Late gestation and fawn rearing for white-tailed deer in South Texas coincides with the time of year that sees high temperatures throughout the day and night. Pregnant deer, like this doe carrying triplets, must balance staying cool while meeting the energetic needs of growing fawns.

Turning Up the Heat!

How white-tailed deer balance high temperatures and pregnancy demands in South Texas

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Nothing quite encompasses the meaning of 'heat' like a Texas summer, and as our electric bills will attest, summer temperatures in the state aren't restricted by a calendar. High temperatures before the spring equinox herald a season that could see months without a daily high temperature below 90°F. These extended periods of heat put considerable strain on our air conditioners, but at least we have a cool refuge to escape the heat. Refuge for wildlife is relegated to what they can find around them: shady trees, swimming holes, and sweet treats from the icebox.

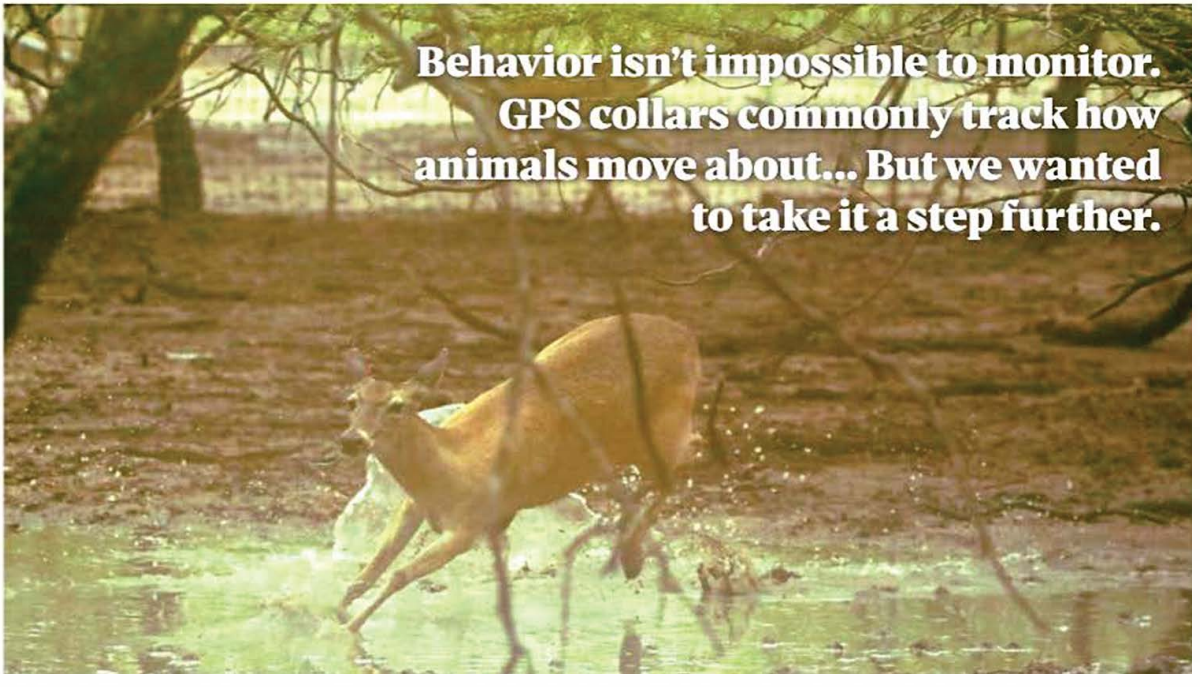
Of course, wildlife don't actually have popsicles to soothe overheated bodies, but they do decide how best to get on with their days while staying as cool as possible. Namely, they adjust their daily schedules: when they eat, sleep, socialize and visit water. Hot days are best spent doing as little as possible, while the cooler nights can be used to catch up on all those procrastinated activities.

White-tailed deer are naturally crepuscular (active during dawn and dusk). This is in part because deer have greater visual sensitivities to shorter wavelength light and some sensitivity to ultraviolent light suggesting deer visual perception is specialized for crepuscular conditions. This also gives them a leg up on dealing with the heat. But what about when they've got a bun (i.e., a fawn) in the oven on top of the heat?

In South Texas, white-tailed deer breed in December and January, giving birth approximately 200 days later. Third trimester, birth and fawn rearing--the most energetically demanding periods of reproduction--coincide with the time of year where daytime highs frequently reach 95°-105°F in the region. It begs the question: how do these deer balance increased heat stress and energetic demands during reproduction? In the past, researchers have employed the use of vaginal implant transmitters (VITs) which are deployed following the rut and are expelled just prior to the birth event allowing researchers to capture fawns shortly after birth for studies on fawn survival. We, however, wanted to investigate what was going on before fawns were born, when does were dealing with the stress of high temperatures and the extra load of developing a fawn.

Behavior isn't impossible to monitor. GPS collars commonly track how animals move about, and cameras can capture when and who is visiting specific areas. But we wanted to take it a step further. After all, it's one thing to say an animal is doing something because they're pregnant or hot, it's another to link it to consequences of those behaviors.

Facilities like the Alkek Ungulate Research Facility at Caesar Kleberg Wildlife Research Institute provide the perfect place for conducting such studies. First, even with precise GPS coordinates, it can be difficult to infer behavior and how an animal used a given location. Secondly, to identify the effect of pregnancy, one would need adult does that weren't pregnant, a rare find in wild populations. With captive deer, we can selectively breed half of our does while using trail cameras on feeders to identify exactly who was feeding where and when. Additionally, we used



White-tailed deer can beat the heat by taking advantage of water, either by drinking it or, like this doe at the Albert and Margaret Alkek Ungulate Research Facility, immersing in it.

This approach allowed us to not only link behavioral changes to increased temperatures and demands of pregnancy status, but also to measure how these pressures influenced a physiological cost.

A Vaginal Implant Transmitter (VIT), often deployed in pregnant, wild deer to track birth events for fawn survival studies. We used modified VITs that recorded the internal temperature of deer to identify the physiological cost of pregnancy and high temperatures.

modified VITs deployed to collect the internal temperature of each animal every minute from first trimester through two months post-birth for two years. This approach allowed us to not only link behavioral changes to increased temperatures and demands of pregnancy status, but also to measure how these pressures influenced a physiological cost (i.e., maintaining a steady internal body temperature).

As mentioned before, deer are crepuscular. This behavior has lead hunter and wildlife enthusiast to refer to the twilight as the "golden hours" for deer activity. Unbred does exhibit this behavior strongly, especially when daytime temperatures increase. They'll visit the feeders at first and last light and that activity will be reduced during the day and night hours. Again, deer are crepuscular. That is a universal truth.

Until it isn't.

Pregnant does in our research challenged this pattern in the face of high temperatures and increasing energetic needs, exhibiting a 23% change in activity patterns compared to unbred deer. Instead of strongly patterned and predictable feeding activity around the "golden hours," pregnant deer maintained relatively even activity at the feeders throughout day and night hours. The energy demands to produce young along with the reduced rumen space due to the growing fawns result in animals that require more food but no ability to gorge and rest, as is typical for ruminants. Rather, these deer had to face the blazing heat of the midday South Texas sun to satisfy those pregnancy cravings.

Unsurprisingly, when presented with options, these pregnant animals chose feeders that provided some relief in the form of shade, choosing to bypass food that required being in direct sun to feed. While unbred does still preferred the shaded feed options when they were active during the day, they were also willing to use the sun-exposed option as well. This suggests that pregnant deer are more sensitive to environmental conditions than their unbred counterparts, and that while they need to forage more regularly regardless of time of day, the food available to them will be limited by sun exposure conditions at a given location.

The process of developing a fawn also caused pregnant deer to run internal temperatures higher than females that weren't pregnant, averaging around 1°F warmer regardless of outside temperatures or time of day. Additionally, when foraging in the sun, pregnant does were nearly 2°F warmer than unbred does that were also feeding in the sun. Night hours provided little relief; while cooler nights saw more similar temperatures between pregnant and unbred deer, hotter nights—a common occurrence in South Texas--resulted in pregnant deer again running nearly 2°F warmer than their unbred counterparts. Not only is that bun in

the oven turning up the heat, but it is also reducing the effectiveness of behavior changes meant to mitigate heat stress. When animals like deer can't dump the heat, their metabolism rises to compensate. But this burns energy needed to grow a fawn, which increases their foraging needs and the time they need to be active. Long-term fever-like temperatures can be detrimental to the health of the animal, so deer must decide between prioritizing their own needs versus those of their future fawn.

Unexpectedly, visits to water did not vary based on pregnancy status or outside temperature. This suggests that, like camels, deer are able to adjust the quantity of intake in response to other conditions, rather than strictly needing to increase visits. This can be especially advantageous in semi-arid landscapes like South Texas where water availability and temperature can vary throughout the day and season. After all, no one enjoys a hot drink on an even hotter day.

White-tailed deer are widespread across a large variety of climates and are renowned for their adaptability. Here in South Texas, they balance intense heat and competing demands for activity to successfully reproduce. While the increased energy demands push them into feeding more frequently throughout the day, they balance the stress of heat exposure by increasing selection of feeding locations which provide some refuge from the sun. Additionally, they may be able to compensate for higher water needs by increasing intake quantity rather than needing to find water more often. But their adaptability has limits. Despite these efforts, pregnancy induces a physiological cost of higher internal temperatures regardless of conditions, and a compounding cost when outside temperatures rise. These limits could have implications towards fawn recruitment when conditions promote prioritizing the does' health over pregnancy needs.

Ultimately, we can't expect deer to have limitless adaptability when it comes to these pressures. But perhaps we could help the efficiency of their innate behavioral modifications by considering how their needs on rangelands change with pregnancy and high temperatures. We know that they need to forage more to meet higher energy demands, but now we also know that they need that food accessible at all hours of the day. Of course, not all forage options are equally available to pregnant deer, and they may forgo accessible forage if the calories are not worth the heat exposure. Rangelands with characteristics which help lessen the degree at which deer must choose between foraging and staying cool (i.e., woody mottes for thermal refuge near forage resources) could help them continue to produce healthy fawns despite continued rising temperatures. After all, big bucks were once healthy fawns, and healthy fawns come from does who can best stay cool and keep their stomachs full.

Pregnancy caused deer to have internal body temperatures that were nearly 1°F warmer than their unbred counterparts and almost 2°F warmer when outside temperatures were high (>95°F). However, this doe successfully adjusted her activity patterns to meet her own needs and that of her pregnancy, producing a healthy and strong fawn.