

To Lori Wood
Supervisor
Ozark St. Francis
National Forest

from Kent Bonar Naturalist

Kent Bonar

I am writing to object to the E.A on the Forest Plan Amendment for Bat Conservation. An obvious start is the finding of no significant impact on any species of concern on the regional list, let alone bat species.

Define significance in anything other than economic terms. If there are never significant impacts, the forest service itself is unnecessary. Just let industry run amuck like it always has and nothing will matter.

Hopefully, you know better so I'll try to avoid personal attacks on individuals. But planning team coercion takes on a mindset of its own to where team goals override concerns for God and country. Professional organizations can be run like fraternities, where one size fits all in operational methodology.

It would be more logical to suspend the operations with questionable impacts carried over from a plan that is overdue for revision than to continue to grind out the old plan until there's nothing left. The bats aren't all that's threatened, if amending is only an excuse to prop up the old plan legally. The recent executive order did have the covering clause consistent with existing laws. The old plan is legally overdue for revision so is no longer legal until replaced by one that is. There is nothing in the proposed amendment to address the bats' food supply or impacts on it. Nothing addresses escape cover from predators and how that relates to connectivity fragmentation results; what you call clutter is needed by both the bats and their prey.

Symbiosis isn't considered. Ecosystem dynamics aren't considered. Population cycles aren't considered, but all of these have impacts, and can and will result in further decline of bat populations if management is wrong.

I recommend that you suspend approval of new proposals and implementation even if approved of burning and herbicide use until a new plan is approved. Objections to the E.A follow. I'm sorry I haven't had time to do this better but concerns I raise are valid and only part of what needs to be done. I'll admit my shortfall, but have many excuses, the biggest being the process. If you have any questions, I'd be happy to discuss them with you.

K.B.

To Regional Forester Ken Arney
Southern Region Reviewing Official

From Kent Bonar, Naturalist
acting board director chair
Newton County Wildlife Association

objections to the programmatic
Plan Amendment for Bat Conservation

Kent Bonar

To begin with, I object to E.A. as presented and will provide comments on it separately, although redundantly. I object to a process which requires the equivalent of two dissertations in 45 days as an overburden on the public, especially on a subject that requires research in the middle of a pandemic when access to university libraries is restricted. I don't have or want a computer since they're a constant source of misinformation and staring at a lit screen for any length of time strains my remaining eye. Like Indiana bats, I have good night vision but have problems adjusting to glaring light or overhead light on unshaded eye which blurs images.

I submitted a bibliography to the draft comments along with a copy of a paper on the optics of bats, with Indiana bats being one of the most studied. (Suthers and Wallis 1970) I was reading an English translation of An Oxford University Press 2000 edition of The Biology of Bats by Gerhord Neuweiler, originally in German in 1993 by Georg Thieme Verlag, Stuttgart when I found a comparison of the optics of several types of bats worldwide. One of the most studied species was the Indiana bat (*Myotis sodalis*). Neuweiler did his own research on many species worldwide but his information on Indiana Bats was from two researchers from Indiana U - Roderick A Suthers and Norman E. Wallis in Optics of the Eyes of Echolocating Bats 1970 in Vision Research, vol 10 pp 1165-1173 Pergamon Press (UK)

Even with Neuweilers' expanded research, Indiana bats had by far the best effective power (Fc) in diopters +965 compared to the nearest bat species studied (*Carollia perspicillata*) at +634 or compared to man at +60. So with, over 900 times more effective power than humans, Indiana bats can see details at very low light (shadows) levels, as in a tight closed canopy. Their Noctuid moth prey also has excellent vision and hearing but their eyes point forward so their ears point backwards on their thorax to hear bats approaching from behind and above. They fly low in canopy or at that level. So Indiana and eastern small footed bats (personal observations) both hunt moths by sight, although eastern small-footed echolocate over water.

I object to the standards being applied forest-wide FW 48 50-70% canopy closure is not optimal, despite recent research. Some stands may have been used in that condition but extreme weather events have caused canopies to be open in the Ozarks more than ever. This orchard approach to forestry ruins the quality of the leave trees; a shelterwood, savannah, or whatever you call it is management for its own sake.

Climate change is responsible for the events that opened this canopy. Working for Arkansas State Parks in the 1970s, I worked and lived at Devils Den and Lake Fort Smith (Boston Mt district); Lost Valley (Buffalo RD) the Ozark Folk Center and Buffalo River (Sylamore district) all in or near the Ozark National Forest — and Queen Wilhelmina (Mena RD) in the Ouachita N.F. Unmanaged (inoperable) forests in the Ozarks and western Ouachitas (hardwood) had 80-90% canopy closure, thick leaf litter protecting soil moisture and organic life in topsoil, a layered understory including dense shade patches of pawpaw and umbrella magnolia and a diversity of understory trees dogwood, redbud, service berry, spice hawthornes, plums, blackhaws, azaleas, furtleberrys, deerberrys, huckleberrys, ironwood, etc.

In 1978-79 winter we had continual snow and/or ice cover on the ground for 6 weeks on mountaintops (above 1,800' elevation) From the cabin in Swain where I was staying, I could hear booms and breaks all night when we got more ice. Earlier in the 70s, I had to kick my cabin door open at Devils Den when ice froze it shut. Dust storms from Oklahoma and Texas blew into Mena, (dust bowl over again).

Eightys had droughts and a heavy snow when bent trees froze to dirt roads and closed them. Floods were frequent, into ninetys.

In 1997, my dad's second pacemaker was failing, so I went to Missouri to help him. Our farm was a little over a mile from Whiteman Air Base (SAC) which had a weather station, so our weather was broadcast on Kansas City television. We went over three months in summer without a measurable trace of rain.

Arkansas did better that year, but 98 and 1999 were both record drought years, with early heat waves. By midsummer, trees were shedding leaves. Finally in September 99 it started raining. Rain and warm temperatures continued through November. Dormant trees leafed out again to get all of the food they could — and got caught by a record ice storm the first week of December. Whole hillsides of trees were broken — caught with sap up.

The unnecessary concern for roost creation must mean those forests are extremely healthy with no management. In fact mortality is ongoing, you don't have to anticipate God or Nature and the bats are adaptable to using live trees. More important considerations are canopy closure (near full) and escape cover (clutter) for both predators and prey.

Roost trees are constantly shifting every 3-4 days as bats reduce a Noctuid swarm near host trees while dominant species lay eggs on them which quickly go into leaf litter. The swarm then moves on as new dominants reach their peak, to lay eggs on their host trees, and the bats move with them to find new proximal roosts.

Before you compromise areas around caves, you need a thorough inventory of woody plants in the area and of insect availability matched to time of occupation of all bat species.

A real problem is that the circular zones around the caves include private land and most or all extend beyond Forest boundaries. Much of that land is converted from forest and is no longer suitable foraging habitat. If those circles are considered to be adequate habitat for the bats, then that much acreage proximal to the caves should be taken off forest lands and put in the zones which should be minimal impact instead of trial and error reduction. In fact those circles don't account for varying bat populations in varying habitats. One size won't fit all unless it's oversized.

The obvious management options are either custodial (let God do the thinking Nature doing the work and foresters observing and monitoring) or single-tree selection in an ongoing but slow and careful process timed for minimal impact. Endangered species require careful consideration of any destructive or disruptive "treatments." There is no room for mistakes based on a crying need to defend orthodox dogma as the only option. Career enhancement should not further extirpate. You can't put them back once they're gone. Whether or not the Fish and Wildlife people accept their responsibility for oversight, whatever is on the forest is your responsibility. Comfort levels of operation aren't what's needed.

Dragging your feet on reform while attempting to justify even more damage short term shows intent - which is not to help the bats but excuse all current and planned management as having no significant impacts. Define significant.

The included bibliography has mostly been given previously but apparently lost in process so redundancy is necessary. New isn't necessarily better and doesn't negate previous valid research. These sources have withstood editing and peer review outside of agencies involved with agendas based on executive orders, or dependent on agency funding for the most part. Older agency research is less agenda-driven than recent, but distortions and assumptions on the current trend date back to WWII.

The pandemic and university library renovations have crippled my research considerably, although I have books checked out now and can get more through an increasingly complicated process. It bothers my remaining eye to stare at a screen very long, so I need hard copy for research and don't trust information that can be altered, redacted or eliminated by undisclosed parties. (Another reason for going back to older sources) I also need access to publications that are up to date and can't be checked out and to be able to reference many sources briefly without checking them out of the library, since I'll have all I can carry anyhow.

Timing on all of these sudden decisions is bad, and seems designed to perpetrate the forest plan indefinitely and let the Forest Service and Fish and Wildlife Service scapegoat each other for the demise of the bats. The plan should never ^{have} been approved in the first place and is past mandated revision. The plan should immediately be revised and meanwhile quit burning the bats' food supply and creating voids or disjunct populations of species needed in sequence timed to lunar phase. Herbicides can also have impacts on insects. Some moths need understory trees or shrubs (Horrid Zale needs blackhaws) or even down logs and stumps (Dead wood Borer I've seen pollinate Blue Ridge Gatefly). No need to create roost trees constantly, especially since weather events already have much of the forest thinned already, and standing dead trees (especially black locust) will be standing for years (also oaks chinkapins and beech.) Even with 90% canopy closure (beech and hard maple with umbrella magnolia understory) there will be occasional dead snags at any time. Some ridges with iron deposits have continual lightning strikes with moving light gaps as old ones fill back in. Most glades are over shallow bedrock which doesn't change. Tornado swaths can take years or decades to repair but will grow to blend with intact canopy on the sides. Insect damage is self-correcting (move on or starve) but defoliation in bad timing will kill some trees. Don't anticipate God - let Nature work. Restraint is a form of management, and usually the best one.

When I was at the University of Missouri - Columbia in 1972, I was illustrating a key to Missouri Bats for my advisor, Dr. William H. Elder, using five bats that were then banded and released (including Indiana bats). Dr. Elder had me reading his correspondence with Dr. Ulla Norberg from the University of Götterberg (Sweden), who was a leading world authority on bat flight mechanics. At that time, she had done intensive research on European bats and was wanting information on North American species. She was particularly interested in applying ecomorphology to foraging habitats and techniques.

Ecomorphology simply put is that form follows function and is the result of natural selection. Body shape, wing shape, sensory organs, and other specific modifications indicate foraging potential and preferred habitat for bat species, and for their prey. Ecomorphology also applies to the insects' host trees shrubs and plants, since tree shape reveals both growing conditions of the individual tree and site history. (What was above, below, and around it)

Bats with long, narrow wings are built to fly fast, but can't slow down enough to work their way through clutter, so they are foraging in open air, above treetops or outside edges or gaps in forests. Bats with shorter wide wings are built to fly slow through tight clutter, may even hover, and target individual large insects. Indiana bats have the slowest flight speeds of their genus in the Ozarks in caves or forests. I've seen them glean moths out of rock crevices near a cave entrance and even pick a moth off the gate (Roland cave - Stone county.) The other slow-flying Ozark bats outside the genus are the Ozark big-eared bat and the silver-haired bat. Ear shape shows food preferences and habitats.

Other bats that fly fast in the open are the hoary and red bats, tricolored bats, and big brown bats, evening bats, and Seminole bats. Some bats forage ^{and silver-b.} over water, but in or near clutter. Gray bats forage over rivers or creeks in forests; ^{go} Eastern small-footed bats over springs in closed canopy (as I've observed), and several species over ponds, but all of them prey on aquatic insects that are sensitive ^{ne} to temperature and wind and quit flying in adverse weather conditions, so the bats then shift to terrestrial habitats. Gray bats have modified wings that attach at the ankles of their feet instead of the base of the toes like other Ozark bats.

for the rest of the night.

The angle attachment of the wings allows Gray Bats to skim water to catch aquatic insects without wetting their wings. Insects are the soft stage of emerging adults, which have to float on top of the water until their wings harden enough to fly. While many bats catch the adults in flight, Gray bats are the only North American bat that can trawl the surface, (similar to Fishing bats of Central and South America) which gives them the advantage of first predators. Apparently aquatic insects are needed for lactation and going into hibernation, because as soon as young are volant, grays shift to eating soft-bodied beetles in bottoms and valleys (soldier beetles, fireflies). In the Ozarks NF, this shift happens around the Fourth of July, when fireflies make bat foraging obvious.

Aquatic insects are also excellent fish bait, so many species float in shallow slack water near the banks, to avoid large fish. Smaller streams have overhanging branches and vines. To avoid clutter while trawling, to escape owls by flying into the nearest clutter, and to focus on individuals when hunting beetles, gray bats have a long pointed thin tragus (inner ear lobe) in each long ear.

Bats with long ears and long thin tragus rely on relatively close precision echolocation; moving through clutter to forage or escape or move through caves. They focus on large individual prey. Ozark big-eared bats and Northern Long-eared bats are the most extreme. The big-eared bats locate prey (Saturnid moths) by smell, but echolocate through clutter to glean perched prey in canopies or on edges. Northern long-eared bats fly low in forests to catch individual large hard-winged beetles. Beetles don't hear, so Northern long-eared bats are constantly echolocating to work through clutter and find often scattered prey.

Eastern small-footed bats have long ears and a long, pointed tragus. They hunt over ponds, pools, and springs below canopies early, then blufflines and rock outcrops. They differ from western small-footed bats mostly through dentition. Western small-footed teeth are thick and blunt for grinding hard-bodied prey, while eastern small-footed teeth are thin and curved for holding soft-bodied prey.

Indiana bats have thin tragus in a fairly long ear, tapering on top half to a blunt tip. They echolocate in caves and to avoid predators on their way to and from foraging or roost trees, but when foraging are usually quiet. Their prey (Noctuid moths) have ears and excellent hearing to detect bats, so Indiana bats hunt and move through clutter by sight.

When a bat calls, the tragus moves to block the direct sound from the mouth while funneling the echo from the top of the ear. Round ears and tragus funnel echoes from a wider range of angles with a long sharp point pinpointing echoes from an exact target or spot. To detect swarms from a distance.

Little brown bats have straight thin tragus in medium long ears, and hunt open air above canopy, in gaps, edges, or open woods, and above water.

In contrast, bats which hunt in open air away from or far above clutter have short wide and blunt tragus in short, rounded ears. They hunt for swarms of insects instead of individuals and aren't in clutter except when going to a roost or cave, so they ^{loudly or} call at longer intervals to hear further echos ^{at low frequency}. Most have long, narrow wings and fly relatively fast. (the exception is the silver-haired bat, which flies slow and low over water or along edges near cover.) They range in size from Hoary and Big Browns down to tricolored, with red-eared and Seminole bats between.

Another morphological feature impacting hearing is the shape of the skull. Bats with short ears and tragus have flat-topped or domed round-topped skulls. Ear muscles on top of the skull have nothing to attach to but their counterparts from the other ear. Thus when one ear is repositioned, it pulls the other ear. Long-eared bats with long tragus are likelier to have a prominent sagittal crest, a bony ridge in the center of the top of the skull. This allows muscles from each ear to attach to their side of the ridge, and allows independent articulation of each ear. Independent focus of ears allows for location and tracking of prey while dodging clutter and potential predators. Big-eared bats have prominent crests.

Since all ~~Oxark~~ bat species are in the low FM range with their calls, F.M. radio clutter could distort or drown out their signals. Changing their frequency might avoid the loudest local stations, but where there is good radio reception, some level of noise clutter is on almost all frequencies.

Since Noctuid moths hear within the F.M. range of local bats (since the moths don't communicate with each other, their hearing is only for bat avoidance), the moths are also impaired by intense F.M. radio clutter.

The logical response for both predators and prey is to move to places with poor or no radio reception (tight hollows or bottoms) or where loudest local stations are blocked (far side of mountains or ridges) on essential frequencies.

The ability to move to blocked spaces is limited by population distributions of host trees, and gravid females ability to access them. This can vary with each species and can result in drastic changes in prey populations and their distributions. So if host trees are gone, so is the food supply for bat prey - at critical timing

A diagnostic feature for identifying *Myotis* bats is the keel (or lack of) on the calcar, a bone extending from the foot or ankle toward the Tail. (halfway or more) The calcars combine to fully extend the tail membrane. Keels are flaps of skin and muscle that can be extended to block or slow air flow from the tail membrane. The additional pressure from trapped air increases the camber of the tail membrane to provide lift and allow for slow movement through clutter or gleaning perched prey. Bats which forage in or below canopies (Indiana, Northern long-eared, eastern small-footed) can hover or move at near-stall speeds, the keel acting as a rudder.

Skin flexibility, thickness, pressure resistance, and form changes with metabolic state, at rest or in motion, state of hydration, temperature factoring windchill, flight direction relating to wind and general health, so wing, tail and keel skin and muscles are more conspicuous in live bats flexed in motion. I was drawing live Indiana bats and comparing them to older specimens in the research collections. The keels on dry skins shrink considerably, since to preserve skin as appearing natural, rapid dehydration is needed. Most bat wings are folded as specimens, but if the wing is extended it has to be pinned or blocked without distortion. A block over the keel would dry it to be noticeable, but many collectors miss details when unaware of significance, and too much alum or salt shrinks it away. When flexed against wind or air pressure, the camber stretches the keel to better function. All of these factor into performance potential, and vary between species as well as age, gender and individual life-history within a species.

Senses beyond hearing (smell in Ozark Big-eared Bats, sight in Indiana) are well documented and obvious. The big-eared bats are also called lump-nosed bats from the shape of their nose, which is to find and track female pheromones from Saturniid moths. Big-eared bats are able to tack into the wind to follow scent trails, but need ears to pinpoint prey while working edges or canopies. The probable reason for quiet calls is to use passive echolocation (sound generated by prey such as fluttering wings) and to locate proximal clutter. The Oklahoma study on foraging ranges of Ozark Big-eared Bats admitted in methodology their equipment had limited range, but in results and conclusions used the same distance as defining maximum nightly foraging range.

The same problem (limitations of technology dictating results) is apparent in recent radio-tracking in the ONF. I know practically how C.B. radios work in the Ozark bioregion from fox and coyote and bobcat hunting in Little Dixie (west central Missouri) as a teenager. Even with a thousand watt linear in range of walkie-talkies, any ground between blocks reception

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Younger hunters had to do the most legwork (saving hounds hung in fences, catching packs too close to major highways, railroads, or state parks, getting them off tree on bobcats out of season, etc.) so we had walkie-talkies, while my father and other hunters his age or older had mobile units in their trucks and we had a base unit at home so mom could pass on phone calls from neighbors where we were hunting if missing dogs showed up hurt or lost. Even with a thousand watt linear in dad's truck, if there was any physical barrier between us (knob, ridge, hill) radios wouldn't work. Boston mountain topography in Arkansas is much more extreme relief. Since bats usually stay close to tree line or just over canopy, contact loss is expected and anticipated with mobile units, but results conform to expectations considering technological expectations of equipment.

Research money would be better spent studying the prey of the bats. When several closely related species are concentrated in a small area by a limited resource (waterholes in deserts, certain types of caves in forests) they partition available foods. In time, some foods go from preferences to necessities at the time of availability, which changes throughout a season.

For example, gray bats eat mostly aquatic insects in spring and again in fall. This seems linked to lactation in spring and pregnancy in fall going into hibernation, because as soon as the young bats are volant (1st week of July) grays shift to eating soft-bodied beetles (soldier beetles, fireflies, etc.)

We've observed them eating fireflies in bottom fields on or around July 4.

Likely, Indiana bats also need riparian foods for maternity colonies, since known colonies are along streams. In the upper midwest, remaining trees are mostly in riparian galleries. Willows and poplars are hosts to many species of Noctuid moths, while other riparian or bottomland trees (box elder, sycamore, green ash, pin oak, butternut, pecan) are hosts for others. But like grays, as soon as young bats can fly, foods shift to terrestrial species, as Indians move south into upland forests.

Indians have been known to forage in warm weather in winter since the 50s in Kentucky. While a few Noctuids manage to survive winters as adults, brush-footed butterflies (Commas, Question Marks, Mourning Cloaks, Red Admirals) can usually be seen flying in small gaps with a standing dead tree or two in warm winter weather.

Caddisflies are the the best aquatic food for dependability year-round. The diversity is seasonal by water level. Big Piney - Spring in Buffalo Fall
Other aquatic are seasonal with short timing for flight.

Eastern Small-footed bats are the smallest, but one of the hardiest Oark bats. They usually roost under slab rocks around or above the top bluffline to the top bench on the north or east side of a mountain. I was helping a neighbor move rocks with a mule and sled from an old cabin foundation and chimney. As we lifted the slab from one end of the rockpile we'd made a temporary rock wall from, a bat fell off the bottom of the caprock and was crawling between jumbled lower rocks back into the wall. Those rocks were next, so as soon as we sat the slab on the sled, I caught the bat (with gloves). I held it long enough to identify it (small, gold hair, black wings and mask) then took it to the other end of the wall and sat it on open ground near the rocks. Instead of flying, it ran back into the rocks, scrambling like vampire bats I've seen on film. It was very agile, and moved fast between rocks. Since they're last to hibernate and first out in spring, I suspect they come out of hibernation to eat cave crickets on the guano piles. Foraging without flying would lower metabolic demands and gain fat for more dormant times.

A family of small-footed bats (3 to 6) was on the same farm for years. another was here (4 miles apart) in both places. They were easily observed over a pond in twilight (and easily separated from families of Northern ~~long~~ long-eared bats which were here too). Northerns forage low over roads or along edges at sunset. As soon as the air cooled after dark, insects quit flying over water, and bats move into the forest.

I was cleaning out a spring a few miles away at twilight when a small-footed bat hovered over the spring almost within reach. I got the flashlight on it for positive identification. That was on a bench below the top bluffline.

A small-footed bat crawled into a horizontal stovepipe more than once, and flew out of the wood cookstove firebox into the house, so they probably roost in hollow trees, like I've seen chimney swifts do in hollow beeches in Dismal Hollow RNA. As with Indians, roosts are chosen for proximity to prey species, breeding caves, hibernaculeums or prey swarming sites. Phenology of prey flight times (sequence) determines the location of roosting trees. Availability determines which individual rocks trees are roosts and changes when fluctuating prey populations decline locally and other populations or species erupt elsewhere. Necessity forces adaptation to availability.

Indiana bats aren't the only Ozark forest bat that hunts Noctuid moths by sight. In 1998 and 1999, both record drought years, I was caretaking a friend's cabin near Deer. There was a sliding glass door to the back porch, which overlooked the hollow above a spring that never went dry. The table where I drew, or read or wrote lined up with the door and a wall mirror doubled my candlepower. Moths seem attracted to low-intensity light, so there were moths on the glass door and windows. Every 20 minutes or so, I'd go out the front door and around to the back porch to check for new arrivals and sketch patterns I didn't recognise.

One night, I'd just got back in and sat down when I heard a soft thump on the glass door. I looked over and saw a small bat had slid between the screen door for hot days and the glass panel beside the door. I went over close and easily identified it as an eastern small-footed bat (*Myotis leibii*). It was confused for several seconds, then echolocated its situation, crawled out and flew off.

It had tried to catch one of the moths on the door. Gleaning moths, bats catch moths with their feet or in the scooping tail membrane, so it was moving slow, feet first, when it hit. Minimal impact; nothing broken.

Echolocation would have told the bat that the glass door was there, but it would have told the moth that the bat was there. So the bat was hunting by sight to avoid alerting the moths and didn't see the glass door.

Indiana bats also hunt by sight and avoid clutter without echolocation while foraging. I saw them gleaning large moths in crevices and cracks beside and above the mouth of Roland Cave (Stone Co.) and one hovered as if to land on the gate above me before snatching a big moth off the gate. (Catocala; probably cara or amatrix) ^{or junction} That was in twilight but I could still see them. With a night scope, I've watched them emerge from caves in pitch dark with no problems navigating around obstacles or other bats.

I was reading an Oxford University Press (UK) English translation updated in 2000 of The Biology of Bats by Gerhard Neuweiler originally in German in 1993 by Georg Thieme Verlag, Stuttgart when I found a comparison of the optics of several types of bats worldwide. One of the species considered was the Indiana bat (*Myotis sodalis*).

Neuweiler did his own research on many species worldwide, but his information on Indiana bats was from two researchers from Indiana U. Roderick A. Suthers and Norman E. Wallis in Optics of the Eyes of Echolocating Bats 1970 Vision Research vol. 10 pp 1165-1173 Pergamon Press (UK) Even in Neuweilers expanded research, Indiana bats had by far the best estimated effective power (F_e) in diopters +965 compared to the nearest bat studied (*Carollia perspicillata*) +634 or to man (by comparison) at +60. So Indiana bats have over 900 diopters better power than ours, extending into infrared and ultraviolet ranges.

I've used an ultraviolet black light to briefly examine several species of *Catocala* moths in university collections. Although most weren't recently collected and visual patterns somewhat faded, some patterns showed with the UV light. Infrared detects heat, so a swarm could be detected from a distance; ultraviolet could detect preferred species or sexes or individuals.

The wide range of effective power means they can see at a distance at low levels of light intensity (in shadows or under closed canopy). Overhead light blurs images, so above the canopy in a full moon Indianas can still see landscapes enough to travel, but focus on prey would be less precise. Noctuid moths worldwide as a group are photonegative they are more attracted to a low intensity, single point light, if at all. (Although they see well enough to evade capture and relocate in daylight, so their vision in daytime is good too) Ultraviolet patterns probably help with species recognition in a mixed swarm; since in Saturniid moths pheromones are specific to genus more than species — this would account for mixed swarms where species breed true. Pheromones of the genus cause the swarm, vision takes over after that.

Suthers and Wallis don't appear in North American bibliographies — probably why they had to get it printed in Britain. Errors of omission are easier if you only read what is fed to you by computer. Newest science isn't necessarily the best and older science is still valid unless proved otherwise. If all you have is recent research your agency USDAFS has funded or "partnered" with industry; Most lack any peer review outside of the agency, industry, or universities they fund and can intimidate or extort if results don't meet expectations. So you get the best science money can buy.

The measurements Neuweiler used were from Suthers and Wallis, from Indiana State U. They measured Big Brown and Tricolored Bats as well and other species south of U.S. Neuweiler added more, but Indians were clearly the best vision at low-intensity levels of light. This would mean they're built to hunt by sight in deep shadows and/or to pick their way through clutter without warning their prey in or near that clutter, all in shade.

Noctuid Moths have a pair of ears on the thorax, pointing backwards, so they hear a bat coming from above and behind them. The bat would be in the upper canopy, moths swarming low in a gap or understory. Instead of coming into the middle of the gap from the top Indians would come in from the edge through clutter without echolocating and catch them from behind (their eyes are good too, but only look forward). Eastern small-footed bats also hunt Noctuids.

Other families of Moths have ears on other parts of their bodies, which shows where bat attacks would come from. Geometrids (inchworms) and Arctiids (Tiger Moths) have ears on the sides of their abdomens, for hearing bats coming from the sides. They fly high above the canopy in the open, so bats here would be Big Brown, Red, Hoary, Seminole and tricolored. Arctiids are toxic to bats, but when they hear a bat coming, they make clicking sounds. Apparently bats train easily (one bad taste).

Hawkmoths (Sphingids) have modified mouthparts for ears. They fly fast, high and far, in the open, so they're listening for bats in front of them (same open species.)

Since all of these ear modifications are for certain types of bats, those families were (and are) subject to intense pressure from those bats. Other families of moths are deaf and so less impacted than preferred prey. "Preferred" prey may be essential or obligate or based on availability but heavy use results in defensive changes, predator adaptations, or abandon.

There are many monotypic genera of Noctuids in the Ozark National Forests that are important Indiana bats foods but the two biggest are *Zale* (spring) and *Catocala* (fall). *Zale* (owllet moths) overwinter as cocoons in leaf litter. *Catocala* overwinter as eggs or 1st or 2nd instar caterpillars, also in leaf litter. Both mostly feed on certain host trees, shrubs or vines. Most are in the canopy, but some are in the understory.

I said at the scoping meeting in Russellville that you need Lepidopterists specializing in Noctuids (and competent) to survey stands a year before potential impacts to determine species, host trees and timing (dates of occurrence and swarms) to construct a phenology (sequence). Nearby control plots should also be surveyed.

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