Large marble	X
	<i>Pieris rapae</i>	Cabbage white	X

Moths

Over 2800 individual moths were captured during the year of repeated sampling on Mt. Wanda. Specialists positively identified 147 species, and at least 188 unique taxa were documented in 20 families. The collection may actually represent over 210 species. The conservative estimate of unique species as identified by Jerry Powell and Peter Jump is 180 due to specimens identified to the genus with a high level of certainty that the specimen represents a unique taxon not yet documented in the collection. For reporting purposes, we will continue to use the figure of 147 specimens identified to the species

level with a high degree of certainty. This is the number reported in NPSpecies. Appendix C lists each moth species identified during the study.

Of the species documented on Mt. Wanda, eleven were new records for Contra Costa County (Table 3).

Table 3. New moth species records for Contra Costa County as a result of NPS inventory.

Family	Scientific name
Acrolophidae	<i>Ptilopsaltis confusella</i>
Crambidae	<i>Lineodes integra</i>
Gelechiidae	<i>Exceptia sisterina</i>
Geometridae	<i>Dysstroma brunneata</i>
Noctuidae	<i>Catocala ilia zoe</i>
	<i>Homorthodes</i>
	<i>hanhami</i>
	<i>Noctua pronuba</i>
	<i>Orthosia behrensiana</i>
	<i>Orthosia transparens</i>
	<i>Properigea</i>
	<i>albimacula</i>
	<i>Eucosma subflavana</i>
Tortricidae	

Discussion

Mt. Wanda at John Muir National Historic Site supports a large number of moth and butterfly species. At least 35 species of butterflies and 147 species of moths were identified with a high degree of certainty during the study. The presence of five species of swallowtail butterflies on three of four years of annual butterfly counts is noteworthy for such a small area (326 acres). It is rare to see five species of swallowtails anywhere in the greater San Francisco Bay Area in a single day.

Butterflies

The list of potential butterfly species at JOMU (Appendix A) includes 81 species, yet only 36 species were detected during this inventory. This was to be expected since the list was intended to represent all species to look for (and where/when to look for them), rather than just the species that were likely to be found. However, it is likely that some species inhabiting JOMU are yet to be found.

A key factor allowing for the presence of a population of a particular butterfly species is the presence of the host plant(s) for that species. Host plants are the particular plants on which the caterpillars feed. Because caterpillars cannot survive on other plants, a resident butterfly population cannot exist unless the proper host plants are present. Host plants for the species mentioned in the following discussions are given in Appendix A.

There are several species whose host plants are present at JOMU but the butterfly has a cryptic nature or tends to occur in small numbers or localized populations, so they may be present but have yet to be discovered. This was true of the brown elfin until it was first recorded on the 2006 butterfly count. This group includes the checkered white, tailed copper, great purple hairstreak, California hairstreak, gold-hunter's hairstreak, bramble green hairstreak, Boisduval's blue, and Satyr comma.

Another group of butterflies have their host plant present at JOMU only in small numbers. These species therefore have a small likelihood of being present, or perhaps they have been extirpated. They include the Gorgon copper, sylvan hairstreak, dotted blue, Western pygmy-blue, Leanira checkerspot, Northern white-skipper, and Sachem.

Some butterflies were not likely present historically, but due to the introduction of their non-native host plant to JOMU they now have the potential of occurring there. These include the Western pine elfin, silver-spotted skipper, and small checkered-skipper.

Finally, there is a set of species whose host plants may not occur at JOMU, or whose range expands northward at times to include the JOMU area, so the butterflies may appear as occasional migrants. These include the California tortoiseshell, common sootywing, and eufala skipper.

The preceding lists represent the butterfly species most likely to be discovered at JOMU, but they are by no means exclusive. The best approach for finding additional resident

species would be to conduct focused searches in the proper habitat and season for each suspected species. The number of new species documented would likely be a function of the amount of time spent in the field. The likelihood of encountering rare or occasional species certainly increases as field time increases. A program for training all field staff to look for new butterflies might be an efficient way to accomplish this goal. Additionally, local butterfly clubs might be enlisted to search for new butterflies on a volunteer basis.

Moths

No Federally designated endangered or threatened moth species were found during the inventory, but surprising and significant records include the following:

Exceptia sisterina Povolny & Powell, 2001 (Gelechiidae) - A series of very pale, almost white specimens, as though bleached, were collected. This species occurs along the coast from Humboldt to Monterey County, but this is the first record of *E. sisterina* in Contra Costa County or anywhere east of SF Bay.

Isophrictis species (Gelechiidae) - There are two specimens of a relatively large, strongly patterned species of this genus that are unlike anything in the Essig Museum at UC Berkeley.

Mirificarma eburnella (D. & S.) (Gelechiidae) – This Palearctic species was collected in California in 1965, and was determined to be widely distributed along the Sacramento Valley and adjacent foothills by 1969. This is the first record in Contra Costa Co. and in the East Bay area.

Eucosma avalona McDunnough (Tortricidae) – Although originally described from Catalina Island, *E. avalona* occurs along the mainland coast northward. There had been one record at Walnut Creek, and Mt. Wanda is the northernmost known occurrence. The larvae feed in the roots of *Artemisia californica*.

Eucosma subflavana (Walsingham) (Tortricidae) – This species occurs primarily east of the Cascades and Sierra Nevada, in eastern Washington, Oregon, and northeastern California, with an apparently disjunct population in the Vaca Mts., Solano-Napa Counties. This is the first record south of the San Joaquin Delta.

There is an unplaced Crambine (Crambidae), which has not been seen before by Jerry Powell. Further study will be needed to identify it taxonomically and assess relationships.

Bandera species (Pyralidae) – Several specimens were collected from Mount Wanda, all of which were very small compared to *Bandera* species seen elsewhere by Jerry Powell. This may be an undescribed species.

Stamnodes possibly *gibbicostata* (Walker) (Geometridae) – If the specimen is determined to be *S. gibbicostata*, the Mount Wanda population may be a new record for this part of the state. This is a species not known to be present in the Bay Area.

Erannis tiliaria vancouverensis Hulst (Geometridae) – This species has been recorded once at a Walnut Creek location, but this winter flying species has rarely been collected in the East Bay area.

Noctua pronuba L. (Noctuidae) – This conspicuous Palaearctic species was first recorded in North America at Nova Scotia in 1979, then it gradually spread across the continent, reaching coastal California by 2001. It has been recorded sporadically in California in recent years. This is the first time in Contra Costa County and the East Bay area. The caterpillars are general feeders in herbaceous vegetation.

Many moth species were expected based on the location and vegetation present on Mount Wanda. Several expected species were either not detected or barely detected during the inventory. The two most surprising are *Telphusa sedulitella* (Gelechiidae) and *Epinotia emarginana* (Tortricidae), which are general oak-feeders and two of the most commonly seen moths in this region. Their adults aestivate and hibernate prior to oviposition in early spring, so are often seen at lights sporadically throughout the year except in late spring. Many other equally small species were collected, as well as several other oak-feeding species in numbers (e.g. *Ypsolopha cervella*, *Cydia latiferreana*, *Decodes fragarianus*, *Henricus umbrabasanus*, *Hydriomena albifasciata* and *H. nubilofasciata*, *Cosmia calami*), indicating that the oak moth fauna is well represented at the Muir site.

The diamond-back moth, *Plutella xylostella* (Plutellidae) was missing from the samples, even though it is one of our ubiquitous species. This Palaearctic species was introduced into North America long ago, and occurs more widely in diverse habitats than perhaps any other species. The larvae feed on cultivated and weedy crucifers (mustard family), and the moths come to lights almost anywhere one samples in California. The orange tortrix, *Argyrotaenia citrana* (Tortricidae) is a very general feeder that has several generations per year and is usually common at lights in urban areas, but only one specimen was present in the samples. There were no Pterophoridae, though at least 6 or 8 species were expected, some of which are common weed-feeders. It is possible that they weren't recognized as moths by the collectors and discarded. The greasy cutworm (*Peridroma saucia*) and corn earworm (*Heliothis zea*) were among the noctuid cutworms that were expected but were absent. Finally, the sphinx moth (*Hyles lineata*) is a very common species that was not detected during the inventory.

It should be noted that the results presented in this study represent a first step in identifying the moth and butterfly community at Mt. Wanda. From the previous descriptions it is obvious that many more species likely occur on Mt. Wanda, but were not detected during the project suggesting that more work would be necessary to perform a thorough inventory. Not all of the collected species have been identified and further lab work may identify additional species. It is possible that some of them may be new species to science. It is also expected that more species can be documented by applying additional survey methods. Continued inventory efforts, such as annual butterfly counts, will likely increase the number of both moths and butterflies at the site.

For vascular plants and vertebrate animals, the standard for inventories conducted by the Inventory and Monitoring Program is to detect at least 90% of the species present. Because invertebrates are so abundant and so diverse in their life habits, numerous methodologies are required to thoroughly inventory them. For example, although perhaps 60% of moth species can be collected with black light traps and diurnal aerial netting, a considerable number are best collected by rearing larvae. Furthermore, factors such as vagaries of weather and annual population fluctuations mean that sampling on a few nights each month for a single year will likely limit the inventory completeness.

Dr. Powell has developed methods for estimating the expected number of moth species at a site, which allows for estimating the completeness of an inventory. He has found that for many mainland sites in California, the number of moth species is approximately 1.5-2.5 times the number of native vascular plant species. For Mt. Wanda with approximately 200 natives, the corresponding expected number of moth species is therefore 300-500. He has also found that a conservative estimate for the number of expected moth species is 15 times the number of resident butterfly species. Accounting for the fact that some Mt. Wanda butterflies may not be residents, and others may be there due to the presence of non-native plants, 30 butterfly species yields an estimated 450+ expected moth species. It is possible that the small area of Mt. Wanda will cause the actual number of species present to be lower. So 400 may be a fair estimate of the number of moth species expected to occur on Mt. Wanda.

Considering that the methods used in this inventory are expected to sample only about 60% of the moth species present at a site, the estimated number of moth species expected to be collected is around 60% of 400, or 240 species. This estimate is for many sampling events over many years. Considering that this inventory was conducted over the period of a single year, the actual number collected (200) suggests that the number of moths at Mt. Wanda is probably about what would be expected. The estimated degree of inventory completeness is therefore approximately 80% for species targeted by these methods, and about 50% of all moth species present on Mt. Wanda. This inventory has succeeded in its goal of developing a baseline for documenting the diversity of invertebrates in a small natural area within an urban landscape.

It has also succeeded in raising questions for future research. For example, it may be of interest to determine the impacts of non-native grass abundance on native plants and animals including invertebrates. Another useful study would be to assess the ways in which native invertebrates utilize the native and non-native plant species in the highly altered habitat.

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APPENDIX A List of potential butterfly species at JOMU (Paul Johnson, 2003).

JOMU Butterfly Inventory Cheat Sheet

SPECIES	COMMON NAME	BTB	Present at JOMU	MONTHS	WHERE TO LOOK
Family Papilionidae	Swallowtails				
<i>Battus philenor</i>	pipevine swallowtail	44	X	3-10	H: Pipevine(NW-NE: Heavily shaded forest/woodland). Hilltops?
<i>Papilio zelicaon</i>	anise swallowtail	48	X	2-10	Hilltops. H: Fennel(NE: RR tracks), Poison Hemlock, Rattlesnake Weed, Bladder Parsnip?
<i>Papilio rutulus</i>	Western tiger swallowtail	50	X	2-9	Hilltops. Shady canyon bottoms. N: thistles. H: Willow, Cottonwood, Sycamore
<i>Papilio multicaudata</i>	two-tailed swallowtail	50	X	5-6	H: Hop Tree(NW-NE-SE: occ. on forest/woodland edges), Sycamore? Hilltops? Canyon bottoms.
<i>Papilio eurymedon</i>	pale swallowtail	50	X	3-9	Hilltops. H: Oceanspray (NW: draw between chaparral/forest), Coffeeberry (NW-NE-SE: shaded forest, top of train tunnel).
Family Pieridae	Whites and Sulphurs				
<i>Pontia sysimbrii</i>	spring white	52		2?-4?	Canyon bottoms. Hilltops? H: Hedge Mustard(NE-NW-S?: woodland edges).
<i>Pontia protodice</i>	checkered white	52		3?-10?	H: Mustard Family(ALL: grassland, ruderal,...). Hilltops?
<i>Pieris napi</i>	marginated white	54		2-6	H: Mustard Family(ALL: grassland, ruderal,...). Riparian?
<i>Pieris rapae</i>	cabbage white	54	X	a/y	H: Mustard Family(ALL: grassland, ruderal,...).
<i>Euchloe ausonides</i>	large marble	56	X	3-6	H: Mustard Family(ALL: grassland, ruderal,...). Valley bottoms?
<i>Anthocaris sara</i>	Sara orange-tip	56	X	2-6	H: Mustard Family(ALL: grassland, ruderal,...). Canyons?
<i>Anthocaris lanceolata</i>	Gray marble	58		3-5	Canyon bottoms. Hilltops? H: Hedge Mustard(NE-NW-S?: woodland edges).
<i>Colias eurytheme</i>	orange sulphur/alfalfa	60	X	2-11	
Family Lycaenidae	Gossamer-wing Butterflies				
<i>Lycaena arota</i>	tailed copper	76		5-7	On shrubs at edge of clearing near H: Gooseberry(NW: shaded forest near chaparral & near RR tracks).
<i>Lycaena xanthoides</i>	great copper	74	X	5-7	Low spots near H: Dock, Sheep Sorrel(fields, roads, ruderal, woodland edges)
<i>Lycaena gorgon</i>	gorgon copper	78		5-6	H: Nude Buckwheat(ALL: scattered on dry, open hillsides). N: Golden Yarrow(NW-NW: Wildflower Tr., above tunnel/tracks).
<i>Lycaena helloides</i>	purplish copper	82		4-10	Low spots near H: Knotweed?, Dock, Sheep Sorrel(fields, roads, ruderal, woodland edges)
<i>Atlides halesus</i>	great purple hairstreak	84		3-11	Hilltops on tree/shrubtops, p.m. N: flowers of trees/shrubs.
<i>Satyrrium californica</i>	California hairstreak	88		6-8	Treetops, us. on hilltops. N: Milkweed(NW-NE: on top along fire rd.)
<i>Satyrrium sylvinus</i>	sylvan hairstreak	88		5-6	On/near H: Arroyo Willow(NW-NE: dry north-facing slope above tracks). N: Milkweed(NW-NE: on top along fire rd.)
<i>Satyrrium auretorum</i>	gold hunter's hairstreak	90		5-7	Shake/throw rocks at tops of H: Blue Oak, watch anything that flies.
<i>Callophrys affinis</i>	bramble green hairstreak	92		3-5	Low spots/gulches near H: Nude Buckwheat(ALL: scattered on dry, open hillsides), Deerweed(NW-NE: chaparral).
<i>Callophrys augustinus</i>	brown elfin	98	X	5-6	N. Woodland, open hillsides, draw between chaparral/forest.
<i>Callophrys eryphon</i>	Western pine elfin	98		5-6	Sides of shrubs in gulch bottoms near H: Pine(main entrance & entrance to Strain Ranch).

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SPECIES	COMMON NAME	BTB	Present at JOMU	MONTHS	WHERE TO LOOK
<i>Callophrys spinetorum</i>	thicket hairstreak	96		3-8	Hilltops on prominent trees.
<i>Strymon melinus</i>	gray hairstreak	102	X	2?-11?	Hilltops on prominent trees, esp. p.m. N.
<i>Brephidium exile</i>	Western pygmy-blue	106		a/y	N. Low areas. Potential H: Cutleafed Goosefoot(roadside near Maintenance, between sidewalk and fence).
<i>Everes comyntas</i>	Eastern tailed-blue	108		3-9	H: Spanish Lotus, Deerweed, Miniature Lupine, Sky Lupine, Sour Clover, Spring Vetch
<i>Everes amyntula</i>	Western tailed-blue	108		3-4(8?)	H: American Vetch(SE: woodland).
<i>Celastrina ladon</i>	spring azure/echo blue	110	X	2-7	Flying high around H: CA Buckeye, Chamise, Oceanspray, Oak?... (flowers)
<i>Euphilotes enoptes</i>	dotted blue	114		5?	H: Nude Buckwheat(ALL: scattered on dry, open hillsides).
<i>Glaucopsyche lygdamus</i>	silvery blue	118	X	2-5(8?)	Rapidly flying in habitat of H: Deerweed, Spanish Lotus, Arroyo Lupine, Spring Vetch, American Vetch. Mud.
<i>Plebejus icaroides</i>	Boisduval's blue	120		4-6(8?)	H: Shrub lupines: Arroyo Lupine(NW-NE: sunny hillsides), Summer Lupine(NW-NE; N. of fire road, on top of Mt. Wanda).
<i>Plebejus acmon</i>	acmon blue	124	X	2-10	H: Nude Buckwheat, Deerweed, Hill Lotus, Spanish Lotus, Lupines.
Family Riodinidae	Metalmarks				
<i>Apodemia mormo</i>	Mormon metalmark	132		6?-12?	H: Nude Buckwheat(ALL: scattered on dry, open hillsides). N.
Family Nymphalidae	Brush-footed Butterflies				
<i>Speyeria coronis</i>	coronis fritillary	138		6, 8-9	Hilltops. Blue Oak woodland? H: Violets (not found).
<i>Speyeria callippe</i>	callippe fritillary	144		6-7	Hilltops. Blue Oak woodland? H: Violets (not found).
<i>Thessalia leanira</i>	Leanira checkerspot	164		4-6	Hilltops (oft. on side near top). N. H: Indian Paintbrush, Woolly Owl Clover(NW-NE: chaparral on exposed slopes).
<i>Chlosyne palla</i>	Northern checkerspot	168	X	4-6	H: Woodland Aster(ALL: woodland), CA Goldenrod(SW: patch above fire rd. near Everlasting Pea patch).
<i>Phyciodes campestris</i>	field crescent	174		4-10	H: Common CA Aster(NE-NW: large patch in open grassland on top, some above train tunnel).
<i>Phyciodes mylitta</i>	mylitta crescent	178	X	2-11	H: Bull Thistle(North along tracks), Italian Thistle(ALL). Low spots. Along streams.
<i>Euphydryas chalcedona</i>	chalcedon checkerspot	170		3?-7?	H: Paintbrush, Owl Clover(chaparral), CA Figwort(SW: along creek), Sticky Monkeyflower(chaparral)... N.
<i>Euphydryas editha</i>	Edith's checkerspot	172			H: (See above. Only on serpentine soils in Bay Area?) N. May be very localized.
<i>Polygonia satyrus</i>	satyr comma	182		a/y	In patch of sun in shady spot along stream, p.m.
<i>Polygonia faunus</i>	green comma	184		4-8	Riparian. Valley bottoms , p.m.
<i>Polygonia oreas</i>	oreas comma	184		4-8	Riparian. Valley bottoms , p.m.
<i>Nymphalis californica</i>	California tortoiseshell	186		a/y?	Hilltops. Sunny spots on tree trunks/banks.
<i>Nymphalis antiopa</i>	mourning cloak	186	X	a/y	Riparian, esp. on warm winter days.
<i>Nymphalis milberti</i>	Milbert's tortoiseshell	186		a/y?	Rocky area below hilltop, p.m.

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SPECIES	COMMON NAME	BTB	Present at JOMU	MONTHS	WHERE TO LOOK
<i>Vanessa virginiensis</i>	American lady	188	X	a/y	Hilltops, esp. p.m.
<i>Vanessa cardui</i>	painted lady	188	X	a/y	Hilltops, esp. p.m.
<i>Vanessa annabella</i>	West Coast lady	188	X	a/y	Hilltops, esp. p.m.
<i>Vanessa atalanta</i>	red admiral	188	X	a/y	Hilltops, esp. p.m.
<i>Junonia coenia</i>	common buckeye	190	X	2-11?	Bare ground in flat areas/gulch bottoms.
<i>Limenitis lorquini</i>	Lorquin's admiral	192	X	4?-10?	On shrubs/trees in valley bottoms, esp. in habitat of H: Arroyo Willow, Cottonwood?, Oceanspray?
<i>Adelpha bredowii</i>	California sister	192	X	3-10	On trees or patrolling in gulches in habitat of H: Coast Live Oak, Blue Oak, Black Oak
<i>Coenonympha tullia</i>	common ringlet	204	X	2-10	H: grasses.
<i>Cercyonis pegala</i>	common wood nymph	202		6-8	Grassy areas. H: Wild Oat(ALL).
<i>Cercyonis sthenele</i>	Great Basin wood nymph	202	X	6-7	H: grasses. Valley bottoms.
<i>Danaus plexippus</i>	Monarch	214	X	3-11	H: Milkweed(NW-NE: on top along fire rd.) N: thistles.
Family Hesperidae		Skippers			
<i>Epargyreus clarus</i>	silver-spotted skipper	216		5-9	In gullies/clearings mostly a.m. Nectar/mud. H: Black Locust(behind maint. building).
<i>Thorybes pylades</i>	Northern cloudywing	226		6	Hilltop on trees/shrubs.
<i>Erynnis propertius</i>	propertius duskywing	230	X	3-5(6?)	Clearing on sunny edge of hilltop/ridgetop (sometimes on banks in valley bottoms).
<i>Erynnis tristis</i>	mournful duskywing	234	X	3-10	Hilltops. N.
<i>Erynnis persius</i>	persius duskywing	236		(3)5-9	Hilltops.
<i>Pyrgus ruralis</i>	two-banded check'd-skipper	240		5	H: (not found, would be in moist areas). Potential H: Sticky Cinquefoil(SW: dense forest/riparian).
<i>Pyrgus scriptura</i>	small checkered-skipper	240		3-11	H: Alkali Mallow(HOUSE: orchard, ruderal).
<i>Pyrgus communis</i>	common check'd-skipper	238	X	6-10	H: Bull Mallow(NW-SE: ruderal).
<i>Heliopetes ericetorum</i>	Northern white-skipper	242		6-10	H: Bull Mallow(NW-SE: ruderal).
<i>Pholisora catullus</i>	common sootywing	244		4-9	Gulches. Potential H: Cutleafed Goosefoot(roadside near Maintenance, between sidewalk and fence).
<i>Hylephila phyleus</i>	fiery skipper	262	X	4-12	H: Bermuda Grass, Spike Redtop. Swales. Moist places.
<i>Hesperia juba</i>	juba skipper	258		5-6/9	H: Grasses? Gulches.
<i>Hesperia comma</i>	common branded skipper	256		6-7(9?)	Hilltops. H: Bromes, Italian Rye Grass.
<i>Hesperia columbia</i>	Columbian skipper	256		4-5/9-10	Hilltops. H: Junegrass(not found), CA Oatgrass(not found).
<i>Hesperia lindseyi</i>	Lindsey's skipper	258		5-7	H: Rat-tail Fescue. Ridges.
<i>Polites sabuleti</i>	sandhill skipper	266		4-10	Low areas. H: Bermuda Grass.
<i>Atalopedes campestris</i>	Sachem	262		4-10	Grassy swales. Moist places. H: Bermuda Grass.
<i>Ochlodes agricola</i>	rural skipper	272	X	5-6	California Buckeye: on flowers or near trees. Also in shade of shrubs at clearing edges.
<i>Ochlodes sylvanoides</i>	woodland skipper	272	X	6-10	On shrubs (often on ridges). H: Bermuda Grass.

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SPECIES	COMMON NAME	BTB	Present at JOMU	MONTHS	WHERE TO LOOK
<i>Poanes melane</i>	umber skipper	274	X	4-10	Swales/gulches. Moist places. H: Bermuda Grass, CA Brome.
<i>Lerodea eufala</i>	eufala skipper	288	X	4-7/8-10	Swales/gulches. Moist places. H: Bermuda Grass.
					Prepared by Paul G. Johnson II 7 Dec 2002
KEY: a/y=all year		H=caterpillar host plant		N=adult nectar plant	BTB=page # in <i>Butterflies Through Binoculars</i> NW-NE-SW-SE-ALL=section of park

APPENDIX B. Results of 2003-2006. Butterfly Counts at John Muir NHS.

JOMU	Date	14-Jun-03	18-Jun-04	27-Jun-05	20-Jun-06
Butterfly Count Results	Total party hours	6.5	8	4.25	4
	Total party miles	6	4.5	2.5	3.5
	# participants	6	6	4	3
<u>Scientific name</u>	<u>Common name</u>	<u>Number of individuals</u>			
<i>Battus philenor</i>	Pipevine swallowtail	6	2	3	1
<i>Papilio zelicaon</i>	Anise swallowtail	6	3	2	6
<i>Papilio rutulus</i>	Western tiger swallowtail	5	6	1	5
<i>Papilio multicaudata</i>	Two-tailed swallowtail	3	4	0	2
<i>Papilio eurymedon</i>	Pale swallowtail	2	1	0	2
	(unidentified swallowtail)		(2)		
<i>Pieris rapae</i>	Cabbage white	10	27	11	8
<i>Anthocaris sara</i>	Sarah orange-tip	0	0	0	1
<i>Colias eurytheme</i>	Orange sulphur/alfalfa	2	0	0	0
	(unidentified white)	(9)			
<i>Lycaena xanthoides</i>	Great copper	1	0	0	0
<i>Callophrys augustinus</i>	Brown elfin	0	0	0	1
<i>Strymon melinus</i>	Gray hairstreak	2	1	0	1
<i>Celastrina ladon</i>	Spring azure/echo blue	16	0	2	8
<i>Plebejus acmon</i>	Acmon blue	2	1	7	0
	(unidentified brown hairstreak)		(1)*		
	(unidentified blue)	(5)			
<i>Chlosyne palla</i>	Northern checkerspot	2	0	0	0
<i>Phyciodes mylitta</i>	Mylitta crescent	35	0	2	5
<i>Euphydryas chalcedona</i>	Variable checkerspot	15	1	0	(3 larvae)
<i>Nymphalis antiopa</i>	Mourning cloak	1	0	1	1
<i>Vanessa virginiensis</i>	American lady	1	0	1	0
<i>Vanessa cardui</i>	Painted lady	6	3	1	0
<i>Vanessa atalanta</i>	Red admiral	1	0	1	0
<i>Junonia coenia</i>	Common buckeye	54	0	9	0
<i>Adelpha bredowii</i>	California sister	5	1	1	5
<i>Limenitis lorquini</i>	Lorquin's admiral	0	0	0	1
<i>Coenonympha tullia</i>	Common ringlet	4	3	3	3
<i>Ceryonis sthenele</i>	Great Basin wood nymph	0	3	0	3
<i>Danaus plexippus</i>	Monarch	0	(1 larva)	0	0
	(unidentified Vanessa)	(4)			(2)*
	(unidentified Nymphalid)	(2)			
<i>Erynnis tristis</i>	Mournful duskywing	15	2	2	9
<i>Pyrgus communis</i>	Common checkered skipper	5	1	1	0
<i>Ochlodes agricola</i>	Rural skipper	77	22	5	25
<i>Poanes melane</i>	Umber skipper	5	1	4	6
	(unidentified duskywing)	(5)	(1)		
	Total # of Species	25	18	18	20
	Total # of Individuals*	306	86	57	95

() Indicates at least one species identified in this group, or only larval stage recorded, so does not count as a unique species.

()* Indicates no species identified in this group, so counts as a unique species.

* 2005 data were lost. Numbers represent best estimate from Paul Johnson.

APPENDIX C. Results of moth inventory at John Muir NHS as determined by Jerry Powell of University of California Berkeley except Acrolophidae and “Myrmacozela” determined by Peter Jump.

Family	Lowest Taxon	Author, Date	# Specimens	ID Certainty	Est'd min # spp
Tineidae	<i>Nemapogon granella</i>	(L., 1758)	3	3	1
Acrolophidae	<i>Ptilopsaltis confusella</i>	(Dietz, 1905)	19	3	1
Acrolophidae	Acrolophidae		4	1	?
Acrolophidae	<i>Amydria</i> sp.		10	2	1
Acrolophidae	<i>Amydria</i> new sp. "c"		2	3	1
Acrolophidae	<i>Acrolophus laticapitanus</i>	(Wlsm., 1884)	21	3	1
Tineidae	<i>Tinea niveocapitella</i>	Cham., 1875	1	3	1
Gracillariidae	<i>Caloptilia agrifoliella</i>	Opler, 1971	1	2	1
Gracillariidae	<i>Marmara</i>		1	2	1
Gracillariidae	<i>Phyllonorycter</i>		2	2	1
Oecophoridae	<i>Agonopterix oregonensis</i>	Clarke, 1941	1	2	1
Oecophoridae	<i>Esperia sulphurella</i>	(F., 1775)	3	3	1
Oecophoridae	<i>Pleurota albastrigulella</i>	(Kft., 1907)	4	3	1
Blastobasidae	<i>Hypatopa/Holcocera</i>			1	2
Blastobasidae	<i>Blastobasis glandulella</i>	(Riley, 1871)	2	3	1
Cosmopterigidae	<i>Walshia miscecolorella</i>	(Cham., 1875)	1	2	1
Gelechiidae	Gelechiidae		many	1	???
Gelechiidae	Gelechiidae		4	1	???
Gelechiidae	<i>Isophrictis</i>	Meyr., 1917	2	2	1
Gelechiidae	<i>Aristotelia adenostomae</i>	Keif., 1933	many	2	1
Gelechiidae	<i>Evippe laudatella</i>	(Wlsm., 1907)	many	3	1
Gelechiidae	<i>Leucogoniella californica</i>	(Keif., 1930)	4	2	1
Gelechiidae	<i>Xenolechia</i>		many	2	1
Gelechiidae	<i>Exceptia sisterina</i>	Povolny & Powell, 2000	14	3	1
Gelechiidae	<i>Chionodes</i>		many	2	1
Gelechiidae	<i>Chionodes</i>		?	2	1
Gelechiidae	<i>Chionodes ochreostrigella</i>	(Cham., 1875)	?	3	1
Gelechiidae	<i>Filatima</i>		?	2	2
Gelechiidae	<i>Mirificarma eburnella</i>		many	3	1
Carposinidae	<i>Bondia comonana</i>	(Kft., 1907)	1	3	1
Epermeniidae	<i>Epermenia cicutaella</i>	Kft., 1903	1	2	1
Plutellidae	<i>Eucratia securella</i>	Wlsm., 1881	3	3	1
Plutellidae	<i>Plutella vanella</i>	Wlsm., 1881	1	3	1
Plutellidae	<i>Ypsolopha</i>		1	2	1
Plutellidae	<i>Ypsolopha cervella</i>	(Wlsm., 1881)	many	3	1
Tortricidae	<i>Endothernia hebesana</i>	(Wlk., 1863)	2	3	1
Tortricidae	<i>Eucosma avalona</i>	McD., 1938	1	3	1
Tortricidae	<i>Eucosma subflavana</i>	(Wlsm., 1879)	2	3	1
Tortricidae	<i>Epinotia siskiyouensis</i>	Heinr., 1923	1	3	1
Tortricidae	<i>Cydia pomonella</i>	(L., 1758)	1	3	1
Tortricidae	<i>Cydia latiferreana</i>	(Wlsm., 1879)	many	3	1

Family	Lowest Taxon	Author, Date	# Specimens	ID Certainty	Est'd min # spp
Tortricidae	<i>Cnephasia longana</i>	(Haw., 1811)	10	3	1
Tortricidae	<i>Decodes basiplaganus</i>	(Wlsm., 1879)	3	3	1
Tortricidae	<i>Decodes fragarianus</i>	(Bsk., 1919)	many	3	1
Tortricidae	<i>Argyrotaenia citrana</i>	(Fern., 1889)	1	3	1
Tortricidae	<i>Archips argyrospila</i>	(Wlk., 1863)	many	3	1
Tortricidae	<i>Clepsis peritana</i>	(Clem., 1860)	2	3	1
Tortricidae	<i>Amorbia cuneana</i>	(Wlsm., 1879)	2	3	1
Tortricidae	<i>Henricus umbrabasanus</i>	(Kft., 1908)	14	3	1
Crambidae	Crambidae		2	1	1
Crambidae	<i>Cosipara</i>		2	2	1
Crambidae	<i>Eudonia</i>		many	2	0
Crambidae	<i>Eudonia rectilinea</i>	(Zell., 1874)	10	3	1
Crambidae	<i>Hellula rogatalis</i>	(Hulst, 1886)	1	3	1
Crambidae	<i>Dicymolomia metalliferalis</i>	(Pack., 1873)	18	3	1
Crambidae	<i>Pyrausta volupialis</i>	(Grt., 1877)	2	3	1
Crambidae	<i>Pyrausta perrubralis</i>	(Pack., 1873)	3	3	1
Crambidae	<i>Lineodes integra</i>	(Zell., 1873)	1	3	1
Crambidae	<i>Mecyna mustelinalis</i>	(Pack., 1873)	many	3	1
Crambidae	<i>Mimorista subcostalis</i>	(Hamp., 1913)	1	3	1
Crambidae	<i>Herculia</i>		1	1	1
Crambidae	<i>Diastictis fracturalis</i>	(Zell., 1872)	3	3	1
Crambidae	<i>Pediasia</i>	Hbn., 1825	2	2	1
Crambidae	<i>Euchromius ocellus</i>	(Haw., 1811)	2	2	1
Crambidae	<i>Arta epicoenalis</i>	Rag., 1891	many	3	1
Pyalidae	<i>Galleria mellonella</i>	(L., 1758)	3	3	1
Pyalidae	Phycitinae		many	1	3
Pyalidae	<i>Acrobasis tricolorella</i>	Grt., 1878	3	2	1
Pyalidae	<i>Acrobasis comptella</i>	Rag., 1887	many	2	1
Pyalidae	<i>Trachycera caliginoidella</i>	(Hulst, 1889)	10	3	1
Pyalidae	<i>Apomyelois bistriatella</i>	(Hulst., 1887)	2	2	1
Pyalidae	<i>Etiella zinckenella</i>	(Tr. 1832)	many	3	1
Pyalidae	<i>Dioryctria</i>	(Zell., 1846)	3	2	2
Pyalidae	<i>Homoeosoma electellum</i>	(Hulst, 1887)	2	3	1
Pyalidae	<i>Phycitodes mucidella</i>	(Rag., 1887)	1	3	1
Pyalidae	<i>Ephestiodes gilvescentella</i>	Rag., 1887	4	3	1
Pyalidae	<i>Vitula edmandsii</i>	(Pack., 1864)	2	3	1
Pyalidae	<i>Ephestia kuehniella</i>	(Zell., 1879)	2	3	1
Pyalidae	<i>Bandera</i>	Rag., 1887	many	2	1
Geometridae	Geometridae		13	1	3
Geometridae	<i>Alsophila pometaria</i>	(Harr., 1841)	2	3	1
Geometridae	<i>Elpiste marcescens</i>	(Gn., 1857)	7	3	1
Geometridae	<i>Semiothisa</i>		13	2	0
Geometridae	<i>Semiothisa muscariata</i>	(Gn. 1857)	9	3	1
Geometridae	<i>Semiothisa californiaria</i>	(Pack., 1871)	3	3	1
Geometridae	<i>Hulstina</i>		17	1	0
Geometridae	<i>Hulstina wrightiaria</i>	(Hulst, 1888)	7	3	1
Geometridae	<i>Pterotaea</i>	Hulst, 1896	many	2	1
Geometridae	<i>Cochisea sinuaria</i>	B. & McD., 1916	1	3	1

Family	Lowest Taxon	Author, Date	# Specimens	ID Certainty	Est'd min # spp
Geometridae	<i>Phigalia plumogeraria</i>	(Hulst, 1888)	2	3	1
Geometridae	<i>Paleacrita longiciliata</i>	Hulst, 1898	2	3	1
Geometridae	<i>Erannis tiliaria vancouverensis</i>	Hulst, 1896	5	3	1
Geometridae	<i>Pero macdunnoughi</i>	(C. & S., 1922)	4	3	1
Geometridae	<i>Thallophaga</i>	Hulst, 1896	2	2	1
Geometridae	<i>Neoterpes edwardsata</i>	(Pack., 1871)	1	3	1
Geometridae	<i>Sicya morsicaria</i>	(Hulst, 1886)	1	3	1
Geometridae	<i>Plataea personaria</i>	(Hy. Edw., 1881)	1	3	1
Geometridae	<i>Pherne</i>	Hulst, 1896	8	2	1
Geometridae	<i>Synaxis pallulata</i>	(Hulst, 1887)	3	3	1
Geometridae	<i>Synaxis cervinaria</i>	(Pack., 1871)	9	3	1
Geometridae	<i>Prochoerodes truxaliata</i>	(Gn. 1857)	1	3	1
Geometridae	<i>Nemoria leptalea</i>	Fgn., 1969	1	3	1
Geometridae	<i>Nemoria pulcherrima</i>	(B. & McD., 1916)	3	3	1
Geometridae	<i>Dichorda illustraria</i>	(Hulst, 1886)	3	3	1
Geometridae	<i>Synchlora aerata</i>	(F., 1798)	1	3	1
Geometridae	<i>Cyclophora dataria</i>	(Hulst, 1887)	24	3	1
Geometridae	<i>Dysstroma</i>	Hbn., 1825	2	2	0
Geometridae	<i>Dysstroma brunneata</i>	(Pack., 1867)	5	3	1
Geometridae	<i>Hydriomena edenata</i>	Swett, 1909	2	2	1
Geometridae	<i>Hydriomena albifasciata</i>	(Pack., 1874)	11	3	1
Geometridae	<i>Hydriomena nubilofasciata</i>	(Pack., 1871)	many	3	1
Geometridae	<i>Stamnodes gibbicostata</i>	(Wlk., 1862)	2	2	1
Geometridae	<i>Epirrhoe plebeculata</i>	(Gn., 1857)	2	3	1
Geometridae	<i>Zenophraps lignicolorata</i>	(Pack., 1874)	many	3	1
Geometridae	<i>Venusia duodecemlineata</i>	(Pack., 1873)	14	3	1
Geometridae	<i>Operophtera occidentalis</i>	(Hulst, 1896)	1	3	1
Geometridae	<i>Operophtera danbyi</i>	(Hulst, 1896)	5	3	1
Geometridae	<i>Eupithecia</i>		3	2	3
Geometridae	<i>Eupithecia nevadata complex</i>		1	3	1
Geometridae	<i>Eupithecia/Nasusaria</i>		many	1	0
Lasiocampidae	<i>Phyllodesma americana</i>	(Harr., 1841)	4	3	1
Lasiocampidae	<i>Malacosoma californicum</i>	(Pack., 1864)	15	3	1
Sphingidae	<i>Arctonotus lucidus</i>	Bdv., 1852	2	3	1
Notodontidae	<i>Nadata gibbosa</i>	(J. E. Smith, 1797)	many	3	1
Notodontidae	<i>Schizura unicornis</i>	(J. E. Smith, 1797)	2	3	1
Arctiidae	<i>Leptarctia californiae</i>	(Wlk., 1855)	1	3	1
Arctiidae	<i>Spilosoma vestalis</i>	Pack., 1864	1	3	1
Arctiidae	<i>Grammia (Apantes) ornata</i>	(Pack., 1864)	many	3	1
Arctiidae	<i>Hemihyalea edwardsii</i>	(Pack., 1864)	6	3	1
Lymantriidae	<i>Orgyia cana</i>	Hy. Edw., 1881	19	3	1
Noctuidae	<i>Abagrotis</i>		10	2	2 or 3
Noctuidae	<i>Mesogona subcuprea</i>	Crabo &	6	3	1

Family	Lowest Taxon	Author, Date	# Specimens	ID Certainty	Est'd min # spp
		Hammond			
Noctuidae	<i>Mesogona olivata</i>	(Harvey)	4	3	1
Noctuidae	<i>Pseudorthosia variabilis</i>	Grote	2	3	1
Noctuidae	<i>Idia americalis</i>	(Gn., 1854)	17	3	1
Noctuidae	<i>Noctua pronuba</i>		1	3	1
Noctuidae	<i>Noctuidae</i>		many	1	3
Noctuidae	<i>Hemeroplanis finitima</i>	(Sm., 1893)	2	3	1
Noctuidae	<i>Synedoida edwardsi</i>	(Behr, 1870)	1	3	1
Noctuidae	<i>Caenurgis togataria</i>	(Wlk., 1862)	2	3	1
Noctuidae	<i>Catocala aholibah</i>	Stkr., 1874	3	3	1
Noctuidae	<i>Catocala ilia zoe</i>	Behr, 1870	1	3	1
Noctuidae	<i>Catocala verilliana</i>	Grt., 1875	2	3	1
Noctuidae	<i>Autographa californica</i>	(Speyer, 1875)	3	3	1
Noctuidae	<i>Nola minna</i>	Butler, 1881	1	3	1
Noctuidae	<i>Eumicremma minima</i>	(Gn., 1852)	1	2	1
Noctuidae	<i>Acronicta marmorata</i>	Sm., 1897	many	3	1
Noctuidae	<i>Apamea cincta</i>	(Grt., 1881)	2	3	1
Noctuidae	<i>Oligia marina</i>	(Grt., 1874)	many	3	1
Noctuidae	<i>Cobalos franciscanus</i>	Sm. 1899	12	3	1
Noctuidae	<i>Aseptis paviae</i>	(Stkr., 1874)	11	3	1
		(B. & McD., 1912)	many	3	1
Noctuidae	<i>Properigea albimacula</i>				
Noctuidae	<i>Pseudobryomima fallax</i>	(Hamp., 1906)	1	2	1
Noctuidae	<i>Amphipyra pyramidoides</i>	Gn., 1852	2	3	1
Noctuidae	<i>Protoperigea posticata</i>	(Harv. 1875)	1	3	1
Noctuidae	<i>Spodoptera exigua</i>	(Hbn., 1803-08)	17	3	1
Noctuidae	<i>Spodoptera praefica</i>	(Grt., 1875)	2	3	1
Noctuidae	<i>Cosmia calami</i>	(Harv., 1876)	many	3	1
Noctuidae	<i>Agrochola purpurea</i>	(Grt., 1874)	1	2	0
Noctuidae	<i>Agrochola purpurea</i>	(Grt., 1874)	13	3	1
Noctuidae	<i>Pleromelloida cinerea</i>	(Sm., 1904)	2	3	1
Noctuidae	<i>Lacinipolia</i>		1	2	1
Noctuidae	<i>Lacinipolia</i>		20	2	1
Noctuidae	<i>Lacinipolia cuneata</i>	(Grt., 1873)	1	3	1
Noctuidae	<i>Lacinipolia pensilis</i>	(Grt., 1874)	12	3	1
Noctuidae	<i>Lacinipolia stricta</i>				
Noctuidae	<i>cinnabarrina</i>	(Grt., 1874)	1	3	1
Noctuidae	<i>Lacinipolia strigicollis</i>	(Wallgr., 1860)	6	3	1
Noctuidae	<i>Lacinipolia quadrilineata</i>	(Grt., 1873)	3	3	1
Noctuidae	<i>Dargida procincta</i>	(Grt., 1873)	1	3	1
Noctuidae	<i>Faronta terrapictalis</i>	Buckett, 1969	2	3	1
Noctuidae	<i>Pseudaletia unipuncta</i>	(Haw., 1809)	6	3	1
Noctuidae	<i>Leucania oaxacana</i>	Schauss, 1898	7	3	1
Noctuidae	<i>Orthosia erythrolita</i>	(Grt., 1879)	3	3	1
Noctuidae	<i>Orthosia erythrolita ?</i>	(Grt., 1879)	1	2	0?
Noctuidae	<i>Orthosia</i>		2	2	0?
Noctuidae	<i>Orthosia transparens</i>	(Grt., 1882)	2	3	1
Noctuidae	<i>Orthosia praeses</i>	(Grt., 1879)	4	3	1
Noctuidae	<i>Orthosia behrensiana</i>	(Grt., 1875)	3	3	1

Family	Lowest Taxon	Author, Date	# Specimens	ID Certainty	Est'd min # spp
Noctuidae	<i>Orthosia macona</i>	(Sm., 1908)	1	3	1
Noctuidae	<i>Orthosia arthrolita</i>	(Harvey, 1875)	8	3	1
Noctuidae	<i>Orthosia pacifica</i>	(Harv., 1874)	2	3	1
Noctuidae	<i>Egira hiemalis</i>	(Grt., 1874)	many	3	1
Noctuidae	<i>Egira crucialis</i>	(Harvey, 1875)	1	3	1
		(B. & McD., 1918)			
Noctuidae	<i>Egira februalis</i>	(B. & McD., 1918)	2	3	1
Noctuidae	<i>Egira rubrica</i>	(Harv., 1878)	1	3	1
Noctuidae	<i>Egira perlubens</i>	(Grt., 1881)	5	3	1
Noctuidae	<i>Homorthodes communis</i>	(Dyar, 1904)	5	3	1
Noctuidae	<i>Homorthodes fractura</i>	(Sm., 1906)	4	3	1
		(B. & McD., 1911)			
Noctuidae	<i>Homorthodes hanhami</i>	(B. & McD., 1911)	5	3	1
Noctuidae	<i>Protorthodes alfkeni</i>	(Grt., 1895)	?	3	1
Noctuidae	<i>Zosteropoda hirtipes</i>	Grt., 1874	17	3	1
Noctuidae	<i>Tricholita fistula</i>	Harv., 1878	1	3	1
Noctuidae	<i>Agrotis ipsilon</i>	(Hufn., 1766)	3	3	1
Noctuidae	<i>Euxoa</i>		2	2	1
Noctuidae	<i>Peridroma saucia</i>	(Hbn., 1803-08)	2	3	1
Noctuidae	<i>Xestia adela</i>	Franc., 1980	1	3	1
Noctuidae	<i>Anomogyna infimatis</i>	(Grt., 1880)	2	3	1
	<i>Adelphagrotis</i>				
Noctuidae	<i>indeterminata</i>	(Wlk., 1865)	3	3	1
Noctuidae	<i>Parabrogrotis insularis</i>	(Grt., 1876)	many	3	1

Totals:

Total # spp. (high estimate) = 210+

Total # spp. (conservative estimate) = 194

Total ID'd at least to genus, high & low certainty ID = 188

Total ID'd at least to genus, high certainty ID = 187

Total ID'd to species, high & low certainty ID = 161

Total ID'd to species, high certainty ID (ID certainty = 3) = **147**

Explanation of terms:

Hodges # - Refers to number assigned to species in the Checklist of the Lepidoptera of America North of Mexico. Hodges, Ronald W. 1983. Negative numbers refer to unplaced taxa.

Lowest Taxon - Refers to the lowest taxon to which specimens have been identified.

Author, Date - Refers to the author and date of publication of the species description.

Specimens - Refers to the number of specimens of this taxon in the collection.

ID Certainty - Refers to the lowest level to which the taxon has been identified with reasonable certainty: 1=Family, 2=Genus, 3=Species.

Est'd min # of spp. - Refers to the estimated minimum number of species in the taxon represented in the collection.

APPENDIX D. Collection site names and UTM coordinates.

Site name	Northing	Easting
Site A	4204400.832	575573.181
Site B	4204034.934	576369.664
Site C	4203652.557	576089.638
Site D	4203632.915	576376.930
Site E	4204509.240	576369.069
Site F	4204320.567	576122.268
Site G	4204279.481	576386.900
Site H	4203694*	575935*
Site I	4204899*	575958*
Site J	4204573.478	576369.314
Site K	4204308.237	576194.653
Site L	4203640.497	576137.631
Site M	4204986.852	576096.531
Site N	4204334.737	576601.272
Site O	4204664.540	576461.222
Site P	4204439.120	575798.778
Site Q	4205029.014	576225.821
Site R	4203807.526	576607.631
Site S	4204150.722	576059.375
Site T	4204864.214	576292.847
Site U	4204356.497	575851.969
Site V	4203628.875	576251.983
Site W	4204115.733	575770.028
Site X	4204392.312	575732.602
Site Y	4204291.649	576033.171
Site Z	4204169.096	575732.465

*no GPS point taken. Location was estimated in ArcView.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS D-51, January 2008

National Park Service
U.S. Department of the Interior



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