Dedicated to Turtle & Tortoise Conservation, Preservation, and Education Since 1964

California Turtle & Tortoise Club

The Tortuga Gazette

Volume 58, Number 2 • March/April 2022

A wild geometric tortoise, *Psammobates geometricus*, photographed in habitat in the fynbos biome in the Western Cape province in South Africa. Photograph © 2020 by Tyrone Ping

featured species

Geometric Tortoise, *Psammobates geometricus* (Linnaeus, 1758)

The Beauty of Geometry

by M. A. Cohen

One of the three members of the genus commonly called the tent tortoises, the geometric tortoise, *Psammobates geometricus*, is among of the most critically endangered tortoise species in the world today. The other two members of the genus are the serrated tortoise, *P. oculifer*, and the tent tortoise, *P. tentorius*. All three tent tortoises are indigenous to southern Africa, where they inhabit the arid and semi-arid zones within their ranges. All members of the genus belong to the Testudinidae, the family of tortoises, land-dwelling chelonians comprising some 40 species total.

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The current article will profile the geometric tortoise, a non-burrowing species regarded as the rarest tortoise on the African continent as well as the flagship species of the fynbos shrubland. The tortoise inhabits a comparatively small biome that includes fynbos and renosterveld in South Africa. A more detailed profile of these ecological zones appears on page 10 of this issue in the Turtle's Garden column.

The genus name, *Psammobates*, consists of two Greek word roots: psammo-, meaning sand, and -bates, meaning one who walks. Thus, the genus name literally means "sand walker." The species name *geometricus* comprises two Greek word roots, geo, meaning earth or land, and -metry, meaning measurement. The common name 'geometric' refers to the lines and shapes forming the species' carapacial patterns.

A geometric tortoise photographed in habitat in the Western Cape province of South Africa. **Photo © 2020 by Courtney Hundermark**

Scientifically described by the Swedish botanist and zoologist Carolus Linneaus (1707-1778) in 1758, the geometric tortoise is one of some 12,000 species of plants and animals named by Linneaus throughout his illustrious career. Credited with furthering the science of taxonomy (naming and classification), Linneaus developed the system of binomial nomenclature, the two-name system of classifying flora and fauna that is used by science to this day.

Depending on the source consulted, there are 40 to 50 species of tortoise worldwide. South Africa is considered a tortoise biodiversity hotspot with some 14 genera endemic to the bioregion, many of which are not well-studied.

Physical Description

Described as the "Fabergé Egg" of tortoises by the Turtle Conservancy, *P. geometricus* is widely regarded as being among the most beautiful tortoises in the world.

The species features a high-domed carapace with a dark-brown or black background. Bright yellow starred patterning fans out from a yellow center on each scute. Each of its four to six vertebral scutes and four or five costal scutes is moderately to prominently pyramided (Craig, 2017). Each carapacial scute displays pronounced "growth rings" (technically known as annuli).

The plastron of the geometric tortoise is typically yellow with brown or black markings at the seams. The head, neck and tail of the species are brown or black with irregular, yellow, web-like patterns. The species' forelimbs are generally dark-colored with large yellow scales while the hindlimbs are more uniformly dark in color (Psammobates geometricus, n.d.). Each forefoot has five toes, and there are four toes on each hind foot (Geometric tortoise - Capenature, n.d.).

Differences between male and female *P. geometricus* (known as sexual dimorphism) prevail in the species with the average female growing to a mature carapace length of 4.9 inches (125 millimeters) and a mass of 15 ounces (430 grams) while the male attains a length of 3.9 inches (100 millimeters) and a mass of 7 ounces (200 grams). Even the largest recorded individuals within the species rarely exceed 6 inches (15 centimeters) in carapace length.

The male's tail is longer and thicker and his plastron is more concave compared to those of the female (Craig, 2017).

The geometric tortoise is a sedentary

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A photograph of a geometric tortoise demonstrating how its cryptic carapacial markings help to camouflage the animal in habitat.
Photo © 2021 by nicholass123

and extremely wary animal that is exceedingly difficult to locate in habitat and makes every effort to evade capture. When caught, the tortoise expels its pungent urine as a defense mechanism. Unfortunately this behavior is apt to cause rapid dehydration and frequently results in the demise of the tortoise (Ferreira, 2016).

There are no recognized subspecies of *P. geometricus*.

Range and Habitat

Characterized by long, hot, dry summers along with shorter cool, wet winters, the Mediterranean climatic zone prevails in several locations worldwide along the western coastal areas of continents in subtropical latitudes between 30 and 40 degrees both north and south of the equator. Mediterranean climate zones include southern and central California, southern and southwestern Australia, central Chile, coastal regions around the Mediterranean Basin in Europe and northern Africa, and the Western Cape of South Africa.

Endemic to the "low-lying renosterveld shrublands of the Swartland, Upper Breede River Valley and Ceres Valley" in the coastal southwestern corner of the Western Cape province in South Africa (Geometric Tortoise – Capenature, n.d.), *P. geometricus* inhabits an extremely fragile and fire-prone ecoregion.

The geometric tortoise inhabits "low-lying open patches of uncultivated land with acidic, nutrient-poor, sandy soil" from 229 to 1970 feet (70 to 600 meters) of elevation (Hofmeyr & Baard, 2018) with an array of vegetation species, including herbaceous annuals, various grasses, shrubs, and shrublets. Additionally, the tortoise's habitat includes many types of geophytes, plants that grow and propagate by way of underground storage organs. Examples of geophytes include bulbs, corms, rhizomes, and tubers.

In the Mediterranean climate that exists in geometric tortoise habitat, the winter rainfall is typically 14 to 20 inches (350 to 500 millimeters per year (Turtles of the World: Psammobates Geometricus, n.d.). Incidentally, winter in the Southern Hemisphere occurs during the months of June, July, and August.

Historically the range of *P. geometricus* was considerably larger than it is currently. Various forces resulting in the significant contraction of the species' range are discussed in more detail in the "Threats" section of this article.

Renosterveld is the Afrikaans language name for the specific habitat in which the geometric tortoise presently occurs. The term renosterveld translates from Afrikaans as "rhinoceros field." The name derives from the presence of the black rhinoceros (*Diceros bicornis*) in the region at the time European colonists arrived and began farming in the area. Having been hunted to extirpation by colonists in the 18th and 19th centuries, the rhinoceros is no longer present in the locality but the name persists (Poulsen, 2015).

Reproduction

Most species of chelonian are subject to environmental, or temperature-dependent, sex determination, meaning that the incubation temperature within the nest determines the sex of the hatchlings. The geometric tortoise is one of only a few exceptions in the world of turtles. The sex of *P. geometricus* hatchlings is determined at the time the egg is fertilized by the union of genetic material from two parents, a process known as sexual reproduction.

P. geometricus females reach reproductive maturity at about 10 years of age. Mating takes place in spring (September to November in South Africa), and female geometric tortoises oviposit one to five eggs per clutch in spring and summer, laying one to two clutches per season.

Eggs usually incubate for five to eight months, and hatchlings typically emerge from the nest in fall (late April and May) following the onset of the seasonal rainfall when the ground is softened and seeds begin to germinate. Newly sprouted plants provide food and shelter for the hatchling tortoises (Geometric Tortoise – Capenature, n.d.).

Foods and Feeding

According the Baard, *P. geometricus* feeds on a variety of native flora, including geophytes, grasses, herbs, reeds, sedges, shrubs and small succulents. In a 2002 study conducted at the Elandsberg Private Reserve in the Western Cape Province, South Africa, a team of biologists documented the feeding habits of the geometric tortoise.

Based on direct observation of tortoise feeding behavior and scat analysis, the team recorded the consumption of some 27 different species of plants, primarily annual and perennial grasses and various geophytes [bulb and bulb-like plants] (Balsamo et al., 2004).

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According to several field researchers, wild geometric tortoises tend to choose "food plants with high levels of phosphorus, iron, soluble carbohydrates, and low levels of acid detergent fiber and lipids" while consuming the leaves, flowers, and fruit of their food plants (Craig, 2017).

Threats

"Human-induced alteration, degradation, and destruction have lead to irreversible alteration" of geometric tortoise habitat (Hofmeyr & Baard, 2018). Habitat fragmentation caused by agricultural development of wheat farming and vineyards, urban build-out, overgrazing by cattle, and uncontrolled wildfire have destroyed well over 90% of the geometric tortoise's former range.

According to Baard, "it is generally believed that the destruction of the habitat favoured by the tortoise has been the major factor which has led to its depletion in numbers" (Baard, 1993). Current estimates indicate that approximately 3% of the species' historic range remains, the other 97% having been cleared for agricultural and residential development.

Infestations of aggressive, invasive alien vegetation pose a serious threat to the native vegetation within the geometric tortoise's habitat. Non-native vegetation out-competes the native flora for resources and often excludes the desirable food plants favored by the tortoise.

Such alien plant species are called "water thieves" by the South African National Biodiversity Institute. In addition to encroaching on and competing with the native flora, alien invaders in the fynbos ecoregion increase the fuel load, thus contributing to the severity of wildfires (Martin & Burgess, n.d.).

Two of the worst alien offenders are species of Acacia that are native to Australia, the Port Jackson acacia (*Acacia saligna*) and the coastal wattle (*A. cyclops*). Typically these noxious shrubs must be eradicated manually because the use of heavy equipment would endanger the geometric tortoise together with its habitat. Suppression of the seedlings of nonnative species so they will not re-establish is an important part of controlling the undesirable vegetation.

Geometric tortoise close-up photographed in the Western Cape province. **Photo © 2016 by Hedi Stummer**

Significant predators of the eggs, hatchlings and adult geometric tortoises include mammals such as feral pigs, feral dogs, jackals, mongooses, baboons, and rodents, along with birds such as hawks, ostriches, storks, white-necked ravens, and pied crows (Ferreira, 2016; Craig, 2017).

P. geometricus is threatened by illegal collection for the black market pet trade. Its diminutive size, stunning carapacial markings, and rarity all contribute to its attractiveness to "collectors," resulting in the poaching of the species and further depletion of the wild populations.

Climate change poses a consequential threat to the species' habitat, and meteorological data indicates that droughts are becoming more frequent and severe, thus increasing the possibility of devastating wildfires. Fires caused by human activities such as traffic accidents are equally destructive to the tortoises' habitats.

Conservation

According to Hofmyer & Baard, "*Psammobates geometricus* has been included in CITES Appendix I since 1975, banning all commercial international trade, and is afforded protection under South African legislation."

As of its most recent assessment in 2017, the IUCN categorized the geometric tortoise as critically endangered with a declining population trend, "due primarily to anthropogenic land transformation" (Hofmeyr & Baard, 2018). The term 'anthropogenic' is defined as 'originating in human activity' and refers to everything from agriculture through cattle and sheep ranching to industrialization and urbanization.

Habitat restoration techniques such as active native plant reestablishment and controlled burning programs to eradicate invasive plants are being utilized to enhance native vegetation recovery in wildlife habitats (Martin & Burgess, n.d.).

During the period from 1971 to 1986, several nature reserves, both provincially and privately administered, were established in the southwestern Cape Province in attempts to protect the diminishing populations of *P. geometricus*.

Unfortunately, because some of these original preserves were comparatively small and isolated, the populations of geometric tortoises that previously inhabited them have disappeared in recent years (Turtle Conservation Coalition, 2018).

Scientists estimated that, as of 2002, only 2,000 to 3,000 individual *P. geometricus* existed in the wild, and its historical range currently consists of perhaps 31 habitat fragments including seven nature preserves (Martin & Burgess, n.d.).

This article will conclude with brief profiles of two of the remaining *P. geometricus* preserves.

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Elandsburg Nature Reserve

Established as a nature reserve in the 1970s, the Elandsburg Nature Reserve has been involved in the conservation of the geometric tortoise since its inception. At that time biologists estimated that a population of 1,000 to 2,000 *P. geometricus* existed in the Reserve (Ferreira, 2016).

However, a veld fire in 2012 swept through nearly 5,000 acres (2,000 hectares) of the Elandsburg Nature Reserve. This proved to be catastrophic for the geometric tortoise. When the veld fire was finally under control, biologists surveying the damage discovered that the population of tortoises in the reserve had been closer to 500 animals, and some 250 of them were killed in the veld fire (Ferreira, 2016).

The Reserve established a research and breeding program following the disastrous 2012 fire. Biologists captured 60 of the remaining tortoises for an ongoing head-starting effort. Because the species does not survive outside its native habitat, the head-starting program is located within the Nature Reserve.

Hatchlings from the breeding program are now subadults and, when they are sufficiently mature, are gradually being released into the wild to replenish the population.

Geometric Tortoise Preserve

Founded through a partnership between the South African Turtle Conservation Trust (a Turtle Conservancy affiliate) and the Rainforest Trust, the Geometric Tortoise Preserve began with the purchase of 897.5 acres (363.2 hectares) of natural fynbos habitat in 2015.

By developing working relationships with neighboring farmers and purchasing suitable parcels of land adjacent to the Preserve as they come up for sale, the Geometric Tortoise Preserve has expanded to 1,214 acres (491 hectares) as of 2021.

The most recent land purchase of 217 acres (88 hectares) includes a brick building that "will serve as a research station and community environmental education center" (Turtle Conservancy — Geometric Tortoise Program, n.d.).

To deter predation of the existing population, biologists are experimenting with 3D-printed geometric tortoise shells fitted with foul-tasting Playdoh limbs in an effort to "reprogram predators to avoid baby tortoises," a program similar to that being conducted in California's Mojave Desert on behalf of the desert tortoise.

Psammobates geometricus in habitat. **Photo © 2021 by Tristan Silver**

Ongoing surveys utilizing radio tracking, conservation detection dogs, and mark-recapture studies monitor the population of *P. geometricus* within the Preserve. Like other nature preserves, the Geometric Tortoise Preserve protects the total habitat — the fauna ***and*** the flora — that comprises this unique biome (Turtle Conservancy — Geometric Tortoise Program, n.d.).

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In Memoriam
Don Williams
June 1947 – January 2022

Tribute prepared by Abigail DeSesa

Don Williams' Facebook profile photo.

The brightness of CTTC's world is a little dimmer as we share the loss of Don Williams. Don's legacy is too meaningful to capture in simple words. We offer the following, acknowledging that it is a meager attempt.

Don, a devoted family man, is survived by his loving wife, Sherry, whom he married in July of 1982, his son Lawrence, his granddaughter Lauren, and grandson Lawrence, six bonus stepchildren, and nine bonus grandchildren all of whom he adored and will miss him dearly.

The Williams family: Sherry, Lawrence, and Don.

As a young man, Don enlisted and served in the United States Army, and was sent to Vietnam from 1968 through 1972. Like so many who served in the Vietnam War, Don returned to civilian life with the burden of PTSD. After years of struggling with its byproducts, Don joined Alcoholics Anonymous (AA). Don's deep commitment to being clean and sober is a large part of what made him the man we all know and admire. Through his fellowship with AA, he has been clean and sober for 24 amazing years. Don was a volunteer sponsor to many, many others battling their dependencies.

Don's eloquent words that graced the many desert tortoise chat rooms and Club meetings, and explained the many mysteries of that remarkable creature, have been silenced. His passion for sharing knowledge shows in the volume of his work.

Don created an outstanding website, a treasure trove of knowledge, which he shared with all of those desiring to provide the greatest care for their tortoises. All his efforts were always "for the tortoises" (www.donsdeserttortoises.com). Don has spent decades admiring, studying, and researching what one could assume is his spirit animal—the desert tortoise.

Don had a special talent where he could explain, in person or in writing, even the most complicated information about desert tortoises so all could easily understand it. To many California Turtle & Tortoise Club (CTTC) members, Don was affectionately referred to as their "desert tortoise guru" or "DT guru".

Don volunteered his time by serving in many key positions within the CTTC for more than two decades. It began with the Kern County Chapter while he lived in Bakersfield. Don served as their adoption chair and then as their chapter president.

After Don relocated to Port Hueneme, he became the president of the Santa Barbara / Ventura Chapter (SB/Ventura). While serving as the president for SB/Ventura, Don championed sponsoring a new branch that became a chapter, Santa Clarita Valley (SCV).

Don with members of the Kern County chapter.

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During SCV's early years Don served as their Vice President. Due to his expertise with the desert tortoise and his experience as a chapter adoption chair, he became the Executive Board's first appointed adoption chair supporting all the chapters' adoption chairs.

It wasn't long before he became the Executive Board Vice-Chair followed by Executive Board CEO. We were blessed to have him and can never express our gratitude enough for all he contributed to the California Turtle & Tortoise Club.

Don's desert tortoise Serenity enjoying hibiscus.

Don's family is tentatively planning a Celebration of Life gathering in June, 2022. If you would like to receive a notice regarding the event, please send an email to abigaildesesa@sbcglobal.net

We thank Don for everything he's taught us and what he has done for the captive desert tortoise, as he joins his beloved desert tortoise, Serenity, in everlasting peace.

§ § §

The following are thoughts and feelings about Don shared by several colleagues and friends for this memorial tribute.

"I was always pleased when Don would visit and attend our meetings. I knew I could call upon him to comment or explain, from a very experienced position, on some aspects of DT behavior or health. So sad. We were so blessed to have him."

—Robert Hazard, Valley Chapter

"Don to many of us was a friend who guided us to new ways of seeing what Desert Tortoises and other species needed outside the box. I considered him the "God" or "Guru" of Desert Tortoises living throughout California and shared regions. His knowledge has touched so many. Don was a great friend and mentor and shared with me ways of dealing with politics in clubs and more. He was a leader and mentor for many groups in the California organizations. We always shared the science of rearing Desert Tortoises in various climates. Don, you will be missed my friend. Thank you for your military service representing the USA, and thank you for your friendship I was fortunate to have for the past 15+ years." Rest in peace my friend.

– Kevin Norred, The Tortoise Home

Don speaking at a Santa Clarita Valley chapter meeting in 2015.

"The "Tortoise Guru's" voice is forever silenced, however, his words regarding The Desert Tortoise will live on! There are not enough words to express my sadness with the passing of Don Williams. He was never too busy to answer questions or share his expert knowledge about our endangered Desert Tortoise. I learned so much from Don and because of his generous words of wisdom, my tortoises are thriving. Thank you, Don. I will always be grateful for your friendship and your expertise. Forever Grateful."

– Frank Kaufman, Santa Clarita Valley Chapter

"Although I never got to meet Don in person, we had lots of correspondence and phone calls over the past 15-20 years which made me feel as though he was a friend. He was always willing to help out with a tortoise in need and was always willing to share any and all of his knowledge about Desert tortoises. I will miss not only his dedication to the tortoise community, but his wit as well. The only consolation is he is no longer suffering. May his memories live on in all of us, and may he rest in peace."

– Julie Gary Maguire, Turtle Rescue of Long Island

Don

He sat more than walked for life has its way.
Voice gruff and soft eyes, lead me to say…
Tell me more of this beauty, shelled creatures of God.
Feeding on earth, grasses and sod.
The young one's you loved tortoise table to roll.
Keeping the sunlight with ambient glow.
Many were cared for by your hands, long and thin.
Leading others to join, teaching to win.
The drum beats slower now, I hear it still.
The constant is change and forever its will.
Your voice silent like the turtle's call.
It will live in victory, until we all fall.

– Poem written by Heather Ponek, January 2022

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"I was so sorry to learn this. I've used his **donsdesertortoises.com** website for years to help me create the best possible captive desert tortoise habitat. I spoke to him, once, at a CTTC-Valley show and he talked to me about tortoise bladder stones and helped me to figure out what to do when it turned out the DT I'd inherited had a huge bladder stone. Don has done so much to help tortoises and also the people who keep them. I am so sad and so sorry at this loss."

– Carrie Hernandez, Valley Chapter

Don and Karen Berry visiting the Ojai Sulcata Project.

"I met Don at my first EB meeting after becoming Valley Chapter's treasurer. He had been pointed out to me as the "go-to-guy" when it came to desert tortoises, and later became known as our "desert tortoise guru". He reminded me of a retired biker in appearance, but that big smile and those soft blue eyes revealed a peaceful kindness. As we became friends, I learned his desert tortoise was named "Serenity", which confirmed his gentleness. Don was a great mentor, helped me learn a LOT about DT's, and was always ready with an answer for a question about "off-the-wall" desert tortoise behavior or how to best simulate natural life for them. My respect for him grew not only for his dedication to CTTC and willingness to help better the lives of tortoises, but also for how he gave back to help others overcome their personal hardships. Don, you left some big footprints on my heart, and I will miss you so much. Enjoy time with Serenity, and I'll see you on the other side, my friend."

– Karen Berry, Valley Chapter

Don at a Santa Clarita Valley chapter Christmas Party.

"I have lots of good memories of Dave both on the board and as a member. Don was always a most helpful gentleman and a super friend to the club. We sadly keep losing our wonderful friends but can keep those memories in our minds forever. Bless and keep Don and family in years to come."

– Dave Zantiny, High Desert Chapter

"I love you and I am going to be lost without you for a long time. I know you had to go and hope you breathe easy now. You challenged me to learn so I could be worthy to discuss and argue with you. You set the bar high for me and I am a better knowledgeable person because of it. I loved every minute of it even if at times I struggled, and I did, I am deeply thankful. The journey with you has been worth it all. I do hope you get to spend time with Serenity now. I know how much you missed her. Please look for me some time down the road my friend. I hope to see you again. Say hello to Dave and Robin for me. It is getting awfully lonely here."

– Abigail DeSesa, Santa Clarita Valley Chapter

"It was always about the animals for me, just spirits wearing different types of earth suits; all parts of the One in the beginning and the end."

–Don Williams, December 17, 2021

Cover of the San Diego Turtle & Tortoise Society's newsletter, *The Voice of the Turtle*, featuring the speakers at a 2009 desert tortoise seminar that included Dr. Todd Driggers, Dr. Michael Connor, and Don Williams.

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The Radiated Tortoise *(Astrochelys radiata)* is the 6th rarest tortoise in the world, and the heroes at Turtle Survival Alliance (TSA) are fighting for its future. As a non-profit, the TSA relies on support from the community. Zoo Med has pledged to donate pallets of their Natural Grassland Tortoise Food to TSA's Madagascar location 3 times a year. This food prevents shell and spinal growth deformities by matching the nutrient profile and high fiber content of a wild tortoise diet.

Join Zoo Med in supporting the TSA's conservation efforts; visit their website to learn more and how to contribute: turtlesurvival.org

TSA
turtle survival alliance

the Turtle's Garden
planting for chelonians
by M A Cohen

Introducing the Fynbos Biome and the Renosterveld Ecoregion

Habitat of the Geometric Tortoise

Baboon root (*Babiana lineolata*), a mauve-blue and white flowering member of the Iris family, and Upright Satyr (*Satyrium erectum*), a pink flowering member of the Orchid family, two bulb-like native geophytes photographed in bloom in the renosterveld habitat. Photo © 2021 by Nick Helme

The pronunciation of the term fynbos is [fayn-boss], a word that derives from Afrikaans, a West Germanic language spoken by the European colonists who settled and farmed in South Africa. The meaning of fynbos is "fine bush" or "fine-leaved," referring to the distinctive vegetation that is characteristic of the fynbos biome. The plant life in this Mediterranean-type shrubland is typically evergreen with thin, narrow, hard leaves, an adaptation to seasonal drought that enables such foliage to reduce water loss (Chadbon, n.d.).

The composition of the fynbos biome consists of two related vegetation types, namely the **fynbos** and the **renosterveld** plant communities. Both will be described in more detail below.

Having a Mediterranean climate, the fynbos habitat features the notable seasonality of long, hot, dry summers coupled with comparatively short, cool, wet winters. The biome includes both lowland and montane (mountainous) microhabitats. The focus of this column is the lowland portion of the fynbos biome, the habitat of the geometric tortoise.

Renosterbos (*Elytropappus rhinocerotis*), a member of the daisy family (Asteraceae), is the dominant species in, and namesake of, the Renosterveld vegetation type of South Africa. Photo by Abu Shawka. Public domain.

Fynbos

Belonging to the Cape Floristic Kingdom, the fynbos biome is located in coastal South Africa and is part of the smallest and most diverse of the six floral kingdoms recognized throughout the world, much more diverse than rainforest biomes. It is also the only floristic kingdom that exists entirely within a single country.

Fynbos temperatures are typically mild and frost is rare. Even the highest summer temperatures rarely exceed 86°F (30°C) except in the hottest interior valleys (Martin & Burgess, n.d.).

Although fynbos soils are characterized as "nutrient-poor" quartz-based sandstones and limestones (Poulsen, 2015), this biome is designated as one of the world's biodiversity hotspots with some 9,000 plant species, 6,200 of which are found no where else. Because of the comparative infertility of its soils, fynbos is not typically utilized for agriculture except where there is abundant rainfall and modern agricultural practices such as liquid fertilization are used. (Fynbos Biome, n.d.).

Given the low fertility of the fynbos soils, scientists are somewhat mystified by the remarkable array of plant species that are endemic to the biome. Theories explaining this diversity include the presence of microclimates and differing soil profiles within the region, and numerous vectors of pollination such as insects, birds, and mice (Poulsen, 2014).

The primary plant families present in fynbos are Restionaceae (grass-like flowering cape reeds), Proteaceae (proteas), Ericaceae (heathers), Rutaceae (rue or citrus family plants),

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and Iridaceae (irises). There are large numbers of annual and perennial grasses and geophyte species in fynbos as well.

In common with other Mediterranean-type ecosystems, fynbos is both "fire-prone and fire-adapted." The vegetation has evolved to burn at intervals of 10 to 14 years to rejuvenate vegetation that has deteriorated with age and to kill off pathogens (Poulsen, 2014). According to Plantz-Africa, the fynbos biome "must burn at between 6 and 45 years of age in order to sustain its plant species" (Fynbos Biome, n.d.).

Kangaroo grass, *Themeda triandra*, a native grass eaten by geometric tortoises. **Photo © 2020 by tonyrebelo**

Historically the fire season in fynbos occurs in late summer. Periodic fire plays an important part in nutrient cycling in this ecosystem, as there are some fynbos plant species that will only grow and flower immediately following a fire. Additionally, the heat, smoke and chemicals released during the fire are critical to some species' seed germination when the winter rains arrive finally (Poulsen, 2014).

Large quaking grass, also known as rattlesnake grass, *Briza maxima*, a geometric tortoise food plant. **Photo © 2012 by Harry Rose**

Blossoms of the king protea, *Protea cynaroides*, the national flower of South Africa. This is one of many species of protea native to the fynbos biome. **Photo © 2018 by Felix Riegel**

Renosterveld

According to botanist Zoë Poulsen, renosterveld is "one of the world's most species diverse Mediterranean-type shrublands." The term renosterveld, from the Afrikaans language meaning 'rhinoceros field' or 'land of the rhinoceros,' refers to a specialized vegetation type within the fynbos biome (Poulsen, 2015).

Renosterveld soils are fine-grained, granite- and shale-based clay and silt, and fertility is considerably higher than the typical fynbos soil (Fynbos Biome, n.d.). Because of this comparatively high fertility, most of the renosterveld lowlands have been cleared for agriculture, primarily to cultivate wheat and grapes. At least 95% of the historical renosterveld biome has been lost to agriculture and urbanization.

Renosterveld is the world's richest habitat for geophyte species, bulbs, corms, and rhizomes that produce a spectacular display of blossoms in August and September, spring in South Africa (Overberg Renosterveld Conservation Trust, n.d.).

The renosterveld territories are "one of the most threatened habitats on earth," highly fragmented natural environments in which 99% of the remaining fragments are less than 198 acres (80 hectares) in area. The majority of these habitat fragments are privately owned or managed. Surrounding these habitat enclaves are highways, agricultural croplands, and industrial and residential developments (Overberg Renosterveld Conservation Trust, n.d.).

Susceptibility to Wildfire

Mediterranean climates worldwide are experiencing increases in both the frequency and the severity of wildfires. Climate scientists identify a direct correlation between global climate change and wildfire: "Two-thirds of the 1.4-degree rise in average global temperatures since 1880 has occurred since 1975, according to NASA's Earth Observatory."

While the winter rainfall in Mediterranean climates promotes vegetative growth in the landscape flora, the summer heat and drought increase the flammability of the vegetation. Climate change generally results in an earlier spring season along with higher spring and summer temperatures, contributing to stressed landscapes that are likely to burn more easily (Lieberman, 2019).

Baboon flower, *Babiana angustifolia*, a geophyte belonging to the Iris family that is a food plant for the geometric tortoise. **Photo © 2020 by Brian du Preez**

Northern Baja California, southern California, and southern Oregon residents are keenly familiar with the Mediterranean climate cycle and its impact on the chaparral plant community, particularly those who reside within the chaparral-urban interface.

In South Africa this Mediterra-

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Blue ladieshand, *Cyanella hyacinthoides*, a geophyte member of the Asparagus family that provides food for the geometric tortoise. **Photo © 2011 by Roy**

nean-climate cycle frequently results in wildfires known locally as veld fires. The word veld means field in Afrikaans and refers to an open grassland or open country.

Although periodic fire is important for regeneration of the fynbos vegetation, when the burning of an area that is too frequent, it interferes with the natural cycle of seed production and growth, so the native plants are effectively destroyed and the area is subject to invasion by less-desirable alien plant species.

On the other hand, when fires are absent, the fynbos vegetation deteriorates as it ages and forest or thicket plant species may begin to overtake the area (Geometric Tortoise, n.d.).

In summary, the fynbos and renosterveld are unique and fragile bioregions in which "1,700 plant species are threatened to some extent with extinction" (Fynbos Biome. (n.d.). This is due to the fact that much of the fynbos vegetation is localized with very small ranges. Conservation measures that protect the geometric tortoise also preserve the distinctive, irreplaceable fynbos flora.

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Wild hyacinth, *Lachenalia contaminata*, a geophyte food plant eaten by the geometric tortoise. **Photo © 2020 by Samantha McCarren**

Galápagos Islands News

Data Shows Remarkable Recovery of Pinzón Giant Tortoises

Scientists estimate population of 975-1,100; Population growing for first time in more than 100 years

31 January 2022 — Results from a joint expedition between Galápagos Conservancy and the Galápagos National Park Directorate – part of the *Iniciativa Galápagos* (formerly the Giant Tortoise Restoration Initiative) program – reveal a remarkable recovery of the Pinzón Giant Tortoise (*Chelonoidis duncanensis)*. A team of 24 scientists and park rangers carried out the 10-day census in December 2021, nearly a decade after the eradication of black rats (*Rattus rattus*), an introduced species that, for more than a century, preyed on juvenile and hatchling tortoises.

The team also collected information on the state of Pinzon's ecosystems. Wacho Tapia, Director of Conservation at Galápagos Conservancy and leader of the expedition, indicated that the recovery of the Pinzón Giant Tortoise population has already begun to have a positive cascade effect on the overall health of the native plants and wildlife on the island.

Based on the data collected on the expedition, Galápagos Conservancy estimates that Pinzón's Giant Tortoise population is between 975 and 1,100. More importantly, the team

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Mike's Turtle Net Picks by Michael J. Connor, Ph.D.

A varied selection of recent articles, stories and sites on the Web that some of you may find as interesting as I did. This list is also posted at tortoise.org/turtlenetpicks/turtlenetpicks.html

A New Galapagos Giant Tortoise Identified By Genotyping Museum Specimens

Genotyping of samples stored at the California Academy of Sciences shows that San Cristóbal Island which is home to the domed *Chelonoidis chathamensis* once had a population of saddle back tortoises.

Expedition Fernandina

On March 3, Park Rangers will start scouring Fernandina island for a mate for Fernanda, currently the only known Fernandina Giant Tortoise (*Chelonoidis phantasticus*).

Save Red Cliffs Desert Tortoise Habitat

The Biden Administration has not acted to stop the Trump Administration highway through Red Cliffs desert tortoise habitat. Join 35,000 other folk and sign the petition.

Fernanda, the Fernandina Island giant tortoise found in 2019. Photo by the Galápagos Conservancy, and provided for media use.

No Listing for Sonoran Desert Tortoises

Yet again, the Feds denied endangered species list protection for Sonoran desert tortoises.

Metabolic Cost of Self-righting in Tortoises

Study published in Nature finds that self-righting in *Testudo graeca* is metabolically expensive costing around two times the mass-specific power required to walk.

Box Turtle Personality Study

Washburn University research measures differences in behavioral traits among a group of test turtles.

Head Started Black Soft-shell Turtles Released

Fifty-three young black soft-shell turtles (*Nilssonia nigricans*), known locally as Bostami tortoises, were released in Chattogram, Bangladesh.

Net Illumination Reduces Sea Turtle and Shark Bycatch

Simple green lights save sharks and turtles from drowning in fishing nets while keeping fishing profits up.

Turtles Fly Too

Turtles Fly Too coordinates "first responder" relocation efforts for sea turtles in trouble.

Face Mask Found in Sea Turtle's Poop

Judging by the number of dumped masks I've seen on trails and sidewalks I expected it would only be a matter of time before I heard this...

Green Sea Turtle Predicts Volcanic Eruption?

One of many media pieces covering the claim that "Tilly the green sea turtle" predicted the December 20, 2021 eruption of Tonga-Hunga.

Sea Turtle Research Databases

For the technical minded this page offers a succinct review of sea turtle database systems.

Ghanaian Soccer Players Work to Conserve Sea Turtles

Soccer players in Gomoa Fetteh, Ghana are guarding turtle nests from poachers and rescuing turtles captured by fishermen.

CTTC's Turtle And Tortoise Listserve

CTTC's Turtle and Tortoise list has now moved to io.groups. If you want to talk with other turtle and tortoise fans in a friendly atmosphere just send an email to: <CTTC-TurtleAndTortoise-list+-subscribe@groups.io>

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located 156 juvenile tortoises between 5 and 10 years old, all born after the eradication of rats. This means that, for the first time in more than a century, the Pinzón Giant Tortoise population is growing.

Despite these encouraging results, the population is not yet self-sustaining. Recovery of the Pinzón tortoise population to its historical numbers can only be accomplished through the continuation of the captive rearing program, in which tortoise eggs are collected and taken to the Fausto Llerena Giant Tortoise Breeding and Rearing Center. There, they are hatched and cared for until they reach the necessary age for survival in the wild, approximately between five or six years old.

For Galápagos Conservancy, it is gratifying to see the recovery of Giant Tortoises on Pinzón Island, but their return is also encouraging for the future of the island's ecosystem as a whole. According to Tapia, "The Pinzón ecosystem has recovered and offers better conditions for the survival of endemic flora and fauna, as a result of which we have observed a greater presence of animals such as Sparrowhawks, Galápagos Rails, Finches, and lizards; as well as plants, especially tree species such as Yellow Cordia (Muyuyo), Carob tree, and Cat's Claw."

—Galápagos Conservancy news release

Florida Approves Rule to Protect Diamondback Terrapin Turtles From Collection, Drowning in Recreational Crab Traps — *Center for Biological Diversity press release*

Tallahassee, Florida — 16 December 2021 — Following nearly two years of advocacy and a petition filed by conservationists and turtle experts, the Florida Fish and Wildlife Conservation Commission approved a final rule today to protect diamondback terrapins (*Malaclemys terrapin*) from wild collection and drowning in recreational blue crab traps.

The diamondback terrapin (*Malaclemys terrapin*). Photo by George L. Heinrich. Image provided for media use.

The rule requires owners of all recreational blue crab traps to reduce terrapin bycatch by using traps with rigid funnel entrances measuring no more than 2 x 6 inches or by installing bycatch reduction devices of the same size by March 1, 2023. The Commission opted to postpone consideration of similar requirements in the commercial blue crab fishery until staff complete a study of terrapin interactions with the state's commercial fishery.

"We're so glad Florida is working to protect our terrapins, but that work isn't done till the state addresses threats from the commercial blue crab fishery too," said Elise Bennett, an attorney at the Center for Biological Diversity who focuses on protecting Florida wildlife. "We expect the Fish and Wildlife Commission to promptly revisit the issue once it completes its own study. "In the meantime, this rule will give these beautiful turtles some protection from the more limited recreational fishery."

The final rule also prohibits collecting terrapins from the wild and possessing them without a permit. This prohibition will help reduce the removal of adult terrapins from the wild and make it more difficult to poach and traffic the species.

Diamondback terrapins, found along the Atlantic and Gulf coasts from Massachusetts to Texas, are the only turtles in the world that live exclusively in coastal estuaries. These estuaries are also home to blue crabs, which are trapped in crab pots by an active blue crab fishery.

Baited blue crab traps are known to trap and drown terrapins, while commercial fleets of traps are capable of steadily removing individual turtles until a population cannot sustain itself. Abandoned or lost traps, also called ghost traps, can capture terrapins by the dozen. Experts agree that blue crab traps pose the greatest threat to the diamondback terrapin's existence.

"Requiring bycatch reduction devices on recreational and commercial blue crab traps is the single greatest action the Fish and Wildlife Commission can take to protect terrapins in Florida," said George L. Heinrich, executive director of the Florida Turtle Conservation Trust. "We commend the Commission for requiring bycatch reduction devices on recreational traps and are hopeful protections in the commercial fishery will follow."

The Commission's forthcoming study of Florida's commercial blue crab fishery follows a large existing body of science regarding terrapin interactions with blue crab traps. In a 2020 statement, the Diamondback Terrapin Working Group, an organization of academics, scientists, regulators working to promote terrapin conservation, concluded that scientific data are "abundant and clear" that commercial and recreational use of blue crab traps threaten terrapin populations and bycatch reduction devices effectively reduce terrapin deaths with minimal effect on crab catch.

A group of leading international turtle experts also urged Florida to require the use of excluder devices on all crab traps in state waters based on the existing body of science, emphasizing that a fleet of blue crab traps is capable of removing enough individual terrapins to cause population declines — or wipe them out completely.

People who currently legally possess terrapins will have 90 days from the rule change to receive a permit to continuing owning them.

Background

The diamondback terrapin is known for its stunning diamond-patterned shell and speckled skin. It lives in coastal marshes, tidal creeks, mangroves and other estuarine habitats, where it primarily feeds on snails, clams, mussels and small crabs. The terrapin is potentially a keystone species in salt marshes and mangroves, helping to maintain the ecological health of those ecosystems.

There are currently seven recognized subspecies of diamondback terrapin, and Florida is home to five, three of which only live there. Florida also has the most coastal habitat of all the states in the species' range.

The International Union for Con-

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servation of Nature (IUCN) Red List ranks the diamondback terrapin's global status as vulnerable and describes its population trend as decreasing. Threats to the species include habitat destruction and degradation, road mortality, crab-pot mortality, sea-level rise caused by global climate change, pollution, boat strikes, predation, collection for commercial and personal purposes, and inadequate regulatory measures to address these threats.

In January 2020 the Center for Biological Diversity, Florida Turtle Conservation Trust and Diamondback Terrapin Working Group filed a petition asking the Commission to require bycatch reduction devices on all recreational and commercial blue crab traps in state waters. When affixed to crab-pot entrance funnels, these small and inexpensive devices prevent most terrapins from entering the pot while having little to no effect on crab haul.

Petition Seeks to Protect Southern Bog Turtle Under Endangered Species Act

North America's Smallest, Rarest Turtle Has Nearly Disappeared Across Its Southern Range

Asheville, North Carolina — 13 January 2022 — The Center for Biological Diversity filed a petition today urging the U.S. Fish and Wildlife Service to protect the southern population of the bog turtle as a federal endangered species in Virginia, North Carolina, Tennessee and Georgia.

The bog turtle, also known as Muhlenberg's turtle, *Glyptemys muhlenbergii*. Photo by Nathanael Stanek, Turtle Conservancy. Image provided for media use.

The bog turtle is North America's smallest turtle, measuring about the length of a human thumb. It is also one of the continent's most imperiled turtles: Its southern population has declined by at least 50% in the past two decades, and fewer than 2,000 individuals are left.

"These little turtles are on the brink of extinction, and they need help now," said Will Harlan, a staff scientist at the Center. "Bog turtles have been hunkered down in Appalachia for 20 million years, yet without federal protection they could be gone forever before we know it."

Habitat destruction and poaching are the primary causes of the bog turtles' steep decline. Bog turtles live in marshy wetlands that are being drained for development. Only 500 acres of mountain bog habitat remain across the turtles' entire southern range.

Bog turtles are divided into northern and southern populations. The northern population was listed as federally threatened in 1997, but the southern population was not, and in the past two decades, its numbers have plummeted. Only 14 viable sites remain across the turtle's entire five-state southern range.

Full protection as an endangered species would ensure that bog turtles and their remaining habitat are safeguarded. It would also require a federal recovery plan to restore bog turtle populations.

"Bog turtles are nearly gone. That's on us," said Harlan. "But there's still time to save them if we act now. With Endangered Species Act protections, these tiny turtles have a fighting chance."

— Center for Biological Diversity press release

Bog Turtle Facts

- The bog turtle is one of the most endangered turtle species in North America.
- Adult bog turtles rarely exceed 4 inches (10.2 centimeters) in carapace length. Hatchlings emerge from their eggs at ± 1 inch (2.5 centimeters) in length.
- Bog turtles are omnivores that consume their food both in and out of the water.
- Bog turtles prefer isolated bogs and wetlands fed by groundwater with acidic soil, thick moss, layers of mud, and short clumps of vegetation that let in sunlight.
- Bog turtles face numerous threats in habitat, including declining water quality, illegal collection by poachers, and mammal predators such as raccoons.

Meeting Schedule: March/April 2022

Click on your Chapter's website link for the latest program information which is posted as it becomes available.

Chino Valley
18 March; 15 April

Foothill
Meetings are on pause until further notice.

High Desert
14 March; 11 April

Inland Empire
4 March; 1 April

Kern County
14 March; 11 April

Low Desert
4 April: in-person meeting at the Living Desert Zoo

Orange County
4 March; 1 April

Ridgecrest
14 March; 11 April

Santa Barbara-Ventura
Meeting information to be announced.

Santa Clarita
Meeting information to be announced.

TOOSLO (San Luis Obispo)
Contact the chapter for meeting information.

TTCS (Long Beach)
19 March; 16 April

Valley
18 March; 15 April

"Turtles always strike me as devastatingly serious. If turtles could talk, I'd believe everything they said."

—Erin O'Brien, American actor (1934-2021)

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