JT SCIENCE

A newsletter to promote a better understanding of the natural, physical, & cultural environment in Joshua Tree National Park

Premier Issue
An annual publication highlighting research in JTNP

JT SCIENCE

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OUR MISSION
Joshua Tree National Park Association works in partnership with Joshua Tree National Park to help in its achievement of programming goals in education and interpretation, along with scientific and historical research and activities.

BEING A PART OF THE ADVENTURE
We operate four visitor centers and one park store that are often the first stop for visitors from around the world. We also offer a field institute, with classes taught by experts in natural sciences, cultural history, and the arts; and we raise funds via donations and our membership program. Visit a park store to learn about wildflower identification, birding, geology, stargazing, native plants and local history; pick up climbing and hiking guides; or sign up for a Desert Institute field class and make the park your classroom.

YOUR MEMBERSHIP MATTERS
As a member you support scientific research, the park's historical collections, youth programs, and assist in the preservation of our fragile desert. Email **membership@joshuatree.org** to find out more!

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Welcome to JT Science

The mission of JT Science is to promote a better understanding of the natural, physical, and cultural environment in Joshua Tree National Park (JTNP). Each issue highlights scientific endeavors being conducted in JTNP and provides an opportunity for scientists, land managers, and the general public to know and appreciate this desert region.

In support of this mission, the Joshua Tree National Park Association not only provides funding to publish this science-based newsletter for the public, but it also provides annual funding for the **Graduate Student Research Grant Program**. The goals of the grant program are to support graduate student researchers conducting independent field studies in JTNP and more specifically to support high priority research needs that inform park management of socio-cultural, natural, and wilderness resources identified by park management.

Grant awardees will provide lectures and workshops for the Desert Institute, manuscripts for JT Science, public outreach materials for JTNP Interpretation staff, as well as final reports summarizing their findings. By offering up to $5,000 to each student, this program provides opportunities for the student to gain experience with grant and report writing skills, budget management, and most importantly, to demonstrate how their research can apply to land management issues.

To date, we have supported over 30 students, through which we have gained insight on such things as visitor awareness of tortoises, conservation implications for fringe-toed lizards and Joshua Trees, impacts to soil crust, inventories for bees and wasps, and discoveries of new-to-science species of poppies and green algae. The impact of this program and the contributions made by these scientists has been richly rewarding.

Enjoy the Newsletter!



Long-term Butterfly Monitoring at Joshua Tree National Park

Joe Zarki[1] and Marilyn Lutz[1]

"The national parks comprise the very centerpiece of butterfly conservation. As the rest of the American landscape changes around us, the parks and monuments at least remain intact— a reliable core of the continent and its habitats where butterflies persist and survive."

Robert Pyle, author, Handbook for Butterfly Watchers (1984), founder of the Xerces Society, former park ranger, Sequoia National Park

Relatively few studies of butterflies have been carried out in Joshua Tree National Park (JTNP or park), and most of those were short-term in duration. Consequently, many questions about butterfly distribution and the status of park butterfly populations remain unanswered. For the past 25 years, the authors have engaged in a volunteer effort to collect data on butterflies in JTNP. This long-term monitoring is described here along with some of the project's more interesting findings.

Butterflies and moths belong to the Order Lepidoptera and occur on all continents except Antarctica. Worldwide there are between 18,000-20,000 species of butterflies with an estimated 250,000 species including all known moths; approximately 725 butterfly species are found in North America (Lepidopterist Society, 2018; NABA, 2021a).

Butterflies are insects that exhibit a four-part life cycle progressing from egg to larva to pupa to the adult form called imago. Butterflies are generally warm weather creatures with the greatest diversity occurring in tropical regions. Most butterflies have fairly short lives in their adult form, a few weeks to a month for many smaller species, whereas a few larger species, such as the monarch and mourning cloak, may live nine months or more. Adult butterflies largely feed on flower nectar that they obtain through a flexible anatomical tube called a proboscis (Figure 1). They have taste receptors

Figure 1. *Three common generalist species: the painted lady (left), orange sulphur (center), and gray hairstreak (right); all obtain food and lay their eggs on a wide variety of plants. Butterflies largely feed on flower nectar using their proboscis, as all three species demonstrate here.* **Photos by Joe Zarki.**

[1]*Joshua Tree NP Butterfly Count Lead volunteers, lutzarki@gmail.com*

on their feet that enable them to identify specific plants on which to lay their eggs.

With a lifestyle based on visiting flowers for nectar, butterflies are known as important pollinators. They are also highly sensitive to environmental changes and are important indicators of environmental quality. Most butterfly species have populations that are localized to a specific region or habitat, and thus, respond quickly to local conditions such as fires, drought, and fluctuating seasonal precipitation levels. Their rapid response to environmental stresses makes them good candidates for climate-change monitoring efforts.

Desert ecosystems, though hot and arid, offer butterflies a wide range of plants and nectar sources. The Mojave and Sonoran Desert floristic components at JTNP support a diverse butterfly fauna representing all the major North American butterfly families. While generalist species such as the painted lady (*Vanessa cardui*), orange sulphur (*Colias eurytheme*), and gray hairstreak (*Strymon melinus*) are able to use many different kinds of plants (*Figure 1*), some species are more specialized, often using just one or a few larval host plants and/or adult nectar sources. For example, pallid dotted-blue (*Euphilotes pallescens elvirae*) feeds only on buckwheats (*Eriogonum)* as an adult and larvae, whereas tiny checkerspot (*Dymasia dymas*) and 'Loki' juniper hairstreak (*Callophrys gryneus loki*) are specialized at the larval stage only (*Figure 2*). The tiny checkerspot (*Dymasia dymas*) uses only a few species in the Acanthaceae family (Monroe, 2004; *Figure 2*). One of these plants, chuparosa (*Justicia californica*), occurs in JTNP, but only along low elevation bajadas and desert washes within the Sonoran Desert sections of the park.

> "Despite butterflies' importance, few personnel at national parks pay much attention to these invertebrates, and even the largest and oldest parks seldom possess a species list. Much of what is known about butterflies within parks depends on the individual interest of a staff member or volunteer."
>
> *Roland Wauer, former Chief of Resource Management, National Park Service*

Nevertheless, when chuparosa is blooming in March and April, tiny checkerspots become one of the most locally common butterflies at JTNP. Larvae of the 'Loki' juniper hairstreak feed only on California juniper (*Juniperus californica*) while adults take nectar from many annual and perennial flowers.

National parks protect relatively large, intact ecosystems that serve as important refuges for butterfly populations that represent a wide spectrum of North America's lepidopteron fauna. Data collection efforts through citizen science programs have expanded the ability of parks to gather data on a wide range of park resources and science-related questions regarding the impacts of climate change or population trends for individual species or groups of organisms. Although these volunteer-driven data collection efforts have recognized strengths and weaknesses, they can be valuable additions to a park inventory and monitoring program (Wilson, et.al. 2017). Since 1985, the authors have been involved with creating volunteer-led data collection efforts on butterfly populations at three national parks: Yellowstone, Badlands, and Joshua Tree. By obtaining National Park Service (NPS) research permits and establishing monitoring protocols using the Seasonal Count Program of the North American Butterfly Association (NABA), long-term data collection has improved each park's understanding of its invertebrate pollinators (NABA, 2021b).

Figure 2. *Specialist species are limited to specific plant taxa within a genus or family. For example, larvae of the Loki juniper hairstreak (left) feed only on California juniper, whereas tiny checkerspot larvae (center) feed only a few species in the Acanthaceae family; this female (center) is shown ovipositing on chuparosa, JTNP's only member of the Acanthaceae. All stages of pallid dotted-blue (right), shown here mating, are restricted to a few buckwheat species.* **Photos by Joe Zarki.**

The NABA Count Program uses a methodology (www.naba.org/ftp/nabaus.pdf) first developed by the National Audubon Society for its popular Christmas Bird Count, which is one of the oldest ongoing citizen science programs in existence. Under the NABA protocol, a 15-mile diameter circle is established as the area to be surveyed. Each count has one or more volunteer compilers who organize and share the count data with the national database. Compilers also determine the date each year when participants will fan out and, during a single 24-hour period, find and identify any butterflies they encounter. While most individual butterflies will be noted in their adult phase, participants also record butterflies found as eggs, larvae, and pupae if they can be correctly identified. In addition, the number of individual butterflies (in all stages) is counted or estimated. Count dates are selected to assess butterfly populations at their times of peak activity and diversity. For most North American sites, this date will be in summer, but in the Southwest, peak seasons of biodiversity occur in spring and fall in response to seasonal rainfall.

Park	Count Name	Season	Years Held (through 2018)
Apostle Islands National Lakeshore	Cornucopia, WI	summer	33
Big Bend National Park	Big Bend National Park, TX	fall	1
Big Cypress National Preserve	Pinecrest (Tri-Co.), FL	summer	16
Blue Ridge Parkway	Blue Ridge Parkway, VA	summer	27
	Peaks of Otter, VA	summer	26
Bryce Canyon	Bryce Canyon, UT	summer	13
Cape Cod National Seashore	Truro, MA	summer	14
Everglades	Homestead, FL	spring	18
	Shark Valley, FL	spring	12
	Shark Valley, FL	summer	13
Golden Gate	Marin Co., CA (includes Muir Woods)	summer	30
	San Francisco, CA	summer	24
John Muir National Historic Site	Benecia, CA	summer	18
Joshua Tree (includes 2019)	Cottonwood Spring, CA	spring	14
	Joshua Tree, CA	spring	25
	Joshua Tree, CA	fall	6
Lassen Volcanic	Mount Lassen	summer	12
Lava Beds	Lava Beds National Monument, CA	summer	10
Marin County, CA	Marin County, CA	summer	30
Pinnacles	Pinnacles National Park, CA	summer	19
Point Reyes	Point Reyes, CA	summer	14
Shenandoah	Island Ford, VA (partially within park)	summer	20
	Shenandoah National Park, VA	summer	21
Tuzigoot National Monument	Cottonwood, AZ (includes entire park)	summer	3
Yellowstone	Yellowstone National Park, MT	summer	14
Yosemite	Yosemite National Park, CA	summer	6

Table 1. *NPS Units with active NABA Butterfly Counts. A number of counts have been started and discontinued at other NPS units.*

The first nationwide survey, the 4th of July Butterfly Count, was started by the Xerces Society in 1975. Since 1993, the program has been administered by NABA. The emphasis for the NABA Count Program is to conduct non-consumptive studies of butterflies. Identification, data collection, and appreciation of butterflies are the main drivers for the program. Butterfly count compilers are responsible for recording their count data in NABA's online database, and an annual report is issued that contains each count's results. An average of 450 counts are conducted each year. At present, 19 NPS units are either the primary site or are partially covered by 26 active NABA counts (NABA, 2018). With 11 counts, California has the most of any state, while both Florida and Virginia each hosted four counts covering NPS sites (*Table 1*).

In JTNP, three butterfly counts are currently run each year. The oldest count, simply called 'Joshua Tree, CA,' was first run in 1995 and has been conducted for 25 consecutive years between mid-April and early May. The Joshua Tree count circle is centered at Hidden Valley Campground (Figure 3). The second count, referred to as the "Joshua Tree Fall count," was started in 2014. It uses the same count circle but takes place between late September and mid-October. A third count called 'Cottonwood Spring, CA' was added in 2006 and takes place earlier in the spring, most often in late March. The Cottonwood Spring count is centered near the Cottonwood Visitor Center (*Figure 3*).

An initial problem with starting a NABA butterfly count at JTNP was one of establishing trust. In 1995, a major federal investigation on the commercial sale of butterflies illegally collected from national parks broke into the news (Laufer, 2009). Suspicion was high surrounding any new activity involving the study of butterflies in national parks. Eventually, after assurances that park butterfly counts would rigorously adhere to all restrictions and conditions, a research permit was issued. Illegal collecting is still a worldwide conservation issue, and it remains a concern at many national park units.

Challenging field conditions sometimes lead to dramatic up and down swings in our count results. The timing of seasonal wildflower blooms and local weather conditions heavily influences butterflies. Dry years can lead to greatly reduced flights of adult butterflies; in addition, cold temperatures, cloudy skies, and high winds all depress butterfly activity. It is possible on some spring days to find no butterflies at all. Over the years, some counts have been cancelled and rescheduled on fairly short notice when late season storms produced poor conditions for butterfly activity. The variability of desert weather makes setting count dates an annual challenge.

Count participants are divided into parties of 2-4 people and assigned specific areas to survey. It is essential that every party have at least one person able to identify nearly all of the butterflies that might be encountered. Since the count program relies on identification through recognition of field marks, most identification must occur in the moment of observation. Occasionally, netting and releasing butterflies will be done in the field to help identify an individual. Photographs can be used to identify or confirm an identification later, but obtaining usable photos is not always possible, as some species are skittish and highly elusive. Over time, dedicated volunteers can become proficient at field identification.

In developing a group of skilled volunteers for butterfly counts, we often recruited from local birdwatchers and wildflower enthusiasts; these amateur naturalists often make good butterfly observers since they already have developed skills of pattern recognition and looking for very specific field marks to enable correct identifications.

Many experienced birders are also familiar with the NABA data collection protocol through their participation in Christmas Bird Counts.

One way to increase the expertise factor within park-based citizen-science programs is to rely on knowledgeable staff, volunteers, and partners who work in non-science disciplines, but who have the interest and dedication to employ their experience in field-based data collection activities. Where individuals already possess detailed intimate knowledge of an NPS unit, its resource base, and its approaches to resource management, they bring advantages many other volunteers may lack. Networking with NABA members can also generate skilled volunteers, as was the case at JTNP. For several years, Fred Heath, a one-time President of NABA's Board of Directors and co-author of the field guide, *Introduction to Southern California Butterflies* (2004), took part in the Joshua Tree spring count. Also, becoming active in NABA regionally can benefit a local effort. For example, Marilyn Lutz became a regional editor for NABA's Southern California (Region 1) counts. This led to improved awareness of

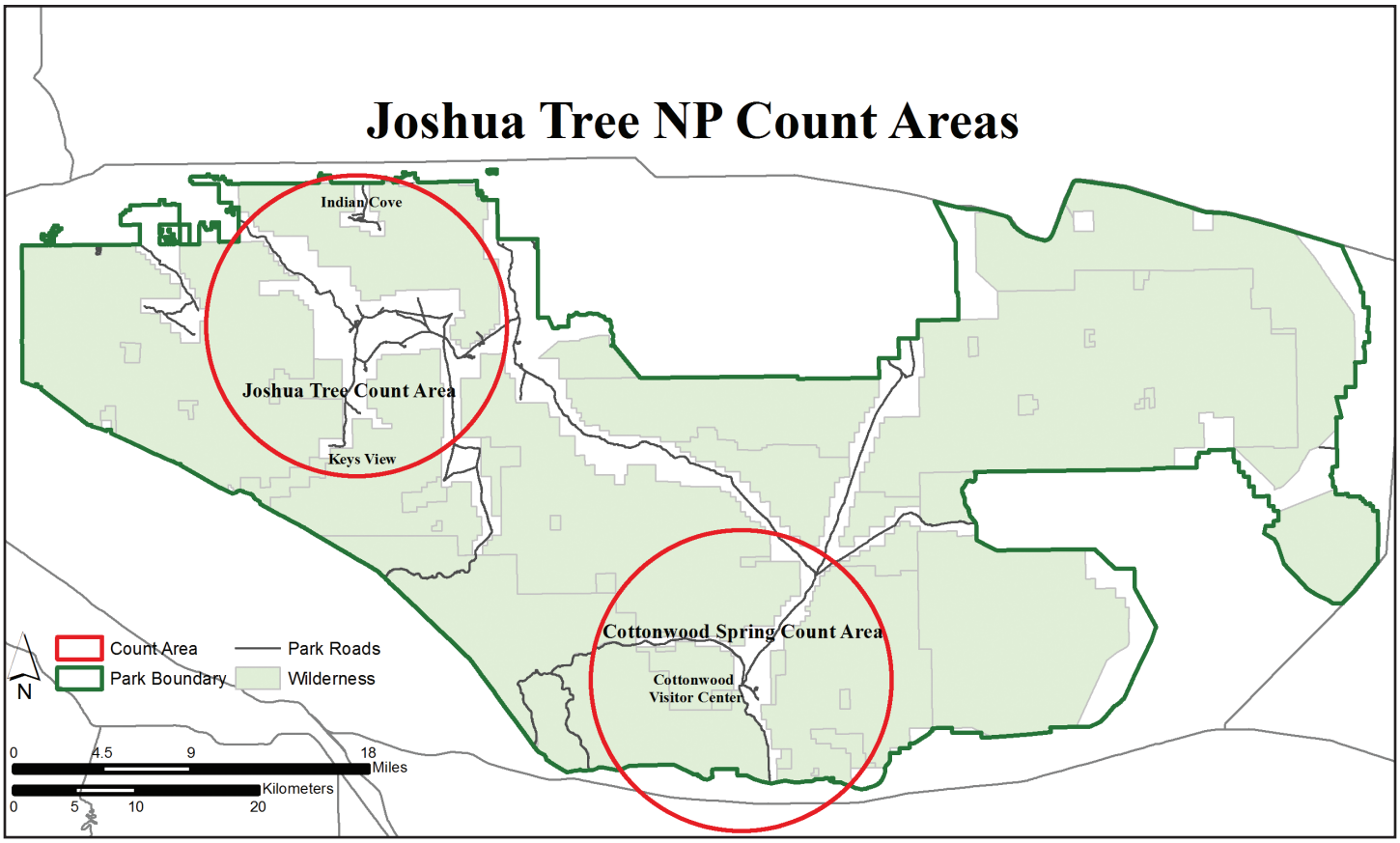

Figure 3. *Map of JTNP showing the two areas used for the annual NABA butterfly counts. The "Joshua Tree" count is conducted in spring and fall, since 1995 and 2014, respectively. The Cottonwood Spring count was started in 2006 and is conducted in early spring.*

JTNP's butterfly counts within the California butterfly community and among NABA's national leadership.

To increase the effectiveness of our early counts, a literature search was conducted to create a checklist of species known, or likely to occur, at JTNP. We reviewed past butterfly studies conducted in and around JTNP in order to gather records on park butterflies, for example:

1. Elbert Sleeper (1959)
Published the results of early invertebrate surveys that included lepidoptera at Joshua Tree National Monument.

2. Thomas and John Emmel (1973)
Included considerable information about park butterflies in their seminal publication, *Butterflies of Southern California*.

3. David Eiler (1985)
Documented his butterfly sightings from Joshua Tree National Monument and the nearby Big Morongo Canyon Preserve.

4. Drs. Gordon Pratt and John Emmel
Conducted field studies at the park from 1969 through 1998, and their field notes have been invaluable resources (Emmel 2018 and Pratt 1995).

5. Wanda Dameron (1997)
Summarized butterfly records for Joshua Tree National Monument and the Coachella Valley.

6. Walter Sakai and Norman Hogg (2000)
Submitted reports on annual inventories conducted by his Santa Monica College field ecology classes that included butterfly specimens from JTNP. Sakai also included published data from the early NABA counts at JTNP.

7. JTNP Museum Collection
The butterfly specimens, comprising 48 species, collected within the park were also an important source.

Based on these sources and the early years of observational data from our counts, a rough checklist of park butterflies numbering about 80 species gradually emerged around 2007. One important outcome of this first checklist was that it highlighted a number of "rare" species. Drs. Pratt and Emmel had recorded a number of species that, even after 25 years of count data, have still not been relocated in the park. This rarity can be due to a number of things from inherent scarcity due to biological or ecological reasons to a lack of appropriate field efforts at the right time or in the proper habitat.

Today, the current park butterfly checklist numbers 85 species. The taxonomy used for the checklist generally follows the North American Butterfly Association's *Checklist of North American Butterflies* (NABA 2001), but for some species and groups, we have chosen to use Warren, et. al. (2013). An additional 14 species occur close to JTNP, but they have not yet been found within the park.

During the twenty-five years of conducting NABA counts, participants have observed and recorded 68 species of butterflies. While no single species has been recorded every year, seven have been found in 21 of 25 years (*Figure 4*): checkered white (*Pontia protodice*), Becker's white (*Pontia beckerii*), sleepy orange (*Abaeis nicippe*), western pygmy-blue (*Brephidium exilis*), marine blue (*Leptotes marina*), variable checkerspot (*Euphydryas chalcedona*), and northern white skipper (*Heliopetes ericetorum*). Nineteen other species have been recorded in at least 15 of the 25 years that counts have been run. Conversely, 27 species have been recorded five or fewer times, and eight species have been found on only a single count.

The annual NABA Count Report includes a list of high yearly totals and record high totals for each North American species. Because the park conducts its counts in the spring and fall seasons, park butterfly counts are sometimes able to produce high totals for the nation for certain species that have their primary flight period outside the summer season. In 2017, the park had high annual totals for five species: 412 individuals of Sara orangetip (*Anthocharis sara*); 2 individuals of Wright's metalmark (*Calephelis wrightii*); 96 individuals of sagebrush checkerspot (*Chlosyne acastus*; *Figure 5*); 427 individuals of tiny checkerspot (*Dymasia dymas*); and 53 individuals of northern white skipper (*Heliopetes ericetorum*). The 2017 total of 412 Sara orangetips (*Figure 5*) set NABA's all-time record high for this species. The two Wright's metalmark sighted would appear to be a small number, but it represented the high for all NABA counts in 2017. This is partly a reflection of the limited range of this species minimizing the number of counts where it

Figure 4. *During the 25 years of conducting NABA butterfly counts at JTNP, seven species stand out as being the most frequently observed (21 of 25 years), three are shown here: Becker's white (top), marine blue (center), and northern white skipper (bottom).*
Photos by Joe Zarki.

Figure 5. *Significant numbers of five butterfly species were observed in 2017, two are shown here: Sagebrush checkerspot (top left), Sara orangetip (top right). In 2017, the park observed a record high of Mormon metalmark (bottom right). Also in 2016, a tagged monarch (bottom left) was observed in Smithwater Canyon.* **Photos by Joe Zarki.**

can be found. The park also set a record high in 2016 of 147 Mormon metalmarks (*Apodemia mormo*; *Figure 5*). It is of interest to note that many authorities have split *Apodemia mormo* into a number of separate taxa, at both the subtaxon and species levels (Pratt, et. al. 2011; Warren, et. al. 2013). If we follow this more recent taxonomy, JTNP has three distinct taxa from this complex of *Apodemia mormo* butterflies: the desert Mexican metalmark (*Apodemia mejicanus deserti*), Behr's metalmark (*Apodemia virgulti mojavelimbus*), and the Mormon metalmark (*Apodemia mormo mormo*). However, NABA does not follow this taxonomy, therefore we count all *Apodemia mormo* taxa as one species for the NABA counts.

One of the most exciting discoveries during a JTNP butterfly count was finding a tagged monarch (*Danaus plexippus*) in the Smithwater Canyon area (*Figure 5*). This exceptional find occurred on October 9, 2016, during the fall Joshua Tree count. Studies have shown that recovery rates for tagged monarch butterflies average only about 1% of all individuals that are tagged (Taylor, et. al. 2016). Careful photographs of the hind wing enabled the tag number to be read, and it was determined through a program called Southwest Monarch Study (swtag.org) that this individual was tagged in southeast Arizona on September 20, 2016, and travelled approximately 350 miles WNW to JTNP in 20 days.

Including other fieldwork done outside the NABA Count program, 79 butterfly species have been documented within the park by volunteer observers. Many of these were photographed and posted to the park's "Arthropods of Joshua Tree National Park Project" on iNaturalist.org. As of October 2019, there were 519 observations in the Arthropods Project, 433 are butterfly records representing 71 different species. Citizen science fieldwork at JTNP has documented the first park records for 11 butterfly species (*Table 2, Figures 6 and 7*). For example, in 2017, park volunteers Bob Cullen, Tom Haworth, and Donna Thomas documented the first confirmed park record for silver-banded hairstreak (*Chlorostrymon*

Common Name	*Scientific Name*	Date Observed	Observer(s)
Pipevine swallowtail	*Battus philenor*	10/13/2014	Bill Truesdell
Giant swallowtail	*Papilio cresphontes*	7/10/2007	Marilyn Lutz
Large orange sulphur	*Phoebis agarithe*	3/27/2015	Marilyn Lutz
Mexican yellow	*Eurema mexicana*	10/24/2014	Joe Zarki
Silver-banded hairstreak *	*Chlorostrymon simaethis*	4/30/2017	Bob Cullen, Tom Haworth, Donna Thomas
Mallow scrub-hairstreak	*Strymon istapa*	3/29/2014	Robb Hannawacker
Variegated fritillary	*Euptoieta claudia*	4/26/1997	Marilyn Lutz
Arizona powdered-skipper	*Systasea zampa*	5/5/2001	Joe Zarki
Mojave sootywing	*Hesperopsis libya*	5/6/2000	Marilyn Lutz
Fiery skipper **	*Hylephila phyleus*	9/29/2015	Tom Haworth
Sandhill skipper	*Polites sabuleti*	5/5/2001	Marilyn Lutz

Table 2. *Eleven species have been added to the inventory through citizen science observations posted on iNaturalist. *There is a record for C. simaethis from April 16, 1992 by Kelly Richers on Utah Trail near the park's North Entrance, however it cannot be determined if the location was within the park's 1992 boundaries. **An exotic species.*

simaethis; *Figure 6*). Thanks to years of butterfly fieldwork, they had the presence of mind to recognize that this Lycaenid was not like any others they had seen before. Also, former JTNP park ranger Robb Hannawacker has made many significant observations in the park, including the discovery of the first ever mallow scrub-hairstreak (*Strymon istapa*; *Figure 6*), found on March 29, 2014, near Cottonwood.

In a broader context, we now have over 25 years of count data for 67 butterfly species (*Table 3*). This kind of long-term data allows the park the document interesting ecological observations, as well as develop monitoring programs to assess distribution and population trends. Butterflies lead much more complex lives than might be suspected given their small size. For example, many hairstreaks and blues have symbiotic relationships with ants, in some cases with a single ant species (Ballmer and Pratt, 1991). These butterflies have evolved anatomical structures enabling them to generate semiochemicals that mimic ant pheromones and secretions containing sugars and amino acids. Some ant species respond positively to these secretions and will actively protect the caterpillars with which they have

Figure 6. *Citizen science fieldwork at JTNP has documented the first park records for 11 butterfly species, three of which are shown here: the silver-banded hairstreak was observed in 2017 (left); the mallow scrub-hairstreak was observed in 2014 (middle); and the variegated fritillary was observed in 2011 (right).*

Photos by Bob Cullen, Robb Hannawacker, and Joe Zarki.

coevolved such a partnership. This can affect the distribution of the butterflies within the park since their caterpillars may not be able to survive without protection from the ants. Even in areas with otherwise suitable habitat, a butterfly species may be absent without the presence of its caterpillar protector.

The pallid dotted-blue (*Euphilotes pallescens elvirae*) is an example of a species that exhibits this relationship. Based on the data we have collected, it is currently known from only a few locations within the park; however, we have only surveyed a small portion of the suitable habitat where its host plant, yucca buckwheat (*Eriogonum plumatella*) is known to occur. At present, it is not known which ant species attends to pallid dotted-blue larvae in the park. Once the ant species is identified, it may be possible to align the distribution of the pallescens-coevolved ants with yucca buckwheat stands to better predict locations for pallid dotted-blues throughout JTNP.

Certain butterflies are known to exhibit irruptive life cycles; the painted lady (*Vanessa cardui*) is one well-known example.

> For the most part, we do not understand the cause for these long-term population cycles where a species will be completely absent from the park for many years at a time, but then be present by the millions in other years.

The California tortoiseshell (*Nymphalis californica*) is a species that also exhibits irruption cycles. Rarely seen at JTNP, these large and boldly marked Nymphalids were reported from many locations across southern California in 2017. This led to their discovery in the Lower Covington area of the park where they were present in modest numbers through the summer and fall of that year.

Joshua Tree National Park's geographic overlap with the Sonoran Desert along its southeastern boundary means that the park is home to a subset of species generally associated with the Sonoran Desert. Following monsoonal rains, typically between July and September, various semi-tropical butterflies will exhibit migrational movements that result in incursions into southern California. Successful breeding causes some individuals to push out beyond the edges of their normal range and bring them into the park. One reason a fall count was started was to capture the presence of some of these species, such as the Mexican yellow (*Eurema mexicana*; *Figure 7*). For other resident species of both the Mojave and Sonoran Deserts, fall is their normal flight time, and you will miss them completely unless you are looking from late summer into early November. Dammer's dotted-blue (*Euphilotes enoptes dammersi*; *Figure 7*) and the Mormon metalmark (*Apodemia mormo*; *Figure 5*) are among these fall flyers at JTNP. Some species may fly in spring, but are nonetheless, more likely to be encountered during the fall season.

Mallow scrub-hairstreak (*Strymon istapa*, *Figure 6*), American snout (*Libytheana carinenta*; *Figure 7*), and red admiral (*Vanessa atalanta*; *Figure 7*) are among the butterflies that are more frequently found in fall.

Joshua Tree National Park is subject to a variety of environmental stresses that may have long-term impacts on butterfly populations. Among these stresses are climate change, exotic plant species, wildfires, air pollution, changes in native plant communities, and urban development along park boundaries (Frakes, 2018). A number of butterfly species found in the park's higher elevations, along its western reaches, have populations that may be at risk if the park becomes warmer and drier over time. Hopkins (2018) in the Inland Deserts Region Report of California's Fourth Climate Change Assessment noted:

Figure 7. *Several species in the park are best observed during the fall season, for example: Mexican yellow (top left), Dammer's dotted-blue (top right), red admiral (bottom right), and American snout (bottom left).* **Photos by Robb Hannawacker (bottom left) and Joe Zarki.**

"A warming and likely drier climate, with more intense droughts, would clearly stress populations anywhere. For those species already at or near their presumed physiological limits living in deserts, there is reason for concern..."

Currently, we have identified four species of hairstreaks (*Table 4*) that depend on host plants that already have restricted ranges across the park's higher mountains. These species: Behr's hairstreak (*Satyrium behrii*), mountain mahogany hairstreak (*Satyrium tetra*), hedgerow hairstreak (*Satyrium saepium*), and thicket hairstreak (*Callophrys spinetorum*), all occur within narrow ecological zones and are adapted to one, or only a few, caterpillar host plants.

If populations of their host plants decline, it is possible that local populations of these butterflies may also decline and could one day be extirpated from the park.

During fieldwork at the park in the 1980s and 1990s, Drs. John Emmel and Gordon Pratt made numerous observations of these species (Emmel, 2018; Pratt, 1995). However, no observations of these rare hairstreaks have been made during the authors 25 years of field work, and little is known about the present park populations of these four butterflies. However, more focused and systematic searches of suitable habitat could produce future observations of these species and shed further light on their status within the park.

Overall, the data collected over the years through the NABA counts and other citizen science efforts has established a much-needed inventory of the butterfly species known to occur in JTNP. In addition, the data has provided baseline information regarding fluctuations in abundance and frequency of these species. Importantly, however, now that we have an inventory and basic population data for the park, the hope is to encourage additional research on the many species that occur here.

Figure 8. *Four vulnerable species of hairstreaks have been identified in the park: Behr's hairstreak (top left), mountain mahogany hairstreak (top right), hedgerow hairstreak (bottom); and thicket hairstreak (not pictured). All occur within narrow ecological zones and are adapted to one, or only a few, caterpillar host plants.* **Photos by Joe Zarki and Tom Haworth (top right).**

There remains a critical need for a better understanding of the population status and trends for most park species. In 2001 when Roland Wauer made the statement that leads this article, only four national parks were participating in NABA count surveys and just a handful more had other efforts in place to document and assess their lepidopteron fauna (Wauer, 2001). Inventory and monitoring programs within the NPS are now more robust and all-taxa surveys have been conducted at a growing number of parks.

Yet invertebrates remain among the poorest known and least studied faunal groups within the National Park System. However, Rep. Raul Grijalva (AZ) recently sponsored the Extinction Prevention Act of 2019, a component of which is the North American Butterfly Conservation Act (H.R. 2918). This legislation would establish a butterfly conservation fund to promote the research, conservation, and education of Lepidoptera and dedicate up to $5,000,000 annually toward those objectives. While the legislation's fate is uncertain, if enacted, it would provide a much-needed boost to severely underfunded efforts by scientists and volunteers on behalf of butterflies at Joshua Tree, and elsewhere.

	Joshua Tree (Spring Counts)	Cottonwood (Spring Counts)	Joshua Tree (Fall Counts)	Total (All counts combined)
Total # Counts:	**25**	**14**	**6**	**45**
# SPECIES RECORDED:				
Total	59	43	46	68
High	36	29	28	36
Low	3	8	18	3
Median	24	22	25	23
Average	22	19	23	21
INDIVIDUALS:				
High	2,626	4,476	957	4,476
Low	3	39	79	3
Median	303	499	299	308
Average	576	884	372	645

Table 3. *Joshua Tree National Park NABA Seasonal Count Summary, 1995-2019. Three counts are conducted in the park each year, two in the spring and one in the fall. Over the last 25 years, we have conducted 45 counts and recorded a total of 68 species. The highest number of individuals ever recorded in one count was 4,476. On average, we observe 645 individual butterflies representing 21 species during our counts.*

Species	Host Plant(s)	Habitat
Behr's hairstreak *Satyrium behrii*	*Purshia tridentata, Purshia glandulosa*	Chaparral, pinyon-juniper-oak woodlands
Mountain mahogany hairstreak *Satyrium tetra*	*Cercocarpus betuloides*	Chaparral, mountain hillsides
Hedgerow hairstreak *Satyrium saepium*	*Ceanothus sp.*	Chaparral, hillsides, canyons
Thicket hairstreak *Callophrys spinetorum*	*Arceuthobium sp.*, dwarf mistletoe on conifers	Pinyon pine woodlands

Table 4. *Vulnerable butterfly species in Joshua Tree National Park. Four species of hairstreaks have been identified in the park as vulnerable due to the restricted distribution of their host plant(s) and habitat in the park. All occur within narrow ecological zones and are adapted to one, or only a few, caterpillar host plants.*

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AUTHOR BIOGRAPHIES

Originally from Maryland, **Joe Zarki** thoroughly enjoyed a 38-year career as a National Park Service ranger. He had stints at Death Valley, Denali, Tuzigoot National Monument, Yellowstone, and he served as Chief of Interpretation at Badlands National Park and at Joshua Tree (1995-2013).

Since his retirement in 2013, Joe has authored a number of publications including the popular history, *Images of America, Joshua Tree National Park*. He has also co-authored publications on birds of Joshua Tree and on the reptiles and amphibians of the park. In 2019, he was named to the Board of Directors of the Joshua Tree National Park Association. Long active in citizen science activities, Joe coordinates Christmas Bird Counts at Joshua Tree National Park and Morongo Valley. Together with his wife Marilyn Lutz, he helps organize butterfly counts at Joshua Tree National Park, Big Bear Lake, and the San Jacinto Mountains. Joe volunteers at the Big Morongo Canyon Preserve and also plays guitar in several local music projects.

Marilyn Lutz has been interested in butterflies since she first assisted Dr. Gillian Bowser with fieldwork for a butterfly phenology project in Yellowstone NP in 1984. She compiled the first North American Butterfly Association (NABA) count in Yellowstone in 1990, followed by counts in Badlands NP 1991-94, and Joshua Tree 1995 to present. While at the Badlands, she began assisting NABA as a count editor for the Northern Plains Region. After moving to Joshua Tree, she switched to editing the Southern California Region. Marilyn and Joe met in Yellowstone in 1985 and have been birding and butterflying together ever since.

Marilyn recently retired from her position as the Facility Management Specialist and GSA Fleet Manager for the National Park Service at Joshua Tree National Park. When not butterfly watching, she enjoys cooking, reading, running, and yoga.

Photos Opposite Page:

*a. Gray buckeye (**Junonia coenia grisea**).*

*b. Yucca giant-skipper (**Megathymus yuccae martini**). Photo by Cary Moore.*

c. Butterfly field volunteers Bob Cullen and Donna Thomas photograph a dainy sulphur during a fall butterfly survey in the Covington Flats area.

*d. Variable checkerspot (**Euphydryas chalcedona corralensis**).*

*e. Sleepy orange (**Abaeis nicippe**).*

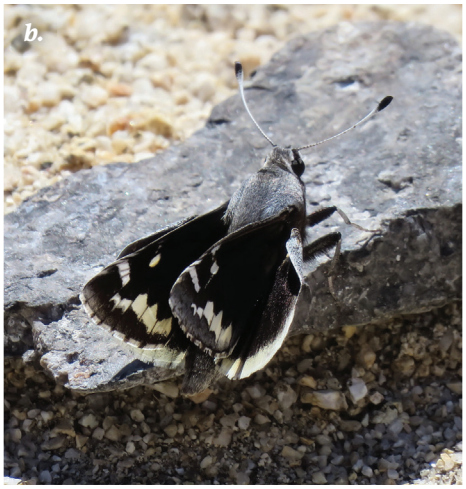
*f. Bernardino blue (**Euphilotes bernardino**).*

*g. American snout (**Libytheana carinenta**).*

*h. Desert black swallowtail (**Papilio polyxenes rudkini**).*

All photos by Joe Zarki except where noted.


a.


b.


c.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*Front cover image: Queen (**Danaus gilippis**) on rush milkweed (**Ascpelias subulata**).* **Photo by Joe Zarki.**
Back cover image: Porcupine Wash, Cottonwood count circle. **Photo by Marilyn Lutz.**

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