Eye on Nature

FALL 2003 A publication of the Wildlife Diversity Branch *Getting Texans Involved*

Migration

By Kelly Bender

The rhythm of life takes on a variety of tempos: the gentle ebb and flow of day into night, the unrelenting changing of seasons from spring to summer, fall to winter, and the punctuated drives of hunger and satiation, fatigue and alertness. Woven throughout these changes and affecting many chains of species is the phenomenon of migration.

Ecologists define migration simply as the movement of an individual or population from one habitat, home range or climate to another. An extraordinary number of species engage in migration, and the purposes and mechanics of these migrations are as diverse as they are fascinating. Additionally, these migratory journeys affect the life history — and even the economy — of many other species, including humans.

Many different species migrate during their life. Garter snakes will move from denning grounds in the winter to foraging and mating grounds in warmer months. How the snakes navigate is still a mystery, but a combination of chemical cues (pheromones that are "smelled" by the snake), visual cues (landmarks), and celestial cues (sun compass and light polarization) all play a role.

The Mexican free-tailed bat also engages in migratory activities. Because the insects on which they feed are not active during the winter months, bats must either migrate to warmer climates with more insect activity or hibernate. Different populations of these free-tail bats have adopted different wintering strategies. The more western populations tend to engage in hibernation or periods of inactivity (torpor) during the coldest months, and they may lose up to half of their body weight. The free-tail bats found in most of Texas migrate to Mexico in the winter and then back to Texas in the spring. The mechanisms that bats use to navigate have not been well-studied, but it appears that visual cues and landmarks, sun compass and echolocation are employed. In addition to the dangers faced by all migrating animals, bats are susceptible to pesticides which have accumulated in their fat stores. As the bats use up their fat reserves during the stressful migration period, the resins of these pesticides are released into the bat's system. In some cases the effect is devastating.

Another species that is susceptible to pesticide use during migration - and throughout its life - is the Monarch butterfly. The Monarch participates in a truly amazing migration, one that can cover thousands of miles and several generations. In the winter, one can find monarch butterfly adults roosting among fir trees high in the mountains of Mexico. Monarchs are amazingly faithful to their winter roosts, and generations will occupy the same sites year after year, even returning to the exact same their great-great grandparents had used. As the weather warms

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Texas Parks and Wildlife Department

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and the days lengthen, the wintering butterflies become more active and start moving down the mountains. They also mate and begin their journey northward, looking for milkweed on which to lay their eggs. It is this generation that re-populates the southern United States with monarch butterflies before it dies. The newly emerged generation of butterfly (or "flight") will continue its parents' flight northward and return to their parents' home. Here they mate, lay eggs and die. Summer flights only live a short three to five weeks as adults, compared to the much longer lifespan of eight or nine months for the overwintering flight. There may be three to four flights of summer Monarchs. The last of these flights will begin the amazing journey south back to the overwintering grounds of their ancestors.

Monarch butterflies are truly one of the most recognized and admired butterfly species in North America, and the roosting sites and migration routes are frequented by tourists eager to experience the wonders of nature. In Mission, Texas, an annual fall Butterfly Festival attracts visitors from the United States and other countries to observe the migrating Monarchs, as well as the other 289 species of butterflies, 487 species of birds, and 77 species of dragonflies and damselflies found in the region. The role that this migration plays in local economies is staggering: The Texas Department of Economic Development states that nature tourism brings a whopping $90 million to the Valley's economy each year. Birds and butterflies are certainly the jewels that draw tourists to Texas destinations, and some local economies have highlighted their own specialties.

Consider one of the most incredible journeys of one of nature's smallest birds: the ruby-throated hummingbird. This tiny sprite of a creature weighs only 1/10th of an ounce (almost exactly the weight of a penny!), and makes an incredible journey from Mexico and Central America in the winter, straight across the Gulf of Mexico (a non-stop flight), to breeding grounds throughout the eastern United States and southern one-third Canada. These seasonal movements may cover a staggering 1,500 miles. In preparation for the exhausting journey over the Gulf, a great concentration of ruby-throats will stop along the coast to restore their fat reserves. The community of Rockport-Fulton, Texas, has taken advantage of this happy occurrence by hosting an annual Hummer-Bird celebration. During the Celebration, recognized experts provide workshops on a variety of subjects, including hummingbird habitat, migration and natural history. In addition, participants are encouraged to participate in a hummer garden tour featuring hundreds of hummers buzzing about incredibly beautiful local garden habitats. This event draws hundreds of visitors to the community and is largely responsible for buoying the tourist season well into the fall months.

Not all neotropical hummingbirds migrate. Many species stay in the warm tropics both in the breeding and overwintering seasons. The journey is perilous and claims the lives of as many as half to three-quarters of all first-year hummingbirds. So why engage in such a dangerous pursuit? By flying to northerly latitudes, ruby-throats are able to exploit the seasonal abundance of flowers available without the brutal competition that would otherwise be prevalent in their tropical habitats.

In preparation for this incredible journey, the little ruby-throat will gorge itself on nectar and tiny gnats and mites to increase its fat reserves and nearly double its weight. When the first brisk days of fall arrive in the northern part of its range, the bird makes its morning rounds to fill up on flower nectar and begins its journey southward. Flying during the daylight hours, the ruby-throat may take advantage of favorable weather patterns and tail winds, but never hitches a ride on the back of larger birds like geese or hawks, as some folklore asserts. Scientists puzzle over the exact mechanism that helps hummingbirds navigate the vast distances they travel during migration, but it seems that young and inexperienced hummers rely on an innate, genetically programmed mental map. If these birds are blown off-course by storms or other occurrences, they tend to continue on their journey following the altered route to a foreign destination. Older and more experienced birds rely not only on their preprogrammed map, but also on visual and other cues that they have learned from previous flights. These birds will compensate for the storm's movements, adjust their course and arrive at their normal destination.

With whatever mechanism, and for whatever reason, the number of migrating species found in Texas is truly amazing. During migration periods, these species are generally much easier to spot and are often found in spectacular aggregations. There are many destinations around Texas that feature nature-watching activities. Be sure to check out the Gulf Coast Birding Trails, state parks, local festivals, private ranches and other attractions that highlight nature's wonders. And this migration season, don't let nature pass you by!

Kelly is the Austin Urban Wildlife Biologist working out of Bastrop.

Migratory Insects

By Mike Quinn

Monarch butterflies are perhaps the best known migratory insect, but do other insects migrate? In fact quite a few insects annually embark on directional mass movements. Within the butterflies, most migrants are either yellow butterflies, known as Sulphurs, such as the Cloudless and Lyside Sulphur or they are in the Nymphalidae family. Examples here, in addition to the Monarch, include the American Snout, Gulf Fritillary, Common Buckeye and Painted Lady.

Some moths migrate as well, mostly agricultural pests in the family Noctuidae such as the Fall Armyworm and the Corn Earworm. These moths migrate at night in huge swarms so dense that they are regularly monitored by radar!

The largest North American moth, the Black Witch, flies year-round in South Texas, but migrates as far north as Minnesota from July to October. Several species of Sphinx Moths, family Sphingidae, occur in massive offshore swarms on oil rigs in the Gulf of Mexico. Caterpillars of Sphinx moths are commonly referred to as "hornworms" due to the short stiff horn-like projection off the end of their abdomens.

A number of species of dragonflies migrate, primarily along the coast and edges of large bodies of water. The North American dragonfly most frequently observed migrating is the familiar Common Green Darner. Nearly all other migratory dragonflies are Skimmers, family Libellulidae. Foremost among this group is the Wandering Glider which Sidney Dunkle in "Dragonflies through Binoculars" calls: "The world's most evolved dragonfly, it drifts with the wind as it feeds on aerial plankton. Over the ocean they fly day and night for thousands of miles."

The Wandering Glider is the only dragonfly found around the world including on many oceanic islands where it's the only dragonfly.

Butterflies, however, are the best studied migratory insects. They tend to migrate at low elevation in what's known

as the boundary layer. While more energy costly than migrating high with the prevailing winds, low elevation flight offers greater control and frequent opportunities to stop and nectar.

Butterfly migratory flight pattern is characterized as remarkably straight, regardless of time of season, time of day or wind. Objects in their path are by passed by flying over rather than by flying around. Like the Monarch, most migratory butterflies are at peak abundance during their fall passage.

In South Texas, the American Snout is sometimes mistaken for the Monarch, a species which it only vaguely resembles in size and color. What confuses people is the phenomenal population explosions and mass movements that the smaller orange and brown snout butterflies occasionally embark upon. Larry Gilbert, a lepidopterists at the University of Texas, reported the following from an earlier published account of a snout swarm. "In late September 1921 an estimated 25 million per minute southeasterly-bound snout butterflies passed over a 400 km front (San Marcos south to the Rio Grande River)." The original observers "noted that this flight lasted for 18 days. It may have involved more than 6 billion (6×10^9) butterflies!"

Raymond Neck, author of "A field guide to butterflies of Texas" and a former Texas Parks and Wildlife entomologist, was the first to find a correlation between weather patterns and snout outbreaks. He found that snout population size was positively correlated with the intensity and duration of dry periods immediately preceding drought-terminating rains.

The snout's caterpillar food plant, granjeno or spiny hackberry, is one of the dominant shrubs in the South Texas brush country. Granjeno is well adapted to this semiarid region with frequent droughts. When heavy rains come, this shrub puts on a "strong pulse" of fresh foliage.

Female snout's typically carry several hundred eggs each which they preferentially lay on the new leaves. These eggs and the resulting caterpillars, pupae and adults are thought to have a high survival rate due to drought induced low population level of predators and parasitoids.

Something to think about next time you pull over to clear your radiator after driving through a swarm of American Snouts!

Mike is an invertebrate biologist working out of Austin.

One of the most amazing insect migration observations occurred on July 15, 2003 as the eye of Hurricane Claudette passed over Port O'Connor. Brush Freeman and two observers reported the following: "When the eye of the storm went over we went outside to the balcony to look for rare birds over the bay after winds went down from about 100 m.p.h. to near 0 in a matter of just a few minutes. The sky cleared and it got real hot. We were only in the eye for about 45 minutes to an hour before the other side of the storm hit and once again we had terrific winds.

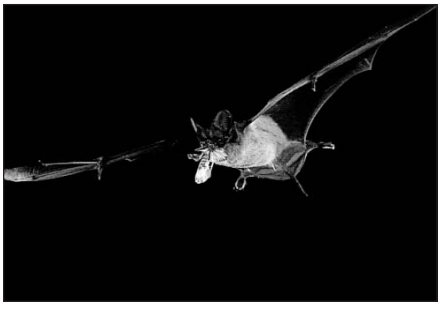
With the eye we had the largest concentrations of Black Witches any of us had ever seen. At any time with any scope view of the bay there was one to several to be seen. They were everywhere on the east side of town in the hundreds."

Bats and Migration

By Meg Goodman

Migration is an important component in the life history of many organisms. Although best known among birds, species of mammals such as some ungulates, cetaceans and bats migrate as well. Both tropical and temperate bat species use migration as one method of avoiding unfavorable conditions; other methods include hibernation or torpor exclusively or in combination with migration. In North America, migratory bats include temperate species that move relatively short distances (50-100 km) seasonally between breeding and hibernating roosts, north temperate tree bats that move south to winter (up to 1,000 km), and semi-tropical migrants that move north long distances to maternity sites and/or feeding sites (> 1,000 km).

Most of the 31 Texas bat species either migrate only short distances seasonally between breeding and hibernating roost sites, such as many Myotis species, or are non-migratory, entering a state of torpor only during the coldest months of the year such Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) in East Texas . Tree bats, such as the hoary bat (*Lasiurus borealis*) and the silver-haired bat (*Lasionycteris noctivigans*) are north temperate bats that migrate long distances spending the winter in the southern 1/3 of the United States including parts of Texas or even further south. Two Texas bat species that migrate long distances are semi-tropical bats that spend the summers in Texas, the Mexican free-tailed bat (*Tadarida brasiliensis*) and the Mexican long-nosed bat (*Leptonycteris nivalis*).



Mexican free-tailed bats are well known in our state as they form especially large maternity colonies in Texas caves and bridges. At least 100 million female Mexican free-tailed bats come to Texas to give birth to one pup each year. The largest Mexican free-tailed bat maternity colony in the world is found in Bracken Cave, which is located in Central Texas and contains 20-40 million bats. Pups are born in late June and can fly on their own by August, when many disperse to other roosting sites due to overcrowding of volant young and high ammonia levels in these caves. The onset of the first fall cold front causes the majority of Mexican free-tailed bats to migrate south to winter in caves throughout Mexico.

Mexican free-tailed bats have long, narrow wings and short fur that make them relatively aerodynamic and able to travel long distances, at least 1,000 km. These bats can fly up to 97 km/h (60 mph) with tailwinds, which also aid in migration. During migration, many stopover sites such as caves, bridges, buildings and bat houses may be used. It is important to protect these stop over sites as well as the winter and summer roosting sites, as each is important to the conservation of this bat.

Conservation of the Mexican free-tailed bat is critical as they are very economically and ecologically important. These bats can eat up to their body weight in insects, so the approximately 100 million bats that migrate to Central Texas can consume up to 1,000 tons of insects each night including many destructive agricultural pests such as the cotton boll-worm moth and corn ear-worm moth. This trend continues in Mexico where insect availability is good throughout the winter.

The other tropical bat migrant in Texas is a nectar feeder, the Mexican long-nosed bat. Mexican long-nosed bats follow a "nectar trail" along a 5,000 km loop, including the Sierra Madre Oriental in Mexico into the southwestern tip of New Mexico and the Big Bend region of Texas. This trail follows the sequential flowering of at least 16 flowering plant species which includes morning glories, columnar cacti and several species of agave or century plant, even the one that tequila is made from!

Females with newborn young and occasional male Mexican long-nosed bats migrate north to the Big Bend region and southwestern New Mexico to feed on blooming agaves or century plants during the summer. Landscape changes due to grazing and the harvesting of agaves for the legal and illegal factions of the tequila industry pose a significant threat to this species. Another threat in Mexico is the persecution of many bats, including the Mexican long-nosed bat, mistaken for vampire bats. Although vampire bats can cause problems for ranchers in Mexico, there is only 1 species of vampire among the 300 species of bats in Latin America that feeds on livestock. Mistaken identity as a "vampire" has contributed to the decline of the Mexican long-nosed bat. It has been listed as federally endangered in the United States and also listed on Mexico's "endangered species list."

During migration, bats occupy many habitats controlled by a wide-range of governments, agencies, communities, and private landowners. Collaboration in conservation efforts are essential to protect and manage areas and habitats needed by bats. In 1994 a program was formed between Bat Conservation International and important partners in Mexico entitled the Programa para la Conservacion de Murcielagos Migratorias (PCMM). This program was designed to formally promote cooperation between the various entities to conserve migratory bats through conservation, education and research. Since this partnership was formed, many significant Mexican bat caves have been identified and

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Bringing Back Whoopers

By Lee Ann Linam

What can cause grown men to don long white robes, dance, bugle, trill and flap their arms like wings? Maybe it's the pure adrenalin rush of looking outside your cockpit high above the heart of America to find yourself in a flight of fancy with a half-dozen of the most majestic birds in the world. Or maybe it's a slightly higher calling to restore a missing piece of the heartland and buy some insurance for a species that's as ancient as the very landscape of the continent.

The sight of those birds in flight is indeed a high point in the long road of recovery for the whooping crane—a road that has challenged the science and art of recovering endangered species. Captive breeding and reintroduction are the last hope for many of our endangered species, but it's a complicated and difficult endeavor (despite the earnest young student who wrote in the 2002 Hometown Horned Toads essay contest, "I think we should buy a bunch of them from Texas Parks and Wildlife and turn them loose so that they won't become extinct.") It's especially challenging when the species is migratory. Just how do you teach a whooping crane to migrate 1,000-3,000 miles twice a year? That has been the challenge facing the whooping crane recovery program over the past several decades.

Whooping cranes historically utilized habitats from the Arctic coast South to Central Mexico, and from Utah East to New Jersey, South Carolina, Georgia and Florida. At that time several different migration routes separated the whooping crane into several different breeding populations. By the 1940s, however, the tallest bird in North America could only be found in one migratory flock — one that wintered on the Central Texas Coast and nested at some then-unknown location in northern Canada. When a hurricane wiped out the tiny non-migratory flock in Louisiana, biologists felt even more

discomfort — all the whooper eggs were literally in one basket.

Captive breeding of whooping cranes began with the capture of a few injured birds in the 1940s, progressed under research conducted at Patuxent Wildlife Research Center and other facilities and collection of eggs from the wild, and finally reached a point where reintroduction to historic habitats seemed feasible by the 1970s. But how to teach a whooping crane to migrate was still the question. In some birds migration and migratory paths are inherited characteristics, but the close bonding between whooping crane parents and chicks for the first 10-12 months of life seemed to indicate that whooper chicks learn how to migrate from their parents.

The first solution tried was to let another similar, but more abundant species in the wild serve as the foster parent for whooping crane chicks. Whooping crane eggs from the wild or from captive breeders were placed in sandhill crane nests, and the sandhill cranes incubated, hatched, reared and introduced the whooping crane chicks into the wild. Cross fostering was tested at Grays Lake NWR in Idaho, home of a population of sandhill cranes that migrated to Central New Mexico. From 1975 through 1988, 216 whooping crane eggs were transferred to Grays Lake. The whooper chicks hatched, learned local diets and repeated the migration pattern of their foster parents.

But all was not well with the cross-fostered flock. High chick mortality was attributed to inclement weather at the time of hatching, poor habitat and food conditions during some years and coyote predation. Mortality was also high on the migration path, with a large number of birds hitting power lines. Most importantly, cross-imprinting of the birds produced whooping cranes that failed to pair with other whooping cranes. High mortality and the absence of breeding resulted in a relatively small population that peaked at 33 individuals in winter 1985 and died out in 2002.

After cross-fostering proved unsuitable, the Whooping Crane Recovery Team identified the need for testing other techniques. Since then, various modifications of leading captive-reared cranes behind trucks or ultralight aircraft, trucking them in the back of open vehicles, and releasing them with migratory sandhill populations have been tested. Researchers learned the visual stimuli obtained during flight seemed to be most important to the cranes. Birds transported along a migration route in cages in an open truck did not successfully repeat the migration, while those flown continually behind a truck did. In addition, birds returned in the spring to the sites where they were first flown free, rather than seeking their hatching site. Recognizing the need to prevent improper imprinting, most projects utilized isolation-rearing with caretakers in crane costumes, while one project used group rearing of chicks to promote proper imprinting.

While teaching birds to follow

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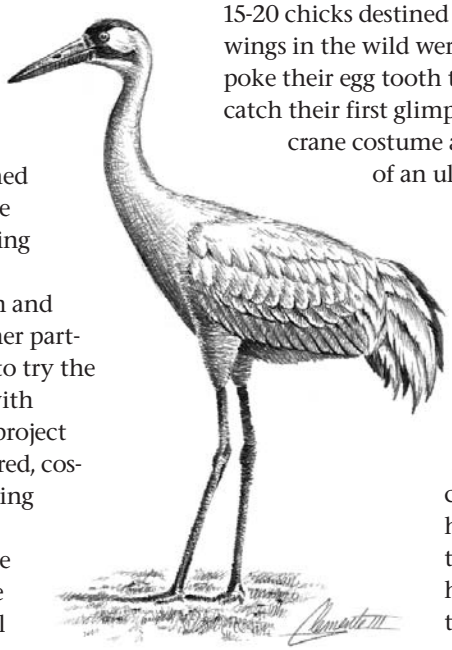
[Bringing Back Whoopers Continued]

vehicles or other birds seem to have promise, it was a more romantic idea (and possibly a more efficient one) that caught the attention of biologists. For several years researchers had been experimenting with techniques to teach reintroduced populations of birds new migration routes by imprinting them on a handler and an ultralight airplane. The techniques were first used on Canada geese (the story upon which the movie Fly Away Home was based). Since then researchers have successfully taught captive-reared geese, trumpeter swans and sandhill cranes to follow an ultralight from a release area south along a migration path to a wintering area. Most importantly, the released birds then migrated north on their own in the spring. Early experiments showed that trained birds also returned to the same (or nearby) wintering area the following fall.

In 2001 the U.S. Fish and Wildlife Service and other partners were finally ready to try the ultralight experiment with whooping cranes. The project team placed captive-reared, costume-imprinted whooping cranes on Necedah National Wildlife Refuge in Wisconsin during the summer. During the fall ultralights flown by costumed pilots led a group of seven whoopers south through Illinois, Indiana, Kentucky, Tennessee and Georgia to a wintering area on Chassahowitzka National Wildlife Refuge in Florida. Biologists celebrated in the spring when the six surviving cranes arrived back at their adopted home in Wisconsin.

The success was repeated in 2002 when 17 whoopers were flown south from Necedah to Chassahowitzka. The sixteen surviving cranes joined five cranes from the "Class of 2001" on their return north this summer (all but two flew directly to Central Wisconsin) ready to play their part in history and perhaps be used one day to teach young whoopers this new, yet old, migration path in a whooper-to-whooper reintroduction technique called 1x1 migration. Meanwhile, at Patuxent Wildlife Research Center and the International Crane Foundation this spring another 15-20 chicks destined to stretch their wings in the wild were just beginning to poke their egg tooth through the shell, catch their first glimpse of a whooping crane costume and hear the whirr of an ultralight engine ...

Find out more about the migration experiments, as well as updates about a reintroduced non-migratory flock of whooping cranes at: http://bringbackthecranes.org or http://www.operationmigration.org



Lee Anne is Texas Nature Trackers Biologist working out of Wimberley

[Bats and Migration Continued]

conserved and a successful education campaign has been implemented.

To find out more about these bats or programs to help these bats, please visit the Bat Conservation International website at www.batcon.org or contact Texas Parks and Wildlife Bat Coordinator, Meg Goodman at (512) 912-7042.

Meg is Bat Coordinator working out of Austin

[Wildlife Viewing Continued]

western diamondback rattlesnake is a resident. However, most snakes are reluctant to reside near heavy traffic areas such as marked trails and campsites.

Deer are a wonderful addition to any wildlife-viewing trip. Palo Duro Canyon has both mule deer and white-tailed deer that can be seen year around. Pronghorns may be sighted on the canyon rim, and aoudad sheep are also present in the park since their introduction into the area over 50 years ago. Other interesting mammals include bobcats, coyotes and ringtail cats. Many nocturnal animals are present and make a great source of entertainment for night hikes.

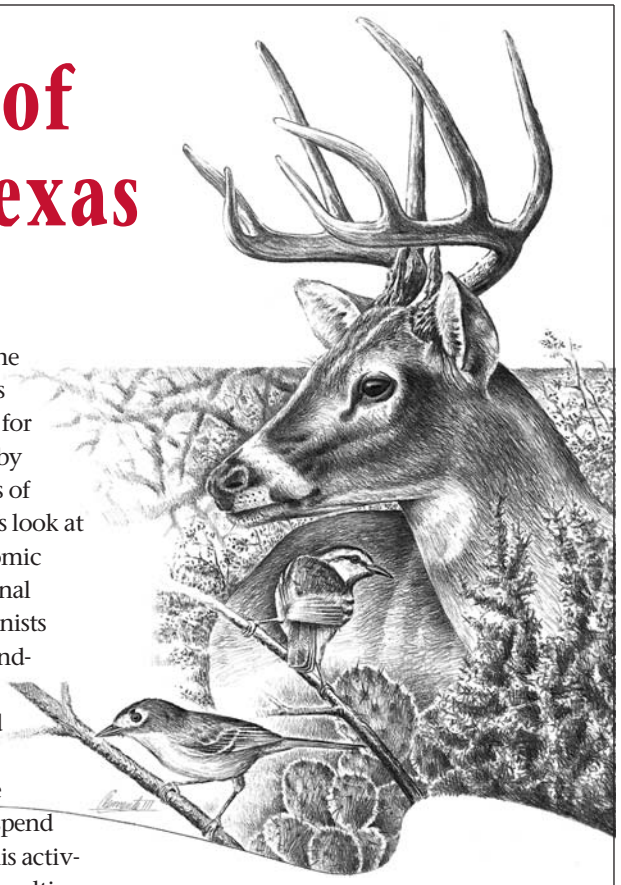
Visitors may take a break from wildlife viewing and enjoy the many plant species found in the canyon. Palo Duro Canyon derives its name from the Spanish phrase for "hardwood" which is in reference to the many junipers that dot the canyon walls and floor. Trees such as western soapberry, hackberry and cottonwoods are commonly seen in the park along with beautiful shrub species like the lemon sumac, agarito and yucca. Wildflower species are a wonderful addition to any hike. From early April through October, many flowering plants are found along the trails. Beautiful purples of star thistle, spiderworts and tansy asters along with golds of gaillardia, sunflowers and evening primrose are abundant in the summer. Prickly pear cactus and tasajillo are a few of the succulents commonly found in the park.

Palo Duro Canyon has over 35 miles of trails for hiking, biking and equestrian use. Many of these trails provide excellent wildlife and plant viewing opportunities. Visitors are encouraged to hike early in the morning in order to have the best opportunity to experience Palo Duro Canyon. For more information, please contact us at (806) 488-2227 or stop by the park. We are located about 12 miles east of Canyon on State Highway 217. From Amarillo, take Interstate 27 south to State Highway 217, and go east 8 miles.

Heather is an Exhibit Technician at Palo Duro Canyon State Park in Canyon.

The Economic Benefits of Wildlife Watching in Texas

By Linda Campbell



According to a recent report to Texas Parks and Wildlife Department by Southwick Associates there were 1 million residents and nonresidents of Texas who travel to observe, photograph or feed wildlife in 2001. These people spent 7.7 million recreation days pursuing these activities. Of those traveling to observe wildlife, 851,044 people were viewing birds and 600,712 were observing mammals (and a lot of people were looking at both). These travelers spent $228,779,736 on travel-related expenses. Texas residents and nonresidents spent $1.28 billion in Texas on equipment and services related to their wildlife watching activities.

Then there are those who watch wildlife at home. There are 2.9 million Texans who observe, photograph or feed wildlife within 1 mile of their home (nearly 3 times more than those who travel). More than 84 percent feed birds at home and 70 percent say they observe wildlife near their home. Feeding wildlife was the most common activity of those who stay close to home, whereas observation is the most common activity for those who travel. Texas residents spent approximately 221 million man-days observing wildlife around their home.

It is interesting to look at the demographics of those who enjoy wildlife-related recreation. According to the Southwick report, wildlife watchers in Texas are 97 percent white, middle-aged (50-51 years), with an average household income of $50,000 to $60,000. About 45 percent are male. In comparison, hunters in Texas are 92 percent white, slightly younger (40.5 years), 90 percent male, with average household income of about $63,000. Anglers (both freshwater and saltwater) are also mostly white (94 percent), average age of 40-45 years, mostly male (70-80 percent), with an average household income of about $47,000 to $63,000.

What does all this mean to the economy of Texas? It means Texas would be a lot poorer if it weren't for the economic activity generated by wildlife watching and other types of wildlife-associated recreation. Let's look at what economists call Total Economic Effect (Output) for example. Original expenditures by wildlife recreationists generate rounds of additional spending throughout the economy. Retailers buy more inventory and pay bills, wholesalers buy more from manufacturers, and all these people pay employees who then spend their paychecks. The sum of all this activity is the total economic impact resulting from the original expenditures. The total economic effect from 2001 fish and wildlife-related recreation in Texas was estimated by Southwick Associates to be $10.9 billion. In other words, if hunters, anglers and wildlife watchers stopped spending money in Texas and did not spend these dollars on other items in state, the Texas economy would shrink by $10.9 billion. Of this total, sport fishing accounted for $4.6 billion, with $3.6 billion and $2.7 billion from hunting and wildlife watching, respectively.

A big part of economic impact can be measured in the number of jobs supported by the activity. Expenditures for wildlife-related recreation support jobs throughout Texas. Some businesses serve recreationists directly, such as retailers and restaurants. Other businesses, such as wholesalers, utilities, manufacturers and grocers support the direct service providers. Total jobs, full and part time, supported in Texas in 2001 from fish and wildlife related activities were estimated at 96,700, with 41,300, 31,700 and 23,700 from hunting, fishing and wildlife watching, respectively.

Tax revenue generated by an activity is another way to look at overall impact to the local and state economy. According to the Southwick report, state sales tax generated from 2001 fish and wildlife-related recreation in Texas was estimated at $298 million ($278 million by residents and $20 million by non-residents). Wildlife watchers accounted for $80.3 million of the total, while anglers and hunters generated $124.8 million and $93.0 million, respectively. The federal government ultimately earns $453 million from fish and wildlife recreation in Texas via income tax revenues.

Tourism is the third largest industry in Texas according to the Texas Travel Industry Association, and nature-based tourism is one of the fastest growing segments of this industry. Nature related tourism offers Texans the opportunity to build and diversify economies based on conserving the natural resources and rural lifestyles important today and for future generations.

For more information, see www.tpwd.state.tx.us/nature/tourism/ or contact Nature Tourism Coordinator at (512) 389-4396.

Linda is Nature Tourism Coordinator working out of Austin

By Craig Farquhar

Raptors can be counted on to spark curiosity and wonderment in all of us. Many superlatives come to mind when describing them: magical, magnificent, majestic, marvelous, mysterious. Such adulation can certainly be directed to one of their most spectacular behaviors: migration. The awesome migratory behavior of raptors first attracted attention of European naturalists in the Americas in the early 1500s, before that Native Americans had been observing and worshipping them for millennia. Unfortunately, due to the fact that they migrate in such large numbers and in such dense concentrations, and because they have traditionally been vilified as vermin, they were shot with abandon and glee by father and son at most, if not all major hawk migration points in the U.S. Finally, in the 1930s this activity declined thanks to federal legislation and grassroots conservation efforts, and a new appreciation of this natural phenomenon began which continues to this day.

In contrast to hummingbirds, warblers and shorebirds whose tiny bodies are continually buffeted by unpredictable weather, and which must expend massive amounts of energy in continuous flapping flight across great nonstop distances, raptors make their journeys with comparative ease. Smaller birds must store tremendous amounts of fat (up to 50% of body mass in some species) in order to make their long, perilous journeys. Smaller birds typically migrate by night which helps them avoid predation, but which denies them the ability to take advantage of vertically rising warm air masses characteristic of daytime heating. Such air masses, called 'thermals,' serve to provide lift for diurnal raptors, and drastically reduces the need to spend energy in flapping flight.

All migrant raptors utilize thermals to some degree, but Broad-winged Hawks and Swainson's Hawks are particularly dependent on them. During migration these hawks remain perched, in trees, on fence lines or even on the ground, until ground temperature is high enough to heat the air and make it move upward, creating a thermal. When this happens the birds fly toward the thermal in search of just the right spot to extend their wings and allow the upward moving air to hold them aloft. Ornithologists call this type of flight 'static soaring,' and it requires very little energy compared to flapping flight. In order to remain inside the thermal, the hawk will tilt its wings and adjust its tail just enough to allow it to rotate in a wide arc. To an observer on the ground this gives the appearance of a swirling, spiraling movement. Add to this hundreds, thousands and even tens of thousands of swirling, spiraling hawks in many groups ('kettles') and you are witness to one of nature's most alluring and dramatic displays.

Hawks will remain in a thermal until it no longer lifts them, usually not more that 3,000 – 4,000 feet above sea level. At this point they merely soar in a slight descent to the next available thermal. In the larger species this is accomplished without having to flap their wings. They repeat this process of gliding from thermal to thermal all the way to their wintering grounds in South America in the fall, and back to their breeding grounds in the spring. As a result, these birds do not need to store the huge amounts of fat that smaller birds do. However, they tend to shift their dietary requirements somewhat. For example, Swainson's Hawks tend to prey heavily on grasshoppers not only in migration but on their winter grounds. This trait unfortunately led to disaster in the mid-1990s when it was discovered that a wintering population in Argentina had been eating grasshoppers laden with toxic pesticides resulting in the seasonal extermination of some 20,000 Swainson's Hawks, approximately 5% of the world's total population of this species. That problem has since been remedied and the hawks seem to have rebounded.

With 35 species Texas has the greatest number of diurnal raptors (including vultures) in the U.S. Twenty (57%) of these seasonally travel from breeding to non-breeding areas. One of Texas' most notorious hawk watching sites is located at Hazel Bazemore County Park west of Corpus Christi, Texas in Nueces County. Over the last five years (1998-2002) the average number of hawks observed at this one site during fall migration is close to three-quarters of a million, fully 93% of which are Broad-winged Hawks! The top five species with the most individuals counted (in descending order, five-year averages in parenthesis) are: Broad-winged Hawks (666,763), Turkey Vultures (23,824), Swainson's Hawks (6,454), Mississippi Kites (6,443) and Sharp-shinned Hawks (1,211). Hazel Bazemore, and nearby Smith Point (at Candy Abshire Wildlife Management Area, another popular hawk watch site) are open to the public.

Craig is an avian ecologist working out of Austin

Post-breeding Dispersal and Migration of Hummingbirds

Along the Central Texas Coast

By Brent Ortego

Eight species of hummingbirds regularly occur in eastern Texas after the breeding season and there are many mysteries about their migration routes, tendencies to linger, site fidelity and survival. Some knowns are: millions of hummers pass through eastern Texas each year; hummingbirds tend concentrate at the edges of large waterbodies, rivers and creeks during migration; hummingbirds do not migrate on the back of geese; and it is not necessary to take your feeders down after Halloween, but it is recommended you keep them up until at least Christmas.

I have been banding hummingbirds along the Central Texas Coast since 1992 to study various aspects of hummer migration, site fidelity and survival. In recent years, I have been joined by Charlie Brower, Robert & Kay Lookingbill, Sumita Prasad, Glenn Swartz and Craig Zalk to conduct more expansive research. In the Table below the number of hummingbirds that we have caught each month from 1992-2002 at a study site near Victoria are reported.

This data is useful to look at relative occurrence of each species by month. Note the peaks of occurrence, and the number of hummingbirds that would be missed if feeders were put away after October.

The Ruby-throated Hummingbird is by far the most abundant migrant hummer in eastern Texas. It reaches its southern breeding limits in Victoria where only a few individuals nest. Millions migrate around the Coast each fall. There is considerable scientific interests in determining the exact routes this species uses. It is fairly well known that most of the species migrates from the tropics across the Gulf of Mexico to the eastern United States each spring, but the magnitude of its flight over the Gulf in the fall is not known. What we do know is that many more Ruby-throats migrate around the Gulf in the fall than in the spring making us believe that a large portion of the Continental population migrates around the Gulf after breeding. Dozens of banders in several states are attempting to answer this question. Data is too sparse to date to make conclusions. We also know that the greatest fall passages of Ruby-throats in Texas occur along rivers, edges of large lakes and the inland side of bays. Catch rates are several times greater at these sites than along the minor creek at the Victoria study area. In addition, individual Ruby-throats do not use the exact same route each fall, because there are virtually no recaptures of migrants in Texas. Very few Ruby-throats over-winter in Texas.

Black-chinned Hummingbird reaches its upper most breeding range along the Coast at Victoria with most of the species breeding west of I-37 and in the states to the north and west. The species is an uncommon migrant in August and September as most Texas breeders tend to fly south rather than eastward to the Coast in migration. It is not known how far up the Texas Coast breeding Black-chins disperse in late summer. More northern breeders from other states disperse at low numbers to the Coast where a few over-winter. Highest winter concentrations are close to the bays for added warmth from Gulf waters. Birds that do arrive in November tend to over-winter.

Anna's Hummingbird is a breeder along the Pacific Coast that infrequently strays to the Gulf Coast. Individuals tend not to linger and normally disappear a few days after arriving.

Broad-tailed Hummingbird breeds in the Rocky Mountains with individuals regularly straying to the Coast. They tend to linger with a number successfully over-wintering and returning in following years.

Rufous Hummingbird is the 2nd most frequent western hummingbird migrant in eastern Texas and tends to over-winter further from the Coast than other hummers because it is more cold tolerant. Individuals start arriving in East Texas in July with most of them leaving after a few days. Individuals arriving in late October tend to try to over-winter and are likely to return in future years to winter at the same site.

Allen's Hummingbird is an uncommon winterer on the Coast and has been proven by this study to be much more abundant than previously thought because banders can catch the bird and examine body features that are not easily observed by birders and that distinguish it from the very similar Rufous Hummingbird. Allen's mostly arrive in late fall and there are too few records to date to determine site preferences.

The diminutive Calliope Hummingbird is rare on the Coast and a few birds arrive to winter most years.

The Buff-bellied Hummingbird was at the northern limits of its breeding range at Victoria during the early 90's, but has since continued its range expansion a short distance up the coast and as far inland as Brenham. It starts post-breeding dispersal in August with a peak in September. This species is unique in that a small part of its population migrates northeast for the winter with most individuals migrating south to the tropics. The species has strong site fidelity and tends to favor evergreen woodlands near creeks and rivers; especially areas with high concentrations of Turk's cap.

This article is too brief to go into great lengths on the migration and dispersal of any species. Looking at capture rates, the Ruby-throat is by far the most abundant on the Coast with catch rates near bays and rivers being 3-10 times faster than sites away from these

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	July	Aug.	Sept.	Oct.	Nov.	Dec.
Ruby-throated	20	977	2741	645	12	6
Black-chinned	11	67	86	14	15	31
Anna's					6	1
Broad-tailed			1		8	16
Rufous		11	13	16	56	76
Allen's		1	3	3	7	12
Calliope						6
Buff-bellied	20	159	315	136	93	121

[Hummingbird Dispersal Continued]

features. During the 3rd week of September when the big pushes of hummers normally occur along the Coast there is a literal sheet of hummers flying south over eastern Texas originating in eastern North America being funneled to the Coast through a relatively narrow gap of about 100 miles wide.

We do not know of the origin of the rumors of hummers migrating on the backs of geese but it is humorous to think of this relationship and many others attributed to hummers. With geese mostly arriving from October through December, timing is not practical if the birds were somehow tolerant of each other. The hummingbird mostly migrates low to vegetation during daylight in the fall, frequenting tops of trees along rivers and just above grasses in the prairies.

Much is not known about migration strategies of each species. There is a tendency for birders to lump all hummers into the same strategy, but caution is needed in that each species has different biological needs and for the most part different breeding/winter grounds. Banding data indicates that most "western strays" are individuals born late in the current year and arrive relatively late in migration. If they survive the winter, they tend to return in subsequent years at earlier dates as adults. There has been considerable debate about western hummers flying directly to the Coast from their breeding grounds, or flying to Central America and making a wrong turn up the Coast to winter. Neither situation has been proven and, in all likelihood, both scenarios occur.

Hummingbirds that potentially winter in Texas tend to linger in areas of abundant insects and flowers. They will be forced to residences with feeders after frost kills available native food. Thus, it is important for over-wintering hummers to have feeders available in late fall. We recommend maintaining fresh sugar water in feeders until at least Christmas to determine if there are any over winterers in your area.

One thing that is certain is that hummers are interesting to study. There is much to be learned and we should try to avoid using generalizations.

Brent is a Wildlife Diversity Biologist working out of Victoria

Great Spots for Wildlife Watching During Migration

By Mark Klym

The migration theme in this Eye on Nature newsletter has me wanting to grab my binoculars, field glasses and camera and head out for a day of wildlife watching. One of the common questions asked though is "where is the best place to go to watch migrants?" This question can only be addressed by another question "what are you looking for, how much time do you have and where do you want to go?" The points below may provide some insight into the wonderful wildlife watching opportunities afforded by migration in Texas. These are simply some of my personal preferences - Texas offers a great diversity of wildlife viewing spots at any time, but especially during migration

- High Island - one of the migration hot spots on the Upper Texas Coast is especially popular when migrant warblers and other songbirds are crossing the Coast in spring. Part of the Bolivar Loop on the Upper Texas Coast section of the Great Texas Coastal Birding Trail, migrants can occur anywhere. Spring and fall find this location very popular with the birders.
- Bolivar Flats - excellent shorebird viewing as well as gulls and terns this property is at the base of the north jetty protecting Galveston Bay. Other possibilities include the Nelson's Sharp-tailed Sparrow, though they are more of a winter bird.
- Rockport- Fulton area - well known as a Hummingbird hotspot, thousands of migrating Ruby-throated Hummingbirds will congregate in this community in early September. The community caters to the hummingbirds, with beautifully landscaped gardens decked out to invite these avian visitors. Other birds are also moving through this area during migration season, and shorebirds are common on the beaches.
- Valley Nature Center - located in the beautiful Rio Grande Valley, the nature center is particularly attractive to butterflies and a good spot to see migrating Monarchs, Red Admirals, Snouts, yellows as well as several migrant birds and hummingbirds.
- Santa Anna Hawk Watch — visitors are always welcome, especially if they are willing to keep an eye to the sky for migrating raptors during the hawk watch at Santa Anna National Wildlife Refuge south of Alamo. The refuge is home to a number of valley specialties as well as a great spot to view some of the migrants that move through this area each year. Butterflies can best be seen at the gardens behind the visitor center as you leave the Hawk Watch.
- The Texas Hill Country is one of the spots where movements of migrating monarchs can be seen. People living along the streams and creeks near Fredericksburg have occasionally reported mass roosts of the butterflies, and moderate numbers can be seen moving around some of the specially landscaped areas in town.
- Davis Mountains - an excellent area to view migrating hummingbirds, in mid August as many as nine species have been seen in a single weekend of easy viewing by visitors to this area. Other western migrants can also be seen in this mountain island area of the Chihuahuan Desert. The elevation makes this area surprisingly comfortable even in mid-summer.
- Muleshoe National Wildlife Refuge - imagine hundreds of "prehistoric birds" swooping in to roost in shallow lakes as you stand on the shores watching. You don't need to imagine it if you visit this refuge in northwest Texas on the New Mexico state line. Sandhill Cranes make this an annual stop, and the resulting wildlife viewing is phenomenal!
- Areas around Lubbock including the highway from Lubbock to Dickens can provide some excellent shorebird migration opportunities.

Mark is an Information Specialist working out of Austin

Migrating Mussels?

By Marsha Reimer

Many Texans are unfamiliar with the variety of bottom-dwelling freshwater mussels, commonly called "clams" (family: Unionidae) found in our Texas water bodies. There are nearly 300 species of mussels in North America, and 51 or so in Texas alone (Howells et al. 1996).

Birds migrate and butterflies migrate, but what about mussels? Merriam and Webster (2002) define migration as: "to move from one country, place or locality to another". The ability of mussels to move within their habitat is greatly limited. Movement is achieved through the use of a highly muscular, flexible foot. This foot is usually used by the mussel to burrow into benthic sediments, wedge into crevices or under rocks (McMahon 1991). They can also use this foot to move from one place to another, but this varies greatly among species (Howells et al. 1996).

Texas has only one natural lake, Caddo Lake. All others are man-made reservoirs. Freshwater mussels in Texas evolved mostly in perennial river systems. Some require moderate to swiftly flowing waters and can not survive in lakes or reservoirs. One such mussel species is the Wabash Pigtoe (*Fusconaia flava*). This species is intolerant to changes in stream environments and populations are reported only in Texas creeks and rivers (Howells et al. 1996). Freshwater mussels that survive the altered habitat of a reservoir are usually found in the shallower shoreline. When the water level in a reservoir is lowered during a draw down, fish can swim to deeper water, but not mussels. The only options that mussels have are to dig in, move to deeper water or die.

The shells of freshwater mussels vary from the very thin and light shell of the Fragile Papershell (*Leptodea fragilis*) to the thick and heavy shell of the Washboard (*Megalonaias nervosa*). The Threeridge (*Amblema plicata*) is a heavy shelled mussel that can dig in during a draw down and survive. Whereas, the Yellow Sandshell (*Lampsilis teres*) is thought to be intolerant of dewatering because it is unable to completely close its shell and becomes dried out (Howells et al. 1996). They also noted that some sources suggest that the thin shelled Giant Floater (*Anodonta grandis*) and other anodontids have the ability to generate gasses or trap air bubbles allowing them to float from one location to another. Juvenile mussels can crawl with the use of the foot for considerable distances, but this form of movement is greatly reduced in some heavier adults (McMahon 1991). Howells et al (1996) stated that many of our Texas reservoirs have maintained low water levels in the past but with current fluctuations of drought and heavy rains, many mussels are now found in deeper waters. This was probably the case last March at Ray Roberts Lake in North Texas. We conducted the field portion of a Texas Mussel Watch workshop at the lake and found no freshwater mussels in the shallow waters of the shoreline. We didn't even find evidence of the ubiquitous, nonnative Asian clam. The lake levels had experienced fluctuations and during that workshop they were very high. If mussels were present at all, they were probably down in the deeper waters of the lake. McMahon (1991) stated that the adaptive significance of surface movement by mussels through sediments is not well understood.

Since the passage of the Endangered Species Act in 1973, 35 freshwater mussels have become extinct (Turgeon et al 1998). Why are we losing these marvelous creatures at such an alarming rate? The life cycle of most of our freshwater mussels includes a parasitic stage where the young attach to the gills or fins of a selected host fish. Some mussels even depend on a specific fish species to complete reproduction. If the host fish is taken out of the mussel's habitat, then they will be unable to reproduce. Overharvesting of freshwater mussels in Texas occurred sporadically during the last 100 years due to pearl rushes and button production but it peaked by 1990-92 due to the demand of the cultured pearl industry. This triggered the revision of Texas Parks and Wildlife Regulations in 1992-93 (Howells et al. 1996). During the 20th century, pollution, building of dams and other human related habitat changes also impacted populations of freshwater mussels in Texas as well as natural hazards such as scouring floods and drought. Their multifaceted life cycle, overharvesting, habitat changes and natural hazards all contribute to the fact that our native freshwater mussels are the most imperiled organisms in North America.

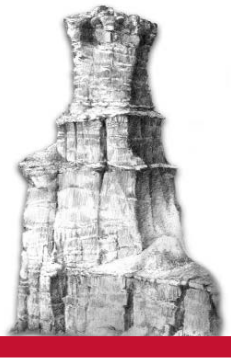
Texas Mussel Watch is looking for volunteers to help with monitoring Texas populations of these amazing freshwater mussels. For more information please visit our web site at: www.tpwd.state.tx.us/mussels

Marsha is coordinator of the Texas Nature Trackers program working in Austin

Wildlife Viewing at Palo Duro Canyon SP

By Heather Lanman

People from all over the world visit Palo Duro Canyon State Park to experience Texas wildlife at its best. This 18,438-acre park is teaming with beautiful lizards, graceful deer and comical turkeys. Wildlife viewing opportunities are available throughout the year, and the park contains many secluded trails and scenic areas in which to enjoy them.



During the spring and summer, many migratory birds arrive in the Texas Panhandle. Palo Duro Canyon attracts many species because of its rich habitat and water. In April, painted buntings begin to make their appearance with their beautiful plumage and Mississippi kites glide gracefully through the air. Turkey vultures and red-tailed hawks are also commonly seen soaring below the canyon rim. Vivid cardinals and chatty golden-fronted woodpeckers are common residents throughout the year. As temperatures cool, visitors may also catch a glimpse of scrub jays and robins.

Palo Duro Canyon is home to a myriad of reptiles. During the summer, many hikers are sure to catch a glimpse of beautiful turquoise collard lizards perched on rocks. Checkered whiptails and prairie lizards are also seen as they dart among the brush. Visitors may come across the rare Texas Horned Lizard (a.k.a. horny toad) as it feasts on ants. Other commonly seen reptiles include various turtle species such as the ornate box turtle and the spiny soft-shell turtle. Snakes make their homes among the canyon slopes and boulders. Hognose, coachwhips and bull snakes are commonly seen throughout the park and provide an exciting element to any hike. While the vast majority of snakes in the park are harmless, the more dangerous

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KEEP TEXAS *wild!*

The Back Porch – The Miracle of Migration

by John Herron

Migration is one of the wonders of nature. The wonder of a hummingbird flying 600 miles across the Gulf of Mexico. The miracle of a monarch butterflies traveling from Wisconsin to the mountains of Mexico, without any of them ever having made the trip before. What exactly is packed into that tiny Monarch brain — a map on a pinhead? The ability to make good guesses?

One hundred years ago, there were also bison and elk and antelope migrating across the plains. They relied in part on instinct, part on learning and were a wonder to the Native Americans and settlers who witnessed the migration spectacle of thousands of mammals on the move.

Birds are certainly the species we think of most often in regards to migration — perfect flying machines with wings and feathers to travel with and light-weight bones and adapted muscles to provide the framework and power for the machine. I can barely walk a straight line, let alone land an airplane, but I'm amazed every time I see a bird land and balance on a branch. I forget that on the grander scale, that same bird can fly 2,000 miles in 200 to 600 mile-a-day stints. What kind of computer can match the ability of what we derisively refer to as a "bird brain," delivering the package on time, every time, year after year? Our computerized cars are amazingly complex machines, but can't hold a candle to a bird brain.

Migration lets wildlife maximize the use of resources, move north into areas of plenty each spring and move out when the resources are gone. It's a strategy that has worked for these species for tens of thousands of years.

But Texas has changed a lot in the past hundred years — ten thousand years of migration habits aren't easily changed. We've lost the vast majority of the wetlands that waterfowl and shorebirds depend upon as resting and foraging areas during their migration. We've lost the coastal and blackland prairies that once teamed with wildflowers for monarch butterflies and provided prey for migrating raptors and songbirds.

Imagine having a highly-evolved car that can go 500 miles on a tank of gas — what if there weren't many gas stations any more and you found that it might be 450 miles, or 550 miles to the next gas station? It's the same for migrating wildlife — are they going to be able to count on finding that next "gas station" they need on their trip?

As this migration season passes, consider the needs of those wild species that used to consider your backyard their stopping place. Provide habitat whenever you can, in whatever amount you can. And support the protection of our remaining habitat gems — they are fewer and farther apart, but they are there as home and refuge to hundreds of species ... us included.

John is Branch Chief of the Wildlife Diversity Branch working in Austin.

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