HOLARCTIC LEPIDOPTERA, 4(1): 1-18

NATURAL HISTORY AND BIOGEOGRAPHY OF THE BUTTERFLIES OF THE TOIYABE RANGE, NEVADA (LEPIDOPTERA: PAPILIONOIDEA)

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ABSTRACT.– The central Great Basin is a region of climatic extremes that supports a biota that rarely has been characterized. The natural history of the butterfly fauna of the centrally located Toiyabe Range, one of the most spectacular mountain ranges in that region, yields insights into both the typical species composition of interior montane landscapes and the susceptibility of such biotas to anthropogenic disturbance and climate change. Over the past 60 years, 72 resident and 27 nonresident butterfly species have been recorded from the Toiyabe Range. Species richness, local distribution, and life history characteristics of Toiyabe Range butterflies are discussed in the context of historic and modern biogeography, climate, and habitat variability. Species presence records for 30 canyons within the Toiyabe Range are summarized. Photographs of butterflies characteristic of the central Great Basin are presented.

KEY WORDS: Great Basin, Hesperioidea, montane butterflies, Nearctic, North America, Papilionoidea, Rhopalocera, riparian, species richness.

From compilations of species lists (Austin, 1985a) and analyses of patterns of differentiation and introgression (Austin and Murphy, 1987), to studies of island biogeography (Wilcox *et al.*, 1986; Murphy and Wilcox, 1986; Murphy and Weiss, 1992) and focused studies of habitats and geographical areas (Austin and Austin, 1980; Austin, 1985b), the biology and distribution of Great Basin butterflies have been well documented during the past decade. These inventories and analyses have been buttressed by a number of regional genetic and taxonomic studies on select butterfly groups (Austin, 1986, 1987, 1992; Brussard *et al.*, 1989; Baughman *et al.*, 1990; Britten *et al.*, 1994; see also papers *in* Emmel, in prep.). Many of these studies, by design, have paid special attention to the periphery of the Great Basin, where a wide array of species reach distributional limits and show substantial variability, local interaction, and introgression (Austin and Murphy, 1987). But no authors to date have characterized the butterfly fauna of the central Great Basin, an area of diverse topography which has been impacted greatly by more than 10,000 years of warming and increasing aridity. The highly isolated montane and valley habitats there probably have experienced extensive species turnover, accompanied by a retreat of many boreal species upward in elevation and northward, presumably following similar shifts in mesic and temperate habitats. In turn, these lowland and southern habitats appear to have been invaded by species typical of more xeric landscapes (Reveal, 1979; Wells, 1983).

The biota of the Great Basin currently is influenced by low precipitation, extreme temperatures, and high annual climatic variability (Houghton *et al.*, 1975). The result is a regional fauna that is composed of species that have been tough-tested by the vicissitudes of one of the most austere environments in temperate North America. A survey of central Great Basin butterflies should

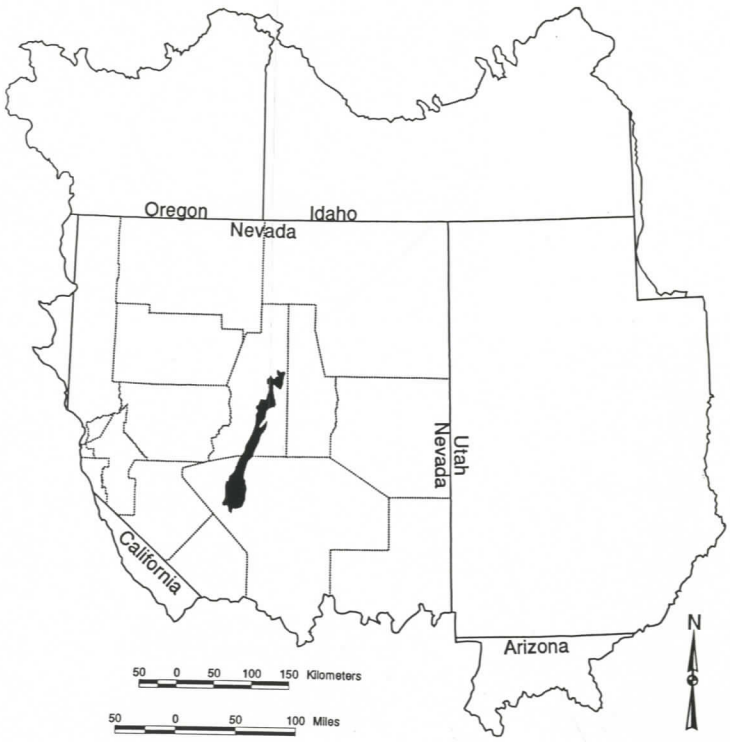
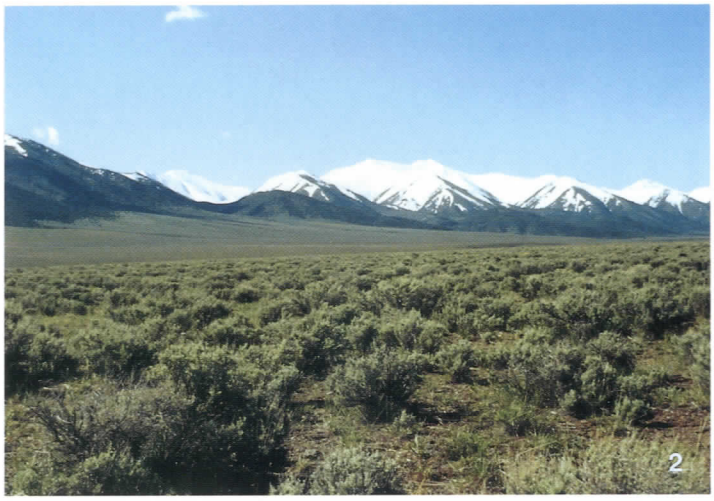


Fig. 1. The Toiyabe Range, Lander and Nye Counties, Nevada, and its position within the Great Basin.

FRONTISPIECE: Toiyabe Range, Nevada (from Reese River Valley).



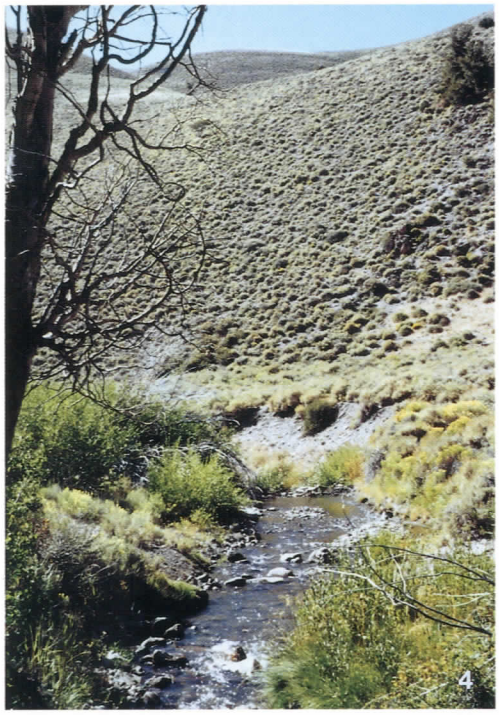
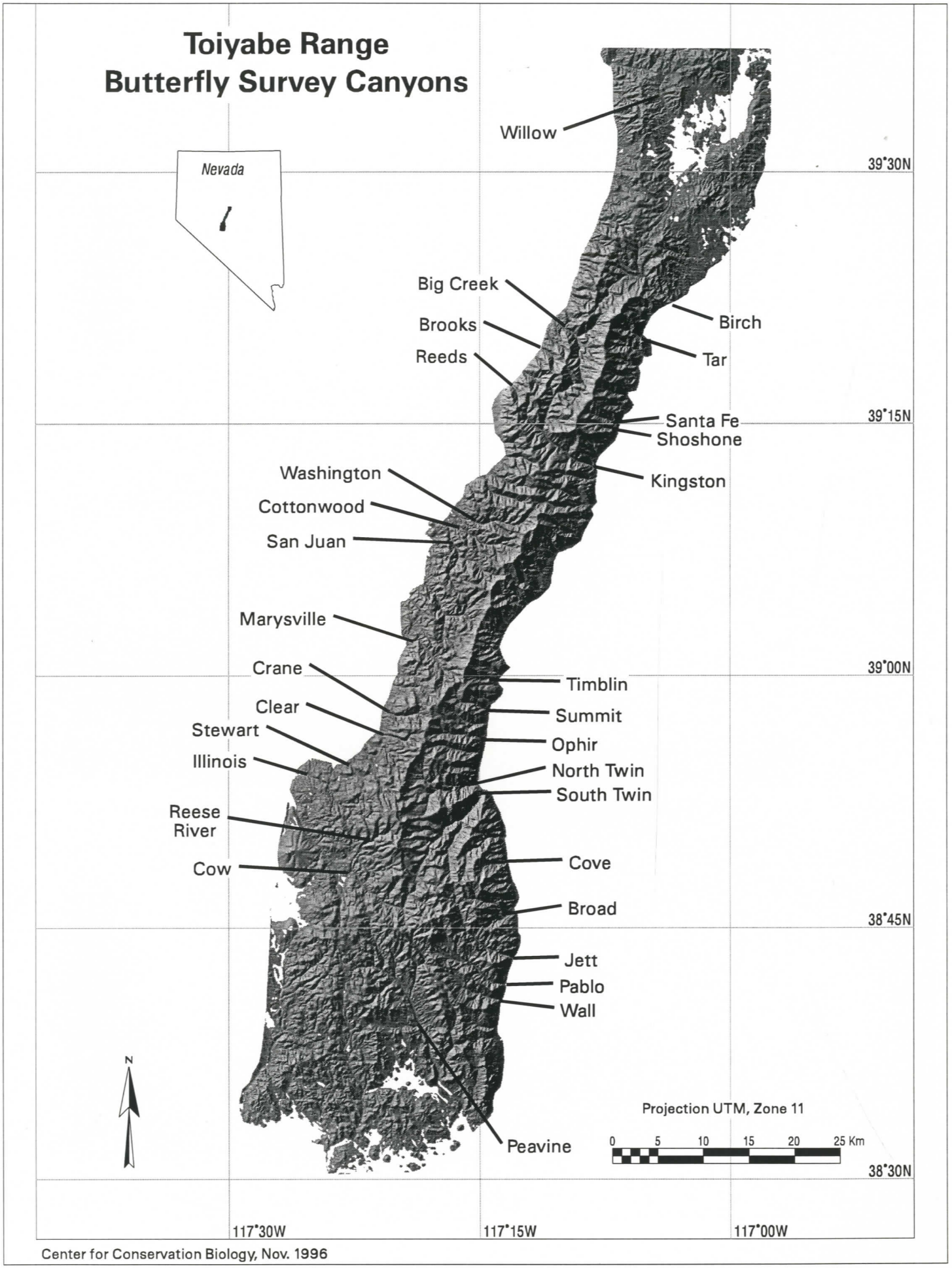


Fig. 2-7. Butterfly habitats in the Toiyabe Range, Lander and Nye counties, Nevada (photographs by E. Fleishman): 2) Toiyabe Range as seen from Reese River Valley, May 1995. 3) Ophir Canyon east to Big Smoky Valley. 4) Riparian corridor at the headwaters of the Reese River, Little Jett Canyon. 5) Wet meadow, Corral Canyon. 6) Hilltop in July, Birch Canyon. 7) Aspen grove, North Twin River.

Fig. 8. Study canyons in the Toiyabe Range (opposite page).


Toiyabe Range
Butterfly Survey Canyons
Nevada
Willow
Big Creek
Brooks
Reeds
Birch
Tar
Santa Fe
Shoshone
Kingston
Washington
Cottonwood
San Juan
Marysville
Crane
Clear
Stewart
Illinois
Timblin
Summit
Ophir
North Twin
South Twin
Reese River
Cow
Cove
Broad
Jett
Pablo
Wall
Peavine
39°30N
39°15N
39°00N
38°45N
38°30N
117°30W
117°15W
117°00W
N
Projection UTM, Zone 11
0 5 10 15 20 25 Km
Center for Conservation Biology, Nov. 1996

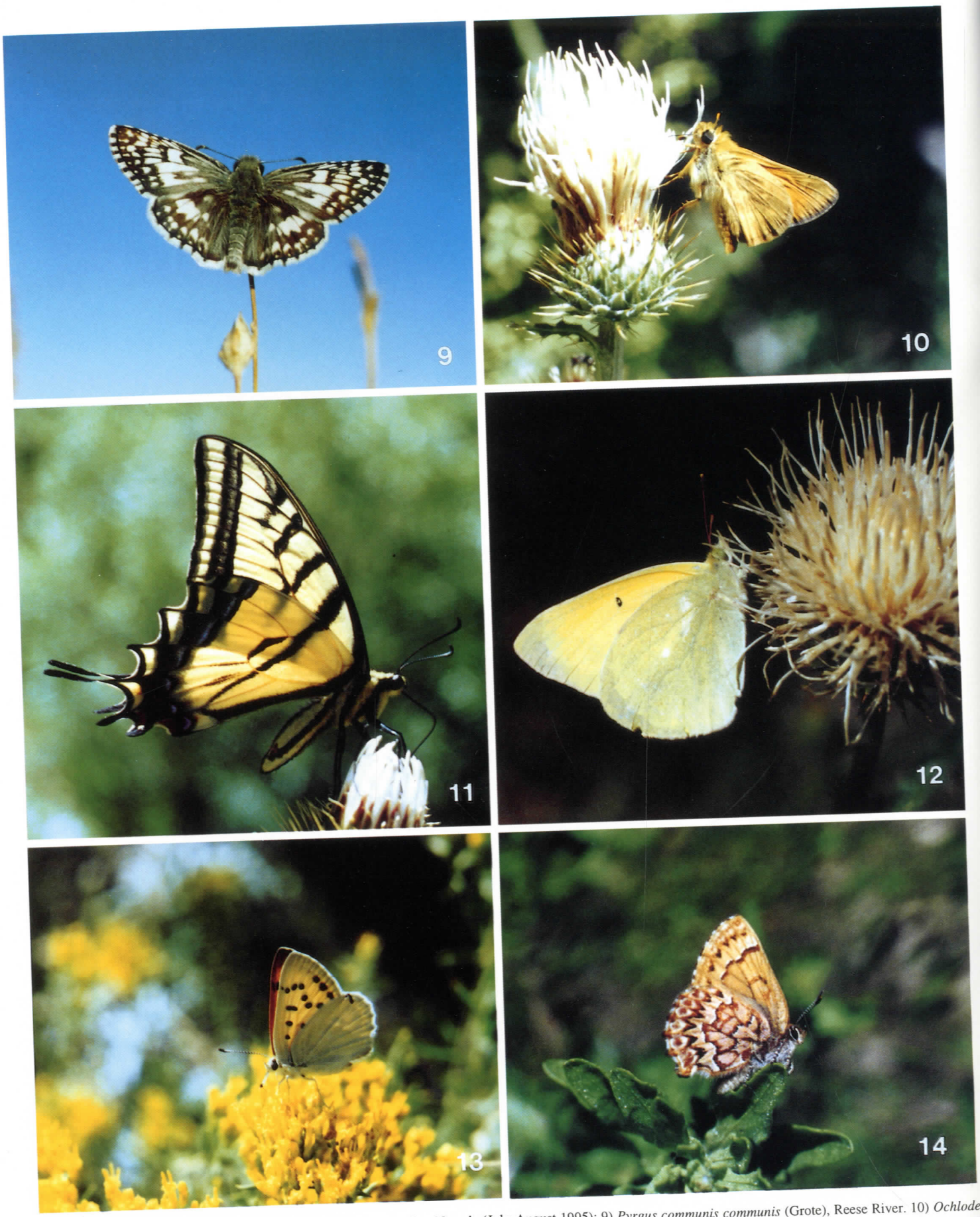


Fig. 9-14. Butterflies of the Toiyabe Range, Lander and Nye counties, Nevada (July-August 1995): 9) *Pyrgus communis communis* (Grote), Reese River. 10) *Ochlodes sylvanoides bonnevilla* Scott, Summit Canyon. 11) *Papilio multicaudatus* W. F. Kirby ssp., Summit Canyon. 12) *Colias alexandra edwardsii* W. H. Edwards, Summit Canyon. 13) *Lycaena rubidus sirius* (W. H. Edwards), Birch Canyon. 14) *Incisalia eryphon* (Boisduval) ssp., Summit Canyon. (photographs by G. T. Austin, except 13 by E. Fleishman)

yield rich insights into the probable composition and fate of similar pools of species in continental interior landscapes as further warming and drying accompanies global climate change (Peters and Lovejoy, 1992).

STUDY AREA

Near the geographic center of Nevada, the Toiyabe Range (Fig. 1) rises some 1920m from the Reese River and Big Smoky valleys to the summit of Arc Dome at 3593m. As the largest and most imposing mountain range in the central Great Basin, the Toiyabe Range serves as an appropriate focus for a study of central Great Basin butterflies. Like most Great Basin mountain ranges, it is roughly linear and oriented in a north-south direction. Arc Dome is the seventh highest summit in the physiographic Great Basin, and the Toiyabe Range is one of only 16 out of the more than 300 Great Basin ranges whose summit exceeds 3353m (11,000 ft.) (Grayson, 1993). Eighty kilometers—roughly 40%—of its crest lie above 3040m (10,000 ft.). In length (203 km), maximum width (29 km), and area (3126 km^2), the Toiyabe Range far surpasses its nearest neighbors, the 1852 km^2 Shoshone Mountains to the west and the 1753 km^2 Toquima Range to the east (Riley and Bishop, 1996). The east slope of the range is noticeably steeper and rockier than the west slope. Numerous canyons, many of which have permanent or ephemeral streams, drain both slopes of the range. The physiographic characters of individual canyons, including their width, gradient, aspect, elevation, and area, are extremely variable (Dobkin and Wilcox, 1986). (Fig. 2-7).

Both the baseline topography of the Toiyabe and climate of the range affect its biota. Mean annual precipitation in the town of Austin, Nevada (2004m), 50 km south of the northernmost end of the range, is 388mm—nearly 70% greater than the statewide mean (Western Regional Climate Center, 1995). Snow often remains on the higher peaks until well past the summer solstice.

The vegetation of the Toiyabe is typical of most central Great Basin mountain ranges. Sagebrush (*Artemisia tridentata* Nutt., Asteraceae) generally dominates lower elevations, grading into piñon-juniper (*Pinus monophylla* Torr. & Frem., Pinaceae, *Juniperus osteosperma* (Torr.), Little, Cupressaceae) woodland at higher elevations, which in turn gives way to a lower sagebrush community at still higher elevations (Tueller and Eckert, 1987). Scattered throughout and above the piñon-juniper zone are individuals and small stands of mountain mahogany (*Cercocarpus ledifolius* Nutt. ex Torr. & Gray, Rosaceae). Pockets of aspen (*Populus tremuloides* Michx., Salicaceae) occur in riparian canyons and on seeps on open slopes. Riparian vegetation of widely varying species richness and extent lines the bottom of many canyons that have constant or seasonal surface waters. Dominant riparian tree species frequently include aspen and cottonwood (*Populus* spp., Salicaceae), willow (*Salix* spp., Salicaceae), birch (*Betula occidentalis* Hook., Betulaceae), and cherry (*Prunus virginiana* L., Rosaceae). Rose (*Rosa* spp., Rosaceae), currant (*Ribes* spp., Saxifragaceae), nettles (*Urtica* spp., Urticaceae), and various grasses and forbs are common in the understory. At the highest elevations, limber pine (*Pinus flexilis* James, Pinaceae) forms a krummholz at timberline and a depauperate alpine tundra is common (Grayson, 1993).

Land use in the Toiyabe Range is fairly typical of the arid western United States. More than 98% of the Toiyabe Range is federally owned; the U.S. Forest Service and Bureau of Land Management bear responsibility for managing 65% and 33% of the land, respectively. Ranches and mines have been in operation in the central Great Basin since the mid 1800s, and the area is popular with recreationists. The 465 km^2 Arc Dome Wilderness Area is the largest area with that designation in the state of Nevada.

METHODS

Species presence data for 30 canyons in the Toiyabe Range (Fig. 8) were compiled from specimens in private and institutional collections, sight records from field notes of experienced workers, and two systematic inventories (sampling effort for these inventories is presented in Table 1).

The field notes of W. N. Burdick (from 1935) are the first known records of butterflies from the Toiyabe Range. Burdick's specimens and notes currently are housed at the University of Colorado at Boulder. In 1983 and 1984, Murphy and Wilcox compiled species lists for 21 riparian canyons, 8 on the west slope and 13 on the east slope of the range. The diversity of habitat types in each canyon was inventoried (i.e., all species present were recorded) from two to five times during the flight season (June-September) in 17 canyons (Wilcox *et al.*, 1986; Murphy and Wilcox, 1986).

From 1994 to 1996, we conducted spatially and temporally comprehensive inventories of 21 riparian canyons, ten on the west slope and eleven on the east slope of the range. Ten of these canyons had been inventoried in the 1980s. Three canyons were inventoried in 1994 only, another four were inventoried only in 1995, and three were inventoried only in 1996. Each of the study canyons was inventoried approximately every two weeks throughout the flight season (May-September). Voucher specimens are deposited at the Nevada State Museum and Historical Society and the University of Nevada, Reno. Nomenclature used herein largely follows Austin (*in* Emmel, in prep.).

A list of potential hostplants in the Toiyabe Range was generated from hostplant data provided by Scott (1986a, 1986b, 1992) and supplemented with records documented by the authors. Data for mating habitat and behavior were gathered by the authors and supplemented with information in Scott (1975, 1982).

Quantification of the abundance of all species in a regional butterfly fauna has been described as "virtually futile" (Shapiro, 1975a, p. 175), and was not attempted here. Estimation of butterfly abundance is confounded by factors including interspecific variation in population structure and vagility (Shapiro, 1975a), staggered emergence, and protandry. Instead, species abundances in appropriate habitats at the peak of the species' flight season were qualified as follows:

abundant (commonly observed and in large numbers);
common (commonly observed, but not in large numbers);
fairly common (commonly observed in small numbers, or not commonly observed);
uncommon (seldom observed, but not a surprise);
rare (always a surprise, but not out of normal range).

Fig. 15-20. Butterflies of the Toiyabe Range, Lander and Nye counties, Nevada (July-August 1995): 15) *Everes amyntula herrii* F. Grinnell, Summit Canyon. 16) *Lycaeides melissa paradoxa* (F. H. Chermock), Birch Canyon. 17) *Plebejus saepiolus* (Boisduval) ssp., Washington Canyon. 18) *Icaricia lupini* (Boisduval) ssp., Kingston Canyon. 19) *Apodemia mormo mormo* (C. & R. Felder), Wall Canyon. 20) *Speyeria nokomis apacheana* (Skinner), Reese River. (photographs by G. T. Austin, except 16 and 19-20 photographed by E. Fleishman)

Fluctuation in abundance among years was qualified as follows:

low (generally remaining within the same relative abundance category);

moderate (abundance fluctuating by one relative abundance category);

high (abundance fluctuating by more than one relative abundance category).

RESULTS

Species richness

During the past 60 years, 99 butterfly species, 72 of them apparently resident, have been recorded from the Toiyabe Range (Table 1). The overwhelming majority of the species records were obtained from within or on the margins of riparian habitats in canyons, by far the most accessible and species rich areas in the range (72 resident, 14 migrant or immigrant, and nine vagrant, marginal, or accidental species have been recorded from the east slope of the Toiyabe Range; 67 resident, 13 migrant or immigrant, and five vagrant, marginal, or accidental species have been recorded to date from the west slope). Photographs of butterflies commonly found in the Toiyabe Range and in the central Great Basin are presented in Fig. 9-26.

Residency

Of the 72 butterfly species that are believed to breed in the Toiyabe Range, only two taxa, *Vanessa cardui* (Linnaeus) and *Danaus plexippus* (Linnaeus) (Nymphalidae), are known to be migrants. An additional 12 species are considered either regular immigrants (occur in the Toiyabe every year but probably cannot survive all winters) or irregular immigrants (either they may not occur every year or they may breed but, with the exception of *Nymphalis californica* (Boisduval) (Nymphalidae), do not overwinter). Three resident species (*Nymphalis antiopa* (Linnaeus), *Vanessa virginiensis* (Drury), and *Vanessa atalanta* (Linnaeus) (Nymphalidae)) are possible partial migrants (some individuals may migrate, but most individuals are resident).

Six butterfly species, *Colias cesonia* (Stoll), *Phoebis sennae* (Linnaeus), *Eurema nicippe* (Cramer), *Nathalis iole* Boisduval (Pieridae), and *Ministrymon leda* (W. H. Edwards) and *Hemiargus isola* (Reakirt) (Lycaenidae), are erratic vagrants (found only a few seasons each decade) from desert areas to the south. Three species (*Hesperopsis libya* (Scudder) (Hesperiidae); *Euphilotes pallescens* (Tilden & Downey) and *Philotiella speciosa* (H. Edwards) (Lycaenidae)) occasionally may stray into Toiyabe Range canyons from adjacent desert valleys (or have small populations there), and *Polites sabuleti* (Boisduval) (Hesperiidae) apparently strays into the Toiyabe Range from adjacent marsh habitat in Reese River Valley. An isolated colony of *Ochlodes yuma* (W. H. Edwards) (Hesperiidae) occurs in a patch of *Phragmites australis* (Cav.) Trin. ex Steud. (Poaceae) on the east slope of the range. The single *Adelpha bredowii* (Geyer) (Nymphalidae) recorded from the Toiyabe was accidental (far from normal range and not to be expected again). A single *Lycaena editha* (Mead) (Lycaenidae) has been recorded from the west slope of the range. Its residency status is unknown. We did not characterize the life history of these 13 species.

Geographic Distribution

The Toiyabe is well within the geographic distributions of 65 (56 resident) of the 99 species of butterflies recorded from the range (Table 2). The Toiyabe Range is on the southern edge of the distributions of an additional 11 species (10 resident), and on the northern edge of the distributions of six species (2 resident). The eastern distributional limit of one resident species and the western distributional limits of three resident species fall near to the Toiyabe Range.

The subspecific level biogeographic affinities of butterfly taxa recorded from the Toiyabe Range are diverse: 33 taxa (25 resident) are distributed widely across at least the western United States and Canada; 12 taxa (six resident) principally are distributed in the southern United States and southward; 2 resident taxa largely are distributed in the northern United States and northward; and 11 resident taxa principally are distributed in the Rocky Mountains and do not extend westward to the Sierra Nevada. Conversely, one resident taxon largely is distributed in the Sierra Nevada and does not extend eastward to the Rocky Mountains, and 27 resident taxa are endemic to the Great Basin.

The vagility of each butterfly species was categorized as tens of meters, hundreds of meters, thousands of meters, or high: 23 species and 29 resident species have vagilities within tens and hundreds of meters, respectively; 20 (19 resident) have vagilities within thousands of meters, and 14 (1 resident) species have high vagilities.

Probable Hostplants and Principal Habitat

The probable local hostplants of butterfly species recorded from the Toiyabe Range are listed in Table 2. The principal habitat of each butterfly species (that in which it most frequently is observed) was categorized according to one or more of the following zones: riparian canyons, canyons (both riparian and dry), and uplands. Thus, 13 species (11 resident) predominantly occur in riparian canyons. Both riparian and dry canyons support 18 species (15 resident); and 53 species (44 resident) are found both in canyons and in uplands. Two resident species largely are restricted to upland habitats.

Relative Abundance

Twenty-six butterfly species (24 resident) can be considered to be abundant in their habitats at the peak of their flight seasons in the Toiyabe Range (Table 2). On an annual basis, there is high fluctation in the abundance of three of these species (1 resident). There is moderate fluctuation in the abundances of 11 resident abundant species, and low fluctuation in the abundances of another 12 resident abundant species.

Twenty-three butterfly species (20 resident) are common in the Toiyabe Range. Three of these species (1 resident) have high annual fluctuations in abudance, 12 common species (11 resident) have moderate fluctuations, and 8 common residents have low fluctuations in abundance.

Nine butterfly species (8 resident) are fairly common. Three of these species (2 resident) have high fluctations in abundance, and 6 resident, fairly common species have moderate fluctuations in abundance.

Nineteen butterfly species (14 resident) may be considered uncommon in their habitat at the peak of their flight season. Of these, all 5 of the nonresidents have high annual fluctuations in abundance, 7 residents have moderate fluctuations, and 7 residents have low fluctuations.

Fig. 21-26. Butterflies of the Toiyabe Range, Lander and Nye counties, Nevada (July-August 1995): 21) *Speyeria callippe harmonia* dos Passos & Grey, Big Creek Canyon. 22) *Euphydryas anicia wheeleri* (H. Edwards), Summit Canyon. 23) *Vanessa cardui* (Linnaeus), Jett Canyon. 24) *Limenitis weidemeyerii latifascia* E. M. & S. F. Perkins, Summit Canyon. 25) *Cercyonis sthenele paulus* (W. H. Edwards), Summit Canyon. 26) *Danaus plexippus plexippus* (Linnaeus), Washington Canyon. (photographs by G. T. Austin, except 26 photographed by E. Fleishman)

Nine butterfly species (6 resident) are relatively rare. The fluctuation in abundance of 2 rare nonresident species is high. Five of the rare species (4 resident) have moderate fluctuations in abundance, and 2 rare resident species have low fluctuations.

Habitat Use

The adults of many butterfly species use habitats other than those in which their hostplants are found for feeding, water, or to locate mates (Table 2). Patrolling and perching are the two principal mate-finding strategies of butterflies (Scott, 1975): 17 (10 resident) Toiyabe Range butterfly species patrol in canyons, 18 (17 resident) both in canyons and uplands, 4 residents in uplands, 2 residents on hilltops, 2 nonresidents both on hilltops and in canyons, and 2 residents both on hilltops and in uplands; 21 species (19 resident) perch in canyons to await mates, 7 resident species perch on hilltops, 7 species (6 resident) perch both on hilltops and in canyons, 5 (4 resident) in both canyons and uplands, 2 (one resident) on hilltops, in canyons, and in uplands, 3 residents in uplands, and 3 (2 resident) both on hilltops and in uplands.

Many butterfly species exploit riparian areas for patrolling and perching sites and for concentrations of nectar-bearing plants and mud puddles (often found around stream crossings and ruts created by vehicles). However, the larval hostplants of most species are not restricted to the riparian. Riparian obligate species were defined as those that could not maintain permanent populations in the absence of a riparian zone because their hostplants do not or rarely occur away from dependable water. Facultative riparian species were defined as species that use the riparian zone to various extents for hostplants, mates, or adult resources, but whose survival and fecundity do not depend directly upon its presence: 17 species (16 resident) are riparian obligates, 65 (52 resident) are facultative users of the riparian, and 4 resident species apparently do not use riparian areas for their necessary resources.

Many butterfly species rely upon moist soil for dissolved minerals (Arms *et al.*, 1974). Relative frequency of use of mud puddles was characterized as low (individuals occasionally recorded at mud puddles) or moderate (individuals frequently recorded at mud puddles): 28 species (25 resident) are moderate users of mud puddles, and use of mud puddles by 42 species (31 resident) is relatively low. There are no records of individuals at mud puddles for 16 resident species.

DISCUSSION

With 99 species, including 72 residents and an additional 14 species that more or less regularly breed, the butterfly fauna of the Toiyabe Range is among the most species rich of the Great Basin mountains (Austin, 1981; Wilcox *et al.*, 1986; Murphy and Wilcox, 1986). Certainly the relatively large geographic area and wide elevational range of the Toiyabe as compared with other Great Basin mountain ranges accounts for much of this diversity (Wilcox *et al.*, 1986). Additional features which likely enhance species richness of the range include the high proportion of riparian canyons and the fact that the Toiyabe Range is located in the central Great Basin, a geographic area in which several faunal zones overlap (Austin and Murphy, 1987). The relatively extensive history and intensity of collecting in the Toiyabe undoubtedly also has contributed to the high number of species recorded from the mountain range.

Most of the inventories in the 1980s and 1990s were conducted in canyons, thus the majority of butterfly species were recorded from those habitats. However, less standardized surveys of varied topography in the Toiyabe Range suggest that most species are most abundant in canyons. More than 90% of species that breed regularly (resident plus migrant) have been recorded from Kingston Canyon alone, and at least 80% of the breeding species were recorded from four other canyons—Summit, Birch, Ophir, and Big Creek. These five canyons have abundant water, well developed riparian vegetation, and a richness and abundance of potential hostplants and nectar sources; provide abundant mating sites for both perching and patrolling species; and their riparian corridors present cooler and moister microclimates than do the surrounding hillsides, ridges, and flats. All but Big Creek are east slope canyons, and all are in the central portion of the range.

Five resident butterfly species (*Papilio indra* Reakirt (Papilionidae); *Callophrys comstocki* Henne, *Incisalia fotis* (Strecker), *Euphilotes battoides* (Behr) (Lycaenidae); and *Polygonia satyrus* (W. H. Edwards) (Nymphalidae)) were recorded in east slope canyons, but not on the west slope. One of these, *P. indra*, is common and widespread on the east slope (10 of 17 canyons, Table 1). We have not observed its hostplant on the west slope. The remaining four species are uncommon to rare, and are known from four or fewer canyons. Their apparent absence on the west slope may be real or an artifact of sampling.

The slightly elevated species richness of the east slope of the Toiyabe Range relative to the west slope is reflected at the canyon level. The mean number of resident species recorded from east slope canyons which have been inventoried on more than three occasions (n=13) is 60, while the mean resident species richness of west slope canyons inventoried more than three times (n=9) is 56. Preliminary analyses suggest that topographic exposure, canyon area, elevational range, and slope are correlated with species richness at the canyon level. East slope canyons often are deeper, larger, span a greater range of elevations, and are steeper than west slope canyons.

The higher incidence of nonresident butterfly species on the east slope (23 species) than on the west slope (18 species) of the Toiyabe Range largely may be an artifact of regional topography. The contiguous southern ends of the Toiyabe and Shoshone Ranges may represent a geographic barrier to northbound dispersal along the western edge of the Toiyabe Range. Big Smoky Valley, by contrast, is open to the south. This geographic orientation could facilitate northward movement of stray butterflies from the southern Great Basin and northern Mojave Desert with warm, dry air masses along the lower east slope of the Toiyabe Range.

Although the Toiyabe butterfly fauna is rich relative to most other Great Basin ranges, it is depauparate in comparison with the major massifs of the Rocky Mountains (e.g., Ferris and Brown, 1981; Wilcox *et al.*, 1986) and the Sierra Nevada (Emmel and Emmel, 1962, 1974; Garth and Tilden, 1963; Shapiro *et al.*, 1979) that bound the east and west sides of the Great Basin. Most notably absent from the Toiyabe (and most other Great Basin mountains) are higher elevation, especially alpine, species in the

genera *Boloria*, *Chlosyne*, *Erebia*, *Oeneis* (Nymphalidae), *Colias* (Pieridae), and *Parnassius* (Papilionidae).

Despite their current ecological isolation, individual Great Basin mountain ranges have few endemic butterfly taxa, with no endemics at the species level and subspecific endemism manifested largely at the regional level and encompassing more than one mountain range (Austin and Murphy, 1987). Single range subspecific endemics are the exception and apparently exist only in two ranges on the periphery of the Great Basin, the Spring Mountains in extreme southern Nevada (Austin, 1981) and the White Mountains on the Nevada-California border (Austin and Murphy, 1987). Endemic butterfly subspecies in the central Great Basin are actually more prevalent in lowland riparian sites than in montane habitats (Austin and Murphy, 1987; Austin, 1987, 1992). Butterflies inhabiting these valley floors well may have been isolated from one another longer than have the surrounding montane butterfly faunas. Montane butterfly faunas undoubtedly include species of diverse origins, from those few that may have been widespread in the Great Basin boreal habitats of the late Pleistocene, to those which almost certainly tracked the westward and northward expansion of more xeric-adapted vegetation through the Holocene (Wells, 1983; Van Devender *et al.*, 1987).

An analysis of the Great Basin butterfly fauna (Austin and Murphy, 1987) showed that nearly two-thirds of its species are widespread, 20% are Rocky Mountain in affinity, and none are endemic. At the infraspecific level, however, its character is vastly different: more than 25% of the Great Basin taxa have Rocky Mountain affinity and about 20% each are widespread or endemic. In the Toiyabe Range, the fauna is composed of 38% widespread taxa, 31% Great Basin endemic subspecies, 14% primarily southern taxa, and 13% taxa with Rocky Mountain affinities. The relatively large number of widespread species and Great Basin endemics undoubtedly reflects the central geographic position of the Toiyabe Range in the Great Basin and its distance from principal source faunas, the Rocky Mountains and Sierra Nevada.

Thus, the majority of central Great Basin montane resident butterfly taxa are time-tested, first having expanded in the Pleistocene from eastern and southern refugia and then, as the Great Basin became increasingly arid and warm, having been compressed into progressively smaller montane areas (Mifflin and Wheat, 1979; Currey and James, 1982). Their true test well may appear in the near future if predicted global climatic change (Schneider *et al.*, 1992) becomes reality; Murphy and Weiss (1992) predicted an average 23% reduction in the current butterfly species richness in the Great Basin mountain ranges with a 3°C increase in temperature. The predicted loss of montane resident butterfly taxa in the Toiyabe Range-Shoshone Mountains was 34% (Murphy and Weiss, 1992).

A number of butterfly species which occur in the Toiyabe Range exhibit either a relictual distribution pattern or reflect more recent dispersal from elsewhere, possibly from the northeastern Great Basin. These species include *Pholisora catullus* (Fabricius) (Hesperiidae), *Speyeria egleis* (Behr) (Nymphalidae), *Lycaena nivalis* (Boisduval) (Lycaenidae), and possibly *L. editha* (all noted by Austin and Murphy, 1987), as well as *Incisalia augustinus* (Westwood) (Lycaenidae), all of which are unknown elsewhere in central Nevada but occur widely in peripheral areas. The phenotypes in the Toiyabe Range of *S. egleis*, *L. nivalis*, *L. editha*, and *I. augustinus* are most similar to those from northeastern Nevada.

Data from the one virtually dry canyon inventoried, Wall Canyon, are instructive. Six riparian obligate butterfly species were recorded from there, and these with the exception of *Harkenclenus titus* (Lycaenidae) (a species that seeks its mates on hilltops) all are highly vagile. At least two small seeps exist in Wall Canyon which may support intermittant populations of these riparian species. Nevertheless, not unexpectedly, fewer obligate riparian species were recorded in Wall Canyon than in all but one of the relatively well-sampled canyons with abundant water (Illinois Canyon). On the other hand, the largest and most diverse canyon in the Toiyabe, Kingston, had all 17 riparian obligates; nine other large and diverse canyons had ten or more riparian obligates.

Despite 60 years of butterfly samples from the Toiyabe Range, the data available are insufficient to examine trends in butterfly presence or abundance. Annual climate-driven fluctuations in abundance, the size of the mountain range, and lack of systematic sampling until the last decade preclude speculations on the long term stability of the fauna. Initial collection records from the Toiyabe Range collected by W. N. Burdick in 1935 included 37 species, but it appears that he simply ignored several of the common species seen today. Subsequent sampling gradually has increased the number of species known in the Toiyabe from 84 (Wilcox *et al.*, 1986) to 96 (Murphy and Wilcox, 1986), then to the 99 reported in this study. During our intensive surveys in 1994-96, we recorded 70 of the 72 resident species, 12 of the 13 migrant or immigrant species, and five of the 12 vagrant, marginal, or accidental species (*Ochlodes yuma*) was observed in 1994 but is not listed in Table 1).

The two resident butterfly species not yet seen in the 1990s are *Callophrys comstocki* (Lycaenidae) and *Polygonia satyrus* (Nymphalidae). The first flies extremely early in the season, generally at the southern end of the east slope of the Toiyabe Range, and is uncommon. These areas have not been sampled recently at the appropriate time of year. As noted above, *P. satyrus* is rare and known from only four canyons. Despite searches in the appropriate habitat we have failed to encounter this species. *Nymphalis californica* is the only migrant or immigrant species that we have not recorded in recent years: this species is known for its extreme population fluctuations (e.g., Shapiro, 1975b; Austin, 1985b), and may not occur in many or most years.

ACKNOWLEDGEMENTS

Peter Brussard, Alan Launer, and Andrew Weiss made helpful comments on the manuscript and valuable contributions to our ongoing research. Thanks to C. D. Ferris for comments on the manuscript. Peter Goin's photographic advice is much appreciated. Field assistance was provided by Bret Boyd, Bruce Boyd, Craig Fee, Alan Launer, Jonathan Longhurst, Becca Miller, Daniel Rubinoff, Andrew Weiss, and Ian Woods. Many thanks to the Humboldt and Toiyabe National Forests, particularly the

Austin Ranger District, for logistic support. We thank the late F. Martin Brown for a copy of the field notes of W. N. Burdick sent to GTA. Lynn Riley and Andrew Weiss assisted with preparation of figures. Funding for this research was provided by the Nevada State Museum and Historical Society, the Nevada Biodiversity Research and Conservation Initiative, and the Center for Conservation Biology at Stanford University. This is Contribution No. 50 of the Nevada Biodiversity Initiative.

LITERATURE CITED

Arms, K., P. Feeney, and R. C. Lederhouse
1974. Sodium: stimulus for puddling behavior by tiger swallowtail butterflies. *Science* (Washington), 185:372-374.

Austin, G. T.
1981. The montane butterfly fauna of the Spring Range, Nevada. *J. Lepid. Soc.* (Los Angeles), 35:66-74.
1985a. Nevada butterflies: preliminary checklist and distribution. *J. Lepid. Soc.* (Los Angeles), 39:95-118.
1985b. Lowland riparian butterflies of the Great Basin and associated areas. *J. Res. Lepid.* (Beverly Hills), 24(2):117-131.
1986. A review of the satyrine genus *Neominois*, with descriptions of three new subspecies. *Bull. Allyn Mus.* (Sarasota), 107:1-27.
1987. Nevada populations of *Polites sabuleti* and the description of five new subspecies. *Bull. Allyn Mus.* (Sarasota), 109:1-24.
1992. *Cercyonis pegala* (Fabricius) (Nymphalidae: Satyrinae) in the Great Basin: new subspecies and biogeography. *Bull. Allyn Mus.* (Sarasota), 135:1-59.

Austin, G. T., and A. T. Austin
1980. Butterflies of Clark County, Nevada. *J. Res. Lepid.* (Beverly Hills), 19:1-63.

Austin, G. T., and D. D. Murphy
1987. Zoogeography of Great Basin butterflies: patterns of distribution and differentiation. *Great Basin Natur.* (Provo), 47:186-201.

Baughman, J. F., P. F. Brussard, P. R. Ehrlich, and D. D. Murphy
1990. History, selection, drift, and gene flow: complex differentiation in checkerspot butterflies. *Canad. J. Zool.* (Ottawa), 68:1967-1975.

Britten, H. B., P. F. Brussard, D. D. Murphy, and G. T. Austin
1994. Colony isolation and isozyme variability of the western seep fritillary, *Speyeria nokomis apacheana* (Nymphalidae), in the western Great Basin. *Great Basin Natur.* (Provo), 54:97-105.

Brussard, P. F., J. F. Baughman, D. D. Murphy, P. R. Ehrlich, and J. Wright
1989. Complex population differentiation in checkerspot butterflies (*Euphydryas* spp.). *Canad. J. Zool.* (Ottawa), 67:330-335.

Currey, D. R., and S. R. James.
1982. Paleoenvironments of the northeastern Great Basin and northeastern Basin rim region: a review of geological and biological evidence. *In* D. B. Madsen and J. F. O'Connell (eds.), *Man and Environment in the Great Basin*, 27-52. Society for American Archaeology Papers 2.

Dobkin, D. S., and B. A. Wilcox
1986. Analysis of natural forest fragements: riparian birds in the Toiyabe Mountains, Nevada. *In* J. Verner, M. L. Morrison, and C. J. Ralph (eds.), *Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates*, 293-299. Madison: Univ. Wisc. Pr. 470pp.

Emmel, T. C. (ed.)
(In prep). *Systematics of Western North American Butterflies.* Gainesville: Mariposa Pr.

Emmel, T. C., and J. F. Emmel
1962. Ecological studies of Rhopalocera in a high Sierra community - Donner Pass, California. I. Butterfly associations and distributional factors. *J. Lepid. Soc.* (Los Angeles), 16:23-44.
1974. Ecological studies of Rhopalocera in a high Sierra community - Donner Pass, California. V. Faunal additions and foodplant records since 1962. *J. Lepid. Soc.* (Los Angeles), 28:334-348.

Ferris, C. D., and F. Brown (eds).
1981. *Butterflies of the Rocky Mountain States.* Norman: Univ. Okla. Pr. 442pp.

Garth, J. S., and J. W. Tilden
1963. Yosemite butterflies. *J. Res. Lepid.* (Beverly Hills), 2:1-96.

Grayson, D. K.
1993. *The Desert's Past: A Natural Prehistory of the Great Basin.* Washington: Smithson. Inst. Pr. 356pp.

Houghton, J. G., C. M. Sakamoto, and R. O. Gifford
1975. *Nevada's Weather and Climate.* Nevada Bureau of Mines and Geology (Reno), Spec. Pub. 2.

Mifflin, M. D., and M. M. Wheat
1979. Pluvial lakes and estimated pluvial climates of Nevada. *Nevada Bureau of Mines* (Reno), 94:1-57.

Murphy, D. D., and S. B. Weiss
1992. Effects of climate change on biological diversity in western North America: species losses and mechanisms. *In* R. L. Peters and T. E. Lovejoy (eds.), *Global Warming and Biological Diversity*, 355-368. New Haven: Yale Univ. Pr. 386pp.

Murphy, D. D., and B. A. Wilcox
1986. Butterfly diversity in natural habitat fragments: a test of the validity of vertebrate-based management. *In* J. Verner, M. L. Morrison, and C. J. Ralph (eds.), *Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates*, 287-292. Madison: Univ. Wisc. Pr. 470pp.

Peters, R. L. and T. E. Lovejoy (eds.)
1992. Global Warming and Biological Diversity. New Haven: Yale Univ. Pr. 386pp.

Reveal, J. L.
1979. Biogeography of the intermountain region, a speculative appraisal. *Mentzelia* (Reno), 4:1-92.

Riley, L. and K. Bishop (eds.)
1996. *Nevada Mountain Atlas.* Univ. Nevada, Reno: Biol. Resources Res. Ctr. 373 pp.

Schneider, S. H., L. Mearns, and P. H. Gleick
1992. Climate-change scenarios for impact assessment. *In* R. L. Peters and T. E. Lovejoy (eds.), *Global Warming and Biological Diversity*, 38-55. New Haven: Yale Univ. Pr. 386pp.

Scott, J. A.
1975. Mate-locating behavior of western North American butterflies. *J. Res. Lepid.* (Beverly Hills), 14:1-40.
1982. Mate-locating behavior of western North American butterflies. II. New observations and morphological adaptations. *J. Res. Lepid.* (Beverly Hills), 21:177-187.
1986a. *The Butterflies of North America.* Stanford: Stanford Univ. Pr. 583pp.
1986b. Larval hostplant records for butterflies and skippers (mainly from western U.S.), with notes on their natural history. *Papilio* (Lakewood, Co.), (n.s.) 4:1-37.
1992. Hostplant records for butterflies and skippers (mostly from Colorado) 1959-1991, with new life histories and notes on oviposition, immatures, and ecology. *Papilio* (Lakewood, Co), (n.s.) 6:1-171.

CONTINUED: p. 13

TABLE 1. Checklist of butterflies of the Toiyabe Range, Lander and Nye Counties, Nevada. Canyon codes are listed in footnotes.

	EAST SLOPE CANYONS (north to south)																	
	WI	BI	TA	SF	SH	KI	TI	SU	OP	NT	ST	CO	BR	JE	PA	WA	PE	Subtotal
Resident																		3
Erynnis icelus						x		x						x				12
Erynnis persius		x		x	x	x	x	x	x	x	x		x	x		x		4
Pholisora catullus						x		x	x					x			x	3
Hesperia uncas		x							x								x	11
Hesperia juba	x	x	x			x		x	x	x	x			x		x	x	16
Hesperia comma	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	15
Ochlodes sylvanoides	x	x	x	x	x	x	x	x	x	x	x		x	x				7
Papilio bairdii		x				x	x	x	x	x						x	x	14
Papilio zelicaon	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x	10
Papilio indra						x		x	x	x	x	x	x	x	x		x	16
Papilio rutulus	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17
Papilio multicaudatus	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		8
Neophasia menapia		x				x		x	x	x	x	x	x	x	x	x	x	16
Pontia beckerii	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	11
Pontia sisymbrii	x	x				x		x	x	x			x	x		x		10
Euchloe ausonides	x	x				x		x	x	x	x		x	x			x	8
Euchloe hyantis		x		x	x	x		x					x	x	x	x	x	10
Anthocharis sara		x				x		x	x	x			x			x	x	11
Colias philodice	x	x		x		x		x	x	x	x		x					17
Colias alexandra	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	7
Lycaena arota		x		x	x	x		x			x		x					7
Lycaena rubidus	x	x				x		x	x		x				x			8
Lycaena heteronea	x	x				x		x	x	x	x					x	x	7
Lycaena helloides	x	x				x		x	x					x				2
Lycaena nivalis		x				x							x					7
Harkenclenus titus		x				x	x	x	x							x	x	13
Satyrium behrii		x		x	x	x	x	x	x	x		x	x	x		x	x	10
Satyrium californicum		x			x	x		x	x	x				x	x	x	x	9
Satyrium sylvinum	x	x				x	x	x	x	x				x				7
Callophrys affinis						x		x	x	x	x			x		x		3
Callophrys comstocki								x						x			x	9
Loranthomitoura spinetorum		x				x		x	x		x	x		x	x	x		13
Mitoura siva		x		x	x	x		x	x	x	x		x	x	x	x	x	1
Incisalia augustinus		x																4
Incisalia fotis						x								x	x		x	16
Incisalia eryphon		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15
Everes amyntula		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14
Celastrina ladon		x		x	x	x	x	x	x	x	x	x	x	x	x	x		2
Euphilotes battoides		x															x	17
Euphilotes enoptes	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	12
Glaucopsyche piasus	x	x	x	x		x		x	x	x	x			x	x			11
Glaucopsyche lygdamus	x	x				x		x	x	x	x			x	x	x		17
Lycaeides melissa	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	9
Plebejus saepiolus	x	x				x		x	x	x	x	x			x			16
Icaricia icarioides	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	6
Icaricia shasta		x				x		x	x					x	x			13
Icaricia acmon		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	13
Icaricia lupini	x	x			x	x		x	x	x	x	x		x		x	x	10
Apodemia mormo		x		x		x		x	x	x	x							2
Speyeria nokomis		x				x												8
Speyeria coronis	x	x	x		x	x	x	x	x		x				x		x	13
Speyeria zerene	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	14
Speyeria callippe	x	x		x	x	x	x	x	x	x	x	x					x	6
Speyeria egleis		x				x			x	x		x					x	8
Thessalia leanira						x			x	x	x	x			x		x	16
Chlosyne acastus	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	10
Phyciodes pulchella	x	x	x			x			x	x		x			x			11
Phyciodes mylitta	x	x	x			x			x	x	x	x		x	x		x	10
Euphydryas anicia	x	x			x	x			x	x	x	x						5
Euphydryas editha						x			x		x							4
Polygonia satyrus					x	x			x	x	x				x		x	8
Polygonia zephyrus		x			x	x			x	x	x	x			x		x	10
Nymphalis antiopa		x	x			x			x	x	x	x			x		x	16
Nymphalis milberti		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	6
Vanessa virginiensis		x	x			x			x								x	11
Vanessa annabella		x	x		x	x			x	x	x	x			x		x	11
Vanessa atalanta		x				x			x	x	x			x	x	x	x	15
Limenitis weidemeyerii		x	x			x			x	x	x	x	x	x	x	x	x	15
Coenonympha tullia		x	x	x	x	x	x	x	x	x	x	x		x	x		x	16
Cercyonis sthenele		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17
Cercyonis oetus		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1
Neominois ridingsii								x										
Subtotal		37	62	21	33	31	67	27	65	59	52	47	16	33	56	32	45	47

	EAST SLOPE CANYONS (north to south)																	
	WI	BI	TA	SF	SH	KI	TI	SU	OP	NT	ST	CO	BR	JE	PA	WA	PE	Subtotal
Migrant or Immigrant																		
Pyrgus communis	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	15
Heliopetes ericetorum		x		x		x		x			x			x			x	7
Pontia protodice	x	x	x	x	x	x		x	x	x	x		x	x	x	x	x	15
Pontia occidentalis	x	x				x	x	x	x	x	x				x	x		10
Pieris rapae		x		x	x	x	x	x	x		x			x	x	x	x	12
Colias eurytheme	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	16
Strymon melinus		x				x		x						x		x	x	6
Leptotes marina		x	x	x	x	x	x	x	x	x	x		x	x	x		x	14
Brephidium exilis	x	x				x		x	x		x		x	x		x	x	10
Nymphalis californica														x				1
Vanessa cardui	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	16
Junonia coenia		x				x		x	x	x				x		x		7
Danaus plexippus	x	x		x	x	x		x	x	x	x		x	x	x		x	13
Danaus gilippus						x	x								x		x	4
Subtotal	7	12	4	8	6	13	7	12	10	8	10	1	7	12	9	9	11	
Vagrant, Marginal, or Accidental[1]																		
Hesperopsis libya					x	x		x	x	x	x						x	7
Polites sabuleti																		0
Colias cesonia						x											x	2
Phoebis sennae		x																1
Eurema nicippe								x										1
Nathalis iole						x					x					x		3
Lycaena editha																		0
Ministrymon leda														x				1
Euphilotes pallescens														x				1
Philotiella speciosa																	x	1
Hemiargus isola								x	x							x	x	4
Adelpha bredowii																		0
Subtotal	0	1	0	0	1	3	0	3	2	1	2	0	0	2	0	2	4	
TOTAL	**44**	**75**	**25**	**41**	**38**	**83**	**34**	**80**	**71**	**61**	**59**	**17**	**40**	**70**	**41**	**56**	**62**	
Sampling effort (visits per canyon), 1980s	**0**	**0**	**0**	**3**	**3**	**6**	**3**	**3**	**4**	**3**	**4**	**3**	**3**	**0**	**4**	**4**	**0**	**43**
Sampling effort (visits per canyon), 1990s[2]	**16**	**46**	**3**	**0**	**0**	**27**	**1**	**16**	**11**	**10**	**10**	**0**	**1**	**9**	**0**	**7**	**5**	**131**

NOTE: see codes at end of Table 1 on p. 15.

Shapiro, A. M.

1975a. The temporal component of butterfly species diversity. *In* M. L. Cody and J. M. Diamond (eds.), *Ecology and Evolution of Communities*, 181-195. Cambridge, Ma: The Belknap Pr. 545pp.

1975b. Why do California Tortoiseshells migrate? *J. Res. Lepid.* (Beverly Hills), 14:93-97.

Shapiro, A. M., C. A. Palm, and K. L. Wcislo

1979. The ecology and biogeography of the butterflies of the Trinity Alps and Mount Eddy, northern California. *J. Res. Lepid.* (Beverly Hills), 18:69-152.

Trimble, S.

1989. *The Sagebrush Ocean*. Reno: Univ. Nevada Pr. 248pp.

Tueller, P. T., and R. E. Eckert, Jr.

1987. Big sagebrush (*Artemisia tridentata vaseyana*) and longleaf snowberry *Symphoricarpos oreophilus*) plant associations in northeastern Nevada. *Great Basin Nat.* (Provo), 47:117-131.

Van Devender, T. R., R. S. Thompson, and J. L. Betancourt

1987. Vegetation history of the deserts of southwestern North America: the nature and timing of the Late Wisconsin - Holocene transition. *In* W. F. Ruddiman and H. E. Wright, Jr. (eds.), *North America and Adjacent Oceans During the Last Deglaciation*, 323-352. Boulder: Geol. Soc. N. Amer. 501pp.

Wells, P. V.

1983. Paleobiogeography of montane islands in the Great Basin since the last glacial pluvial. *Ecol. Monog.* (Durham), 53:341-382.

Western Regional Climate Center

1995. Compilation of National Oceanic and Atmospheric Administration climatological data. Desert Res. Inst., Stead, Nevada.

Wilcox, B. A., D. D. Murphy, P. R. Ehrlich, and G. T. Austin

1986. Insular biogeography of the montane butterfly faunas in the Great Basin: comparison with birds and mammals. *Oecologia* (Berlin), 69:188-194.

TABLE 1. Continued.

	WEST SLOPE CANYONS (north to south)														
	BC	BK	RE	WS	CT	SJ	MA	CR	CL	SW	IL	CW	RR	Subtotal	TOTAL
Resident															
Erynnis icelus				x										1	4
Erynnis persius	x	x		x	x	x	x		x	x				8	20
Pholisora catullus	x													1	5
Hesperia uncas						x			x	x		x		4	7
Hesperia juba	x			x	x	x	x		x	x	x	x		9	20
Hesperia comma	x	x	x	x	x	x	x	x	x	x	x	x	x	13	29
Ochlodes sylvanoides	x			x	x	x	x		x	x		x		8	23
Papilio bairdii	x			x	x		x							4	11
Papilio zelicaon	x			x		x	x	x	x	x				7	21
Papilio indra														0	10
Papilio rutulus	x	x		x	x	x	x	x	x	x	x	x	x	12	28
Papilio multicaudatus	x	x	x	x	x	x	x					x	x	9	26
Neophasia menapia	x			x	x	x	x	x		x	x			8	16
Pontia beckerii	x	x		x	x	x	x		x	x		x	x	10	26
Pontia sisymbrii	x			x	x	x	x		x			x		7	18
Euchloe ausonides	x	x		x	x	x	x		x	x	x	x		10	20
Euchloe hyantis						x		x	x				x	4	12
Anthocharis sara				x	x	x	x			x				5	15
Colias philodice	x			x		x	x		x	x		x	x	8	19
Colias alexandra	x	x		x	x	x	x		x	x	x	x	x	11	28
Lycaena arota	x			x	x	x	x	x					x	7	14
Lycaena rubidus	x			x		x	x		x	x	x	x	x	9	16
Lycaena heteronea	x			x	x	x	x	x	x	x	x	x	x	11	19
Lycaena helloides	x		x	x	x	x	x				x	x	x	9	16
Lycaena nivalis	x	x												2	4
Harkenclenus titus													x	1	8
Satyrium behrii	x			x	x	x	x		x	x	x	x	x	10	23
Satyrium californicum	x			x		x	x		x	x		x	x	8	18
Satyrium sylvinum				x	x	x	x	x	x			x		7	16
Callophrys affinis	x					x			x	x		x		5	12
Callophrys comstocki														0	3
Loranthomitoura spinetorum			x				x							2	11
Mitoura siva				x	x	x	x			x		x	x	7	20
Incisalia augustinus	x													1	2
Incisalia fotis														0	4
Incisalia eryphon	x			x	x	x	x	x	x	x	x			9	25
Everes amyntula	x			x	x	x	x			x	x			7	22
Celastrina ladon	x	x	x	x	x	x	x		x	x	x	x		11	25
Euphilotes battoides														0	2
Euphilotes enoptes	x	x		x	x	x	x		x	x	x	x	x	11	28
Glaucopsyche piasus	x			x	x	x	x	x	x	x	x	x	x	11	23
Glaucopsyche lygdamus	x			x	x	x	x							5	16
Lycaeides melissa	x	x	x	x	x	x	x	x	x	x	x	x	x	13	30
Plebejus saepiolus	x			x	x	x	x	x	x	x	x	x	x	11	20
Icaricia icarioides	x	x	x	x	x	x	x	x	x	x	x	x	x	13	29
Icaricia shasta	x					x			x	x				4	10
Icaricia acmon	x	x		x		x							x	5	18
Icaricia lupini	x	x	x	x	x	x	x		x	x		x	x	11	24
Apodemia mormo	x			x		x					x	x	x	6	16
Speyeria nokomis	x			x	x	x	x							5	7
Speyeria coronis	x	x	x	x	x		x	x	x	x			x	10	18
Speyeria zerene	x	x		x	x	x	x		x	x		x	x	10	23
Speyeria callippe	x	x	x	x	x	x	x	x	x	x		x	x	12	26
Speyeria egleis	x			x	x	x			x	x				6	12
Thessalia leanira						x								1	9
Chlosyne acastus	x			x	x	x	x	x		x	x	x	x	10	26
Phyciodes pulchella	x			x	x	x	x	x		x		x		8	18
Phyciodes mylitta	x			x	x	x	x	x				x	x	8	19
Euphydryas anicia	x			x	x	x	x		x	x	x	x		9	19
Euphydryas editha	x			x	x	x			x	x				6	11
Polygonia satyrus														0	4
Polygonia zephyrus	x	x	x	x	x	x	x			x			x	9	17
Nymphalis antiopa	x			x	x	x	x		x	x	x	x		9	19
Nymphalis milberti	x	x	x	x		x	x	x	x	x			x	10	26
Vanessa virginiensis	x			x			x							3	9
Vanessa annabella	x	x	x	x	x	x	x		x			x	x	10	21
Vanessa atalanta	x			x	x	x	x					x		6	17
Limenitis weidemeyerii	x	x	x	x	x	x	x	x	x	x	x	x	x	13	28
Coenonympha tullia	x	x		x	x	x	x	x	x	x	x	x	x	12	27
Cercyonis sthenele	x			x	x	x	x	x	x	x	x	x		10	26
Cercyonis oetus	x	x	x	x	x	x	x		x	x	x	x	x	12	29
Neominois ridingsii												x	x	2	3
Subtotal	57	23	15	56	47	57	52	22	41	44	26	41	35		

	WEST SLOPE CANYONS (north to south)														
	BC	BK	RE	WS	CT	SJ	MA	CR	CL	SW	IL	CW	RR	Subtotal	TOTAL
Migrant or Immigrant															
Pyrgus communis	x	x	x	x	x	x	x		x	x	x	x	x	12	**27**
Heliopetes ericetorum	x			x								x	x	4	**11**
Pontia protodice	x	x	x	x	x	x	x	x	x	x		x	x	12	**27**
Pontia occidentalis	x			x	x	x	x		x	x			x	8	**18**
Pieris rapae	x			x		x	x		x	x				6	**18**
Colias eurytheme	x	x	x	x	x	x	x	x	x	x	x	x	x	13	**29**
Strymon melinus	x													1	**7**
Leptotes marina	x	x	x	x	x	x	x		x	x			x	10	**24**
Brephidium exilis	x			x		x			x				x	5	**15**
Nymphalis californica														0	**1**
Vanessa cardui	x	x		x	x	x	x	x	x	x	x	x	x	12	**28**
Junonia coenia	x			x		x						x	x	5	**12**
Danaus plexippus	x			x	x	x	x	x	x	x			x	9	**22**
Danaus gilippus	x													1	**5**
Subtotal	13	5	4	11	7	10	8	4	9	8	3	6	10		
Vagrant, Marginal, or Accidental[1]															
Hesperopsis libya		x						x					x	3	**10**
Polites sabuleti				x										1	**1**
Colias cesonia														0	**2**
Phoebis sennae														0	**1**
Eurema nicippe														0	**1**
Nathalis iole				x		x							x	3	**6**
Lycaena editha	x													1	**1**
Ministrymon leda														0	**1**
Euphilotes pallescens														0	**1**
Philotiella speciosa														0	**1**
Hemiargus isola														0	**4**
Adelpha bredowii						x								1	**1**
Subtotal	1	1	0	2	0	2	0	1	0	0	0	0	2		
TOTAL	**71**	**29**	**19**	**69**	**54**	**69**	**60**	**27**	**50**	**52**	**29**	**47**	**47**		
Sampling effort (visits per canyon), 1980s	**0**	**1**	**1**	**1**	**0**	**2**	**0**	**3**	**3**	**2**	**0**	**0**	**3**	**16**	
Sampling effort (visits per canyon), 1990s[2]	**30**	**0**	**0**	**28**	**14**	**22**	**20**	**0**	**8**	**11**	**4**	**6**	**0**	**115**	

[1] *Ochlodes yuma* not included

[2] Complete canyon surveys were not conducted during all visits

CANYON CODES

East Slope		West Slope	
WI	Willow	BC	Big Creek
BI	Birch	BK	Brooks
TA	Tar	RE	Reed
SF	Santa Fe	WS	Washington
SH	Shoshone	CT	Cottonwood
KI	Kingston	SJ	San Juan
TI	Timblin	MA	Marysville
SU	Summit	CR	Crane
OP	Ophir	CL	Clear
NT	North Twin	SW	Stewart
ST	South Twin	IL	Illinois
CO	Cove	CW	Cow
BR	Broad	RR	Reese River
JE	Jett		
PA	Pablo		
WA	Wall		
PE	Peavine		

TABLE 2. Life history characteristics of Toiyabe Range butterflies.

Taxon[1]	Residency status[2]	Relative position of Toiyabe within range[3]	Montane taxon[4]	Biogeographic affinity[5]	Vagility in meters[6]	Potential hostplants in Toiyabe[7]	Principal butterfly habitat	Relative abundance[8]	Relative annual fluctuation in abundance[9]	Patrolling habitat	Perching habitat	Riparian dependence[10]	Relative use of mud puddles[11]
Family Hesperiidae													
Subfamily Pyrginae													
Erynnis icelus (Scudder & Burgess)	resident	central	x	Widespread	1	Salicaceae *(Populus, Salix)*, Betulaceae *(Betula)*	riparian canyons	uncommon	moderate		canyons	obligate	moderate
Erynnis persius (Scudder)	resident	central	x	Widespread	2	usually herb Fabaceae *(Lupinus*, Astragalus)*, Ranunculaceae *(Aquilegia*)*	canyons	abundant	low		hilltops, canyons	facultative	moderate
Pyrgus communis communis (Grote)	irregular immigrant	central		Widespread	4	herb Malvaceae *(Sphaeralcea)*	canyons, uplands	common	moderate	canyons	canyons	facultative	moderate
Heliopetes ericetorum (Boisduval)	irregular immigrant	central		Southern	4	herb Malvaceae *(Sphaeralcea)*	riparian canyons	uncommon	high	canyons		facultative	moderate
Pholisora catullus (Fabricius)	resident	central	x	Widespread	1	herb Chenopodiaceae *(Chenopodium)*	canyons	uncommon	low	canyons		facultative	none
Subfamily Hesperiinae													
Hesperia uncas W. H. Edwards ssp.	resident	central	x	Endemic	1	Poaceae *(Bouteloua)*	uplands	rare	low		hilltops	does not use	none
Hesperia juba (Scudder)	resident	central		Widespread	3	Poaceae (Deschampsia, *Stipa, Bromus, Poa)*	canyons, uplands	common	low		canyons	facultative	moderate
Hesperia comma harpalus (W. H. Edwards)	resident	central		Widespread	2	Poaceae *(Festuca, Poa, Stipa)*	canyons, uplands	abundant	low		hilltops, canyons	facultative	moderate
Ochlodes sylvanoides bonnevilla Scott	resident	central		Endemic	1	Poaceae *(Phalaris, Elymus, Agropyron)*	canyons, uplands	abundant	low		canyons	facultative	low
Family Papilionidae													
Subfamily Papilioninae													
Papilio bairdii bairdii W. H. Edwards	resident	western edge	x	Widespread	3	Asteraceae *(Artemisia*)*	riparian canyons	fairly common	moderate	hilltops	hilltops	facultative	moderate
Papilio zelicaon Lucas	resident	central	x	Widespread	3	Apiaceae *(Lomatium*, Pteryxia*)*	canyons	common	moderate	hilltops	hilltops	facultative	moderate
Papilio indra nevadensis T. & J. Emmel	resident	central	x	Endemic	3	Apiaceae *(Pteryxia*)*	canyons, uplands	common	moderate		near hilltops	facultative	moderate
Papilio rutulus rutulus Lucas	resident	central	x	Widespread	3	Salicaceae *(Populus*, Salix)*	riparian canyons	abundant	low	canyons		obligate	moderate
Papilio multicaudatus W. F. Kirby ssp.	resident	central	x	Widespread	3	Rosaceae *(Prunus*)*	canyons	common	low	canyons		obligate	moderate
Family Pieridae													
Subfamily Pierinae													
Tribe Pierini													
Neophasia menapia (C. & R. Felder) ssp.	resident	central	x	Endemic	2	Pinaceae *(Pinus)*	canyons, uplands	fairly common	high	uplands		facultative	none
Pontia beckerii beckerii (W. H. Edwards)	resident	central		Widespread	2	herb and bushy Brassicaceae *(Sisymbrium*, Stanleya)*	canyons, uplands	common	moderate	canyons		facultative	low
Pontia sisymbrii elivata (Barnes & Benjamin)	resident	central	x	Rocky Mountain	3	herb Brassicaceae *(Arabis*)*	canyons, uplands	common	moderate	hilltops, canyons		facultative	moderate
Pontia protodice (Boisduval & Le Conte)	regular immigrant	central		Widespread	4	herb Brassicaceae *(Lepidium, Sisymbrium, Descurania)*	canyons, uplands	common	high	hilltops, canyons		facultative	low
Pontia occidentalis occidentalis (Reakirt)	regular immigrant	southern edge		Widespread	4	herb Brassicaceae *(Lepidium, Sisymbrium, Descurania)*	canyons, uplands	uncommon	high	hilltops, canyons		facultative	low
Pieris rapae rapae (Linnaeus)	regular immigrant	central		Widespread	4	herb Brassicaceae (principally *Rorippa)*	riparian canyons	common	high	canyons		obligate	low
Tribe Anthocharini													
Euchloe ausonides (Lucas) ssp.	resident	southern edge	x	Endemic	3	herb Brassicaceae *(Sisymbrium*, Descuriana*)*	canyons, uplands	abundant	low	canyons, uplands		facultative	low
Euchloe hyantis lotta Beutenmüller	resident	central		Widespread	3	herb Brassicaceae *(Arabis, Caulanthus, Descurania)*	canyons, uplands	rare	moderate	hilltops, uplands		facultative	low
Anthocharis sara thoosa (Scudder)	resident	central	x	Southern	2	herb Brassicaceae *(Arabis)*	canyons, uplands	common	low	canyons, uplands		facultative	none
Subfamily Coliadinae													
Colias philodice eriphyle W. H. Edwards	resident	central		Widespread	3	herb Fabaceae *(Trifolium)*	canyons	common	low	canyons		obligate	low
Colias eurytheme Boisduval	regular immigrant	central		Widespread	4	herb Fabaceae *(Medicago, Astragalus)*	canyons	abundant	high	canyons		facultative	low
Colias alexandra edwardsii W. H. Edwards	resident	central		Endemic	2	herb Fabaceae *(Astragalus*)*	canyons, uplands	abundant	low	canyons, uplands		facultative	low
Family Lycaenidae													
Subfamily Lycaeninae													
Tribe Lycaenini													
Lycaena arota virginiensis (W. H. Edwards)	resident	central	x	Endemic	1	Grossulariaceae *(Ribes*)*	canyons	abundant	moderate		canyons, uplands	facultative	low
Lycaena rubidus sirius (W. H. Edwards)	resident	southern edge		Rocky Mountain	1	herb Polygonaceae *(Rumex)*	riparian canyons	common	moderate		canyons	obligate	low
Lycaena heteronea Boisduval ssp.	resident	southern edge	x	Endemic	1	Polygonaceae *(Eriogonum)*	canyons, uplands	fairly common	moderate	uplands		facultative	low
Lycaena helloides helloides (Boisduval)	resident	central		Widespread	1	herb Polygonaceae *(Rumex)*	riparian canyons	common	moderate	canyons	canyons	obligate	low
Lycaena nivalis Boisduval ssp.	resident	southern edge	x	Endemic	1	herb Polygonaceae *(Polygonum, Rumex)*	riparian canyons	rare	moderate		canyons	obligate	low
Tribe Theclini													
Harkenclenus titus immaculosus (W. P. Comstock)	resident	southern edge	x	Rocky Mountain	2	Rosaceae *(Prunus)*	canyons, uplands	rare	low		hilltops, canyons	obligate	none
Satyrium behrii crossi (Field)	resident	central	x	Rocky Mountain	2	Rosaceae *(Purshia)*	canyons, uplands	abundant	low		hilltops, canyons, uplands	facultative	low
Satyrium californicum (W. H. Edwards) ssp.	resident	central	x	Rocky Mountain	2	Rosaceae *(Prunus, Cercocarpus)*	canyons, uplands	common	low		hilltops, canyons	facultative	low
Satyrium sylvinum putnami (Hy. Edwards)	resident	central		Rocky Mountain	1	Salicaceae *(Salix)*	riparian canyons	common	low		canyons	obligate	low
Callophrys affinis affinis (W. H. Edwards)	resident	western edge	x	Rocky Mountain	2	Polygonaceae *(Eriogonum)*	canyons, uplands	uncommon	low		hilltops, uplands	facultative	low

Taxon[1]	Residency status[2]	Relative position of Toiyabe within range[3]	Montane taxon[4]	Biogeographic affinity[5]	Vagility in meters[6]	Potential hostplants in Toiyabe[7]	Principal butterfly habitat	Relative abundance[8]	Relative annual fluctuation in abundance[9]	Patrolling habitat	Perching habitat	Riparian dependence[10]	Relative use of mud puddles[11]
Callophrys comstocki Henne ssp.	resident	central		Southern	1	Polygonaceae *(Eriogonum*)*	canyons	uncommon	moderate		canyons	does not use	none
Loranthomitoura spinetorum spinetorum (Hewitson)	resident	central	x	Widespread	2	Viscaceae *(Arceuthobium* on *Pinus)*	canyons, uplands	uncommon	low		hilltops, uplands	facultative	none
Mitoura siva chalcosiva (Clench)	resident	central	x	Endemic	1	Cupressaceae *(Juniperus)*	canyons, uplands	uncommon	low		canyons, uplands	facultative	none
Incisalia augustinus (Westwood) ssp.	resident	central	x	Rocky Mountain	1	Rhamnaceae *(Ceanothus)*	canyons, uplands	rare	moderate		uplands	facultative	low
Incisalia fotis (Strecker) ssp.	resident	northern edge	x	Southern	1	Rosaceae *(Cowania)*	canyons	uncommon	low		uplands	facultative	none
Incisalia eryphon (Boisduval) ssp.	resident	central	x	Endemic	1	Pinaceae *(Pinus)*	canyons, uplands	abundant	moderate		canyons, uplands	facultative	low
Strymon melinus pudica (Hy. Edwards)	irregular immigrant	central		Southern	4	generalist *(Lupinus, Medicago, Melilotis, Sphaeralcea, Eriogonum)*	canyons, uplands	rare	moderate		hilltops, canyons, uplands	facultative	low
Tribe Polyommatini													
Leptotes marina (Reakirt)	irregular immigrant	northern edge		Southern	4	herb Fabaceae (mostly *Medicago*, possibly *Melilotis)*	canyons, uplands	uncommon	high	canyons		facultative	moderate
Brephidium exilis exilis (Boisduval)	irregular immigrant	northern edge		Southern	4	Chenopodaceae *(Atriplex, Salsola, Halogetum)*	canyons	uncommon	high	canyons		facultative	low
Everes amyntula herrii F. Grinnell	resident	central		Southern	2	herb Fabaceae *(Astragalus*)*	canyons, uplands	abundant	low	canyons, uplands	canyons	facultative	moderate
Celastrina ladon echo (W. H. Edwards)	resident	central	x	Widespread	2	generalist but prefers Rosaceae *(Petrophytum, Peraphyllum)*	canyons	abundant	low	canyons, uplands		facultative	moderate
Euphilotes battoides (Behr) ssp.	resident	central	x	Endemic	1	Polygonaceae *(Eriogonum)*	canyons, uplands	uncommon	moderate	canyons, uplands		facultative	moderate
Euphilotes enoptes (Boisduval) ssp.	resident	central	x	Endemic	1	Polygonaceae *(Eriogonum*)*	canyons, uplands	abundant	high	uplands		facultative	moderate
Glaucopsyche piasus nevada F. M. Brown	resident	central	x	Endemic	2	Fabaceae *(Lupinus*)*	canyons, uplands	abundant	low	canyons, uplands		facultative	moderate
Glaucopsyche lygdamus oro (Scudder)	resident	central		Rocky Mountain	2	herb Fabaceae *(Lupinus*, Astragalus)*	canyons, uplands	common	low	canyons, uplands		facultative	moderate
Lycaeides melissa paradoxa (F. H. Chermock)	resident	central		Widespread	2	herb Fabaceae *(Astragalus, Melilotis)*	canyons, uplands	abundant	moderate	canyons, uplands		facultative	moderate
Plebejus saepiolus (Boisduval) ssp.	resident	central		Endemic	1	Fabaceae *(Trifolium)*	riparian canyons	common	moderate	canyons		obligate	low
Icaricia icarioides fulla (W. H. Edwards)	resident	central	x	Endemic	1	Fabaceae *(Lupinus*)*	canyons, uplands	abundant	moderate	canyons, uplands		facultative	moderate
Icaricia shasta (W. H. Edwards) ssp.	resident	central	x	Endemic	1	Fabaceae *(Astragalus*, Trifolium,* possibly *Lupinus)*	canyons, uplands	uncommon	moderate	uplands		facultative	low
Icaricia acmon texana (Goodpasture)	resident	central		Southern	1	Polygonaceae *(Eriogonum),* Fabaceae *(Astragalus, Lupinus)*	canyons, uplands	uncommon	moderate	canyons, uplands		facultative	moderate
Icaricia lupini (Boisduval) ssp.	resident	eastern edge	x	Endemic	1	Polygonaceae *(Eriogonum)*	canyons, uplands	fairly common	moderate	canyons, uplands		facultative	moderate
Subfamily Riodininae													
Apodemia mormo mormo (C. & R. Felder)	resident	central		Sierra Nevada	1	Polygonaceae *(Eriogonum*)*	canyons, uplands	fairly common	moderate		canyons, uplands	does not use	none
Family Nymphalidae													
Subfamily Nymphalinae													
Tribe Argynnini													
Speyeria nokomis apacheana (Skinner)	resident	northern edge		Endemic	2	Violaceae *(Viola)*	riparian canyons	fairly common	moderate	canyons		obligate	none
Speyeria coronis snyderi (Skinner)	resident	southern edge	x	Northern	3	Violaceae *(Viola)*	canyons, uplands	uncommon	moderate	canyons, uplands		facultative	moderate
Speyeria zerene gunderi (J. A. Comstock)	resident	southern edge	x	Endemic	3	Violaceae *(Viola)*	canyons, uplands	abundant	moderate	canyons, uplands		facultative	moderate
Speyeria callippe harmonia dos Passos & Grey	resident	southern edge	x	Rocky Mountain	3	Violaceae *(Viola)*	canyons, uplands	abundant	moderate	hilltops, uplands	hilltops	facultative	moderate
Speyeria egleis toiyabe Howe	resident	southern edge	x	Endemic	2	Violaceae *(Viola)*	canyons, uplands	fairly common	moderate	canyons	hilltops	facultative	moderate
Tribe Melitaeini													
Thessalia leanira alma (Strecker)	resident	central	x	Southern	2	Scrophulariaceae *(Castilleja)*	canyons, uplands	uncommon	low		hilltops	facultative	none
Chlosyne acastus acastus (W. H. Edwards)	resident	central	x	Rocky Mountain	2	Asteraceae (probably *Chrysothamnus)*	canyons	abundant	low		canyons	facultative	low
Phyciodes pulchella (Boisduval) ssp.	resident	central		Endemic	2	Asteraceae *(Aster)*	riparian canyons	abundant	low	canyons		obligate	low
Phyciodes mylitta mylitta (W. H. Edwards)	resident	central		Widespread	2	Asteraceae *(Cirsium)*	canyons	common	moderate		canyons	facultative	low
Euphydryas anicia wheeleri (Hy. Edwards)	resident	central	x	Endemic	2	Scrophulariaceae *(Castilleja)*	canyons	abundant	moderate		canyons	facultative	low
Euphydryas editha lehmani Gunder	resident	southern edge	x	Endemic	2	Scrophulariaceae *(Castilleja)*	canyons, uplands	common	moderate		hilltops, canyons	facultative	low
Tribe Nymphalini													
Polygonia satyrus satyrus (W. H. Edwards)	resident	central		Widespread	3	herb Urticaceae *(Urtica)*	riparian canyons	rare	moderate		canyons	obligate	low
Polygonia zephyrus (W. H. Edwards)	resident	central	x	Widespread	3	Grossulariaceae *(Ribes)*	canyons, uplands	common	low		canyons	facultative	moderate
Nymphalis californica (Boisduval)	irregular immigrant	central	x	Widespread	3	Rhamnaceae *(Ceanothus)*	canyons, uplands	rare	high		canyons, uplands	facultative	low
Nymphalis antiopa antiopa (Linnaeus)	resident (partial migrant?)	central		Widespread	3	Salicaceae *(Salix)*	canyons	abundant	moderate		canyons	obligate	low
Nymphalis milberti subpallida (Cockerell)	resident	central		Widespread	3	herb Urticaceae *(Urtica)*	canyons, uplands	common	moderate		near hilltops, canyons	obligate	low
Vanessa virginiensis (Drury)	resident (partial migrant?)	central		Widespread	3	generalist, prefers Asteraceae *(Gnaphalium, Antennaria, Anaphalis)*	canyons, uplands	uncommon	moderate		canyons	facultative	low
Vanessa cardui (Linnaeus)	migrant	central		Widespread	4	generalist, prefers Asteraceae (especially *Cirsium)*	canyons, uplands	abundant	high		hilltops, canyons	facultative	low
Vanessa annabella (Field)	resident	central		Widespread	3	herb Malvaceae *(Sphalaracea),* Urticaceae *(Urtica)*	canyons, uplands	common	high		canyons	facultative	low

Taxon[1]	Residency status[2]	Relative position of Toiyabe within range[3]	Montane taxon[4]	Biogeographic affinity[5]	Vagility in meters[6]	Potential hostplants in Toiyabe[7]	Principal butterfly habitat	Relative abundance[8]	Relative annual fluctuation in abundance[9]	Patrolling habitat	Perching habitat	Riparian dependence[10]	Relative use of mud puddles[11]
Vanessa atalanta rubria (Fruhstorfer)	resident (partial migrant?)	central		Widespread	4	herb Urticaceae *(Urtica)*	canyons	fairly common	high		canyons	obligate	low
Junonia coenia Hübner ssp.	irregular immigrant	northern edge		Southern	4	herb Plantaginaceae, Scrophulariaceae *(Mimulus)*, *Verbenaceae, Cornaceae*	canyons	uncommon	high		canyons	facultative	low
Tribe Limenitidini													
Limenitis weidemeyerii latifascia E. M. & S. F. Perkins	resident	western edge		Northern	2	tree and shrub Salicaceae *(Salix*)*, Rosaceae *(Holodiscus*, Amelanchier)*	canyons	abundant	moderate		canyons	facultative	low
Subfamily Satyrinae													
Coenonympha tullia (Müller) ssp.	resident	central		Endemic	2	Poaceae *(Stipa, Poa)*	canyons, uplands	common	moderate	canyons, uplands		facultative	none
Cercyonis sthenele paulus (W. H. Edwards)	resident	central	x	Endemic	2	Poaceae	canyons, uplands	abundant	moderate	canyons, uplands		facultative	none
Cercyonis oetus oetus (Boisduval)	resident	central		Widespread	2	Poaceae *(Poa, Bouteloua)*	canyons, uplands	abundant	moderate	canyons, uplands		facultative	none
Neominois ridingsii stretchii (W. H. Edwards)	resident	central	x	Endemic	2	Poaceae (including *Bouteloua)*	uplands	uncommon	low		hilltops, uplands	does not use	none
Subfamily Danainae													
Danaus plexippus plexippus (Linnaeus)	migrant	central		Widespread	4	herb Asclepiadaceae *(Asclepias)*	canyons, uplands	fairly common	high	canyons, uplands		facultative	low
Danaus gilippus thersippus (Bates)	irregular immigrant	northern edge		Southern	4	herb Asclepiadaceae *(Asclepias)*	canyons, uplands	rare	high	canyons		facultative	low

Erratic vagrant from south
Colias cesonia cesonia (Stoll)
Phoebis sennae marcellina (Cramer)
Eurema nicippe (Cramer)
Nathalis iole Boisduval
Ministrymon leda (W. H. Edwards)
Hemiargus isola alce (W. H. Edwards)

Marginal into canyons from adjacent desert
Hesperopsis libya lena (W. H. Edwards)
Euphilotes pallescens pallescens (Tilden & Downey)
Philotiella speciosa speciosa (Hy. Edwards)

Marginal from adjacent marsh habitat
Polites sabuleti nr. *basinensis* Austin

Single colony in specialized habitat
Ochlodes yuma (W. H. Edwards) ssp.

Accidental
Adelpha bredowii eulalia (Doubleday & Hewitson)

Single record, status unknown
Lycaena editha (Mead) ssp.

[1]**ssp:** undescribed subspecies

[2]**Residency status**
resident: completes entire life cycle in Toiyabe Range
migrant: exhibits seasonally determined and predictable mass movement
regular immigrant: occurs every year; probably cannot survive all winters
irregular immigrant: may not occur every year; may breed but with the exception of *Nymphalis californica* do not overwinter
erratic: found only a few seasons each decade
accidental: far from normal range, not to be expected again

[3]Relative position of Toiyabe within species (not subspecies) range

[4]Not occurring in valleys in vicinity of Toiyabe Range

[5]Subspecies level biogeographic affinity
Widespread: occurs over broad area in at least western United States and Canada
Southern: distribution principally southern United States southward
Northern: distribution principally northern United States northward
Rocky Mountain: distribution principally Rocky Mountain, not extending to Sierra Nevada
Sierra Nevada: distribution principally Sierra Nevada, not extending to Rocky Mountains
Endemic: Great Basin endemic

[6]**Vagility in meters**
1: tens
2: hundreds
3: thousands
4: high

[7]***** indicates verified records for Toiyabe Range

[8]abundance in principal habitat at peak of flight season
abundant: generally seen and in large numbers
common: generally seen but not in large numbers
fairly common: generally seen but in small numbers or not generally seen
uncommon: seldom seen but not a surprise
rare: always a surprise, but not out of normal range

[9]**Relative annual fluctuation in abundance**
low: generally remaining within same relative abundance category
moderate: abundance may fluctate by one relative abundance category
high: abundance may fluctuate by more than one relative abundance category

[10]**Riparian dependence**
obligate: probably cannot maintain permanent populations in the absence of a riparian zone
facultative: visit the riparian, but survival and maintenance of viable populations probably do not depend on its presence

[11]**Relative use of mud puddles**
none: no records of individuals at mud puddles
moderate: individuals frequently recorded at mud puddles
low: individuals occasionally recorded at mud puddles