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Maximum male body size in the Florida Softshell Turtle, *Apalone ferox* (Schneider, 1783), from the Wekiva River system, Florida, USA

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Abstract. The Florida Softshell Turtle (*Apalone ferox*) is a widespread freshwater turtle endemic to the southeastern United States. While females are well-documented to reach large body sizes, published records of maximum male size have remained comparatively modest, with the largest previously reported male measuring 324 mm in straight-line carapace length (CL). Here we document an exceptional series of large male *A. ferox* from Wekiwa Springs State Park and Rock Springs Run State Preserve, Florida. Across long-term monitoring (2007–2025), we recorded 16 males exceeding the previously published maximum size, with the largest male reaching a CL of 468 mm. This represents an increase of more than 100 mm relative to the heretofore recognized maximum for the species. We discuss potential ecological and environmental factors contributing to the presence of exceptionally large males within this protected, thermally stable, and resource-abundant spring system.

Keywords. Florida, freshwater springs, softshell, *Apalone*, record size

Introduction

Body size plays a central role in shaping reptile ecology, life history, and evolution (Schmidt-Nielsen, 1984; Shine and Iverson, 1995; Ricklefs, 2001). Turtles represent a unique case for examining sexual size dimorphism (SSD) as size is a critical factor in their life history, impacting their reproductive strategies, survival rates, and ecological roles within their habitats. Among turtles, SSD is common, often with females attaining larger body sizes that enhance reproductive output (Gibbons and Lovich, 1990; Iverson, 1992). However, geographic variation in body size and SSD can reflect adaptations to specific habitat types, with studies indicating that turtles in aquatic environments often exhibit female-biased SSD, whereas those in terrestrial habitats may show a male bias (Agha et al., 2018). Softshell turtles (Trionychidae) are highly aquatic turtles that exhibit unique morphologies and life histories yet remain underrepresented in ecological and life history research compared with other North American chelonians (Pritchard, 2001; Lovich and Ennen, 2013; Munscher et al., 2015a, 2025a, b). In North American softshell turtles (genus *Apalone*), there is marked SSD, with females obtaining much greater sizes than males (Pritchard, 2001; Ernst and Lovich, 2009).

While most studies on turtle populations have focused on size and reproductive output, one significant aspect to consider is the role of environmental factors in shaping sexual dimorphism, particularly as habitats undergo rapid changes due to climate change and urbanisation. For instance, variations in body size may reflect adaptations to local ecological pressures, such as temperature and food availability, which can influence reproductive success and survival rates differently for males and females (Rowe, 1997; Litzgus and Smith, 2010). Additionally, the interplay between size and habitat preferences can further complicate these dynamics, as species inhabiting resource-rich, stable environments may exhibit distinct patterns of sexual dimorphism influenced by local selective pressures (Gosnell et al., 2009). Understanding these relationships

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is crucial for developing effective conservation strategies, especially in fragmented ecosystems where habitat loss can exacerbate the challenges faced by both male and female turtles in their efforts for reproductive success and overall population stability. Given the global threat to turtles as one of the most vulnerable and threatened groups of vertebrates (Stanford et al., 2020; TCC, 2025), understanding these nuanced ecological interactions can help inform conservation strategies.

The Florida Softshell Turtle (*Apalone ferox*; Fig. 1) ranges from Alabama in the west, throughout Florida, and into parts of Georgia and South Carolina and has long been recognised for its extreme female-biased SSD (Meylan and Moler, 2006; Ernst and Lovich, 2009; Munscher et al., 2015a). Females may exceed 500 mm carapace length (CL), and the largest recorded female, from Lake Okeechobee in southern Florida, had a CL of 673 mm (curved CL 738 mm) (Pritchard 2001; Meylan and Moler, 2006). In contrast, males typically mature at < 250 mm CL and have rarely been reported to exceed 300 mm CL (Moler and Berish, 1995; Plummer and Mills, 2015; Meylan and Moler, 2006). The most recent comprehensive checklist of global turtle maximum sizes reports 324 mm CL as the largest documented male *A. ferox* (TTWG, 2025).

Since 2007, we have conducted long-term ecological studies of *A. ferox* at Wekiwa Springs State Park (WSSP; ca. 28.74°N, 81.48°W), expanding to Rock Springs Run State Reserve (RSR; ca. 28.81°N, 81.43°W) in 2016. These sites form the headwaters of the Wekiva River, a protected system of spring-fed habitats harbouring one of the densest known populations of *A. ferox* (Munscher et al., 2015a, 2020, 2025a, b). During this work, we encountered multiple males far exceeding the currently published maximum size. Herein, we present and contextualize these new records of maximum male size in *A. ferox*.

Materials and Methods

Fieldwork was conducted at WSSP (Orange and Seminole counties) and RSR (Orange County), both in central Florida. These second-magnitude springs discharge > 145–164 million litres of water daily while maintaining a stable temperature (~22°C year-round) and high water clarity (Scott et al., 2004; Walsh et al., 2009).

Figure 1. Adult Florida softshell (*Apalone ferox*) resting upon a bed of American Eelgrass (*Vallisneria americana*) in Wekiwa Springs State Park, with a school of Florida Gar (*Lepisosteus platyrhincus*) hovering above. Photo by Bill Hawthorne.

The streams emanating from the springs in the Wekiwa and Rock Springs area converge to form the Wekiva River, which is a federally designated National Wild and Scenic River. Both sites are surrounded by > 16,000 ha of protected uplands and wetlands, providing intact habitat and minimal anthropogenic disturbance. Additional details about the study area can be found in Munscher et al. (2015a, b, 2022, 2025a, b) and Hootman et al. (2025).

From 2007–2025, we conducted systematic turtle surveys via snorkelling and hand capture, supplemented by hoop-net efforts. Standard morphometrics (straight-line CL, carapace width, plastron length, shell height, mass) were taken with callipers to the nearest 1 mm, and turtles were weighted using Pesola or Ohaus scales to the nearest 10 g. Sex was determined via tail length and vent position (Moler and Berish, 1995; Ernst and Lovich, 2009). Recapture identification employed tattooing (Weber et al., 2011) and, since 2009, passive integrated transponder (PIT) tagging (Runyan and Meylan, 2005; Munscher et al., 2025a). We compared our observations to other published records.

Results

We recorded 16 male *A. ferox* that exceeded the previously published maximum of 324 mm CL. The largest individual measured 468 mm CL, representing an increase of 144 mm (44%) over the earlier recognized maximum (Table 1). Several additional males exceeded 400 mm CL, confirming that such large sizes are not singular anomalies but occur repeatedly in this population.

Discussion

Our findings increase the known maximum size of male *A. ferox* by more than 100 mm CL, with 16 individuals from the Wekiva River system surpassing the previously published maximum of 324 mm (Ernst and Lovich, 2009; TTWG, 2025). The repeated appearance of exceptionally large males suggests that this is not a single anomaly but rather a consistent feature of this population. The most plausible explanation lies in the unique ecological qualities of the Wekiwa Springs and Rock Springs environment. Other turtle species have been documented to attain larger sizes within spring-fed ecosystems that provide a stable thermal zone and year-round food availability (Walde et al., 2016).

Wekiwa and Rock Springs are thermally stable environments, maintaining a nearly constant temperature of approximately 22°C year-round (Scott et al., 2004; Walsh et al., 2009). Unlike turtles inhabiting rivers, ponds, or lakes that experience sharp seasonal fluctuations, softshell and other turtle species in these springs avoid the energetic costs of winter dormancy or summer drought. Instead, they remain active, forage, and grow year-round under conditions close to their physiological optimum (Siders et al., 2023). Additionally, turtles from warmer habitats have greater growth rates and larger body size than those from cooler habitat types (Gibbons, 1970; Rowe, 1997; Williamson et al., 1989). Equally important is the extraordinary productivity of the spring system. Wekiwa and Rock Springs support abundant resources, including fish, crayfish, snails, and aquatic insects, as well as plant matter that *A. ferox* opportunistically consume (Moll and Moll, 2004; Munscher et al., 2022, 2025a, b). Clear water and nutrient input from the spring discharge fosters a complex and diverse food web. For a wide-ranging predator like *A. ferox*, such consistent access to prey translates into the capacity to sustain accelerated growth and achieve unusually large body size (Munscher et al., 2025b).

Table 1. A series of 16 large male *Apalone ferox*, listed by their ID, measured at Wekiwa Springs State Park and Rock Springs Run State Preserve in Florida during the period 2007–2025. Measurements for straight carapace length (CL), carapace width (CW), plastron length (PL), and shell height (SH) are given to the nearest mm, weight to the nearest 10 g.

ID	CL	CW	PL	SH	Weight
10	342	259	257	105	3950
14	375	289	288	106	5630
18	332	264	251	100	4200
29	421	295	303	123	6400
33	407	299	313	125	6500
54	428	318	313	118	6000
56	370	265	272	109	4800
57	468	300	331	123	7160
69	367	271	263	100	4455
77	375	274	273	106	4851
80	345	265	250	101	3996
86	380	289	296	106	5000
91	348	265	266	102	4800
100	372	283	285	105	6100
110	374	275	273	100	5200
112	347	245	259	95	3850

Similar relationships between high food availability and exceptional turtle growth have been documented in other protected freshwater systems (Congdon and Van Loben Sels, 1993; Munscher et al., 2015b; Siders et al., 2023). Walde et al. (2016) demonstrated that multiple springs in north and central Florida support large and record sized Common Snapping Turtles (*Chelydra serpentina*). After excluding several possible explanations, they concluded that optimal growth conditions in these springs were responsible for the large sizes (Walde et al., 2016).

A final and likely contributing factor is that these turtles live in a protected ecosystem. For decades, Florida's softshell turtles have been subject to harvest for meat and the pet trade (Moler and Berish, 1995; Munscher et al., 2015a). In most unprotected waterways, the largest individuals, which provide the most meat, are the first to be removed, and this process can truncate the size distribution of populations. Indeed, Pritchard (2001) questioned whether samples of most softshell turtles globally truly represented their full size potential, as they are targeted for food almost everywhere. In contrast, WSSP and RSR are actively managed and protected areas where collection is prohibited, and enforcement is consistent. Munscher et al. (2025a) concluded that the population of *A. ferox* in WSSP still exhibited characteristics typical of protected areas, despite of a recent decline in total population size. The absence of harvest and poaching pressure has likely allowed males to survive long enough to realize their maximum growth potential.

Taken together, these factors, as well as thermal stability, abundant food, and protection from human exploitation, create conditions that permit male *A. ferox* to reach extraordinary sizes. In many ways, the Wekiva system may function as a refugium for this species, a place where its full biological potential can be expressed. This not only challenges assumptions about sexual size dimorphism in *A. ferox* but also underscores the broader ecological and conservation value of Florida's artesian springs. Documenting such exceptional individuals is more than an academic exercise; it provides a reminder of what is possible when species are afforded the environmental stability, resources, and safety required to thrive.

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