



TECHNICAL MEMORANDUM

TO: Chad Furl, Kristy Kollaus
FROM: Matthew Pintar (BIO-WEST)
DATE: **November 14, 2025**
SUBJECT: Summer 2025 Comal System Apple Snail Surveys

Executive Summary

Following the discovery of a live, adult apple snail in the New Channel of the Comal River in May 2025, the Edwards Aquifer Authority (EAA) coordinated with Texas Parks and Wildlife Department (TPWD) to better understand the level of potential impact this exotic snail might have in the Comal Springs ecosystem. Based on these discussions, preliminary literature reviews on this non-native species, and the on-going stressed condition of the Comal River during low total system discharge, EAA acted on this potential threat. In June, EAA authorized BIO-WEST to conduct routine surveys for apple snails throughout the Comal system that extended through September 2025. No additional adult snails (live or dead) or eggs were found during these surveys, and thus it appears the Comal system does not currently support a reproductive population of apple snails. However, review of the literature on non-native species of apple snails suggests that, in the absence of there being some other unknown limiting factor, the environmental conditions in the Comal and San Marcos River systems are highly suitable for apple snails. At this time, continued active survey efforts are not recommended, but people working in the system are encouraged to remain vigilant for any future occurrences of apple snail adults and eggs. Any future discoveries of eggs would be alarming and justify immediate removal and consideration for resuming monitoring.

Project Background

An adult apple snail (*Pomacea maculata*) was found in the New Channel of the Comal River on May 1, 2025 (Fig. 1A). The snail was found during Fountain Darter drop net surveys conducted as part of the routine Edwards Aquifer Habitat Conservation Plan (EAHCP) biological monitoring program. The snail was located between the Landa RV park and the wall below Wurstfest (approximately at 29.707°N, 98.130°W), and it was collected from the submerged aquatic vegetation on the shallower eastern side of the channel. Despite their occurrence in the San Antonio River, apple snails had not previously been found in Comal County or the upper Guadalupe River watershed.

According to the Texas Invasive Species Institute, apple snails are one of the aquatic invasive species of greatest concern in Texas (Texas Invasive Species Institute 2019) because they have been documented to feed on a wide array of aquatic macrophytes, reduce vegetation density, outcompete native snails, alter benthic communities, and serve as disease vectors (Burks et al. 2017). This discovery raised alarm for the potential effects that establishment of a population in the Comal system could have on the federally listed species native to the ecosystem. Breeding populations of these snails can be relatively easily

detected because adults lay bright pink egg masses above the water surface on vertical surfaces such as walls, boulders, trees, and other vegetation (Fig. 1B). However, despite their large size, adults can be more difficult to detect because they are aquatic and relatively camouflaged, often inhabiting submerged aquatic vegetation.

Following this discovery, EAA contracted BIO-WEST to conduct surveys of the Comal system aimed primarily at locating eggs and removing and destroying any eggs or adults that were found. Surveys were planned and conducted approximately once every ten days for the remainder of the expected breeding season (through September). A frequency of ten days was selected because eggs take 10–14 days to develop and they can be removed in that timeframe without hatchlings entering the water and potentially dispersing away from the site that the eggs were laid. The primary objective was to find and destroy any egg masses to hopefully inhibit the establishment of a larger apple snail population.

A public outreach and reporting effort was included in the proposal and contract; however, the City of New Braunfels notified the project team that they had already developed a non-native species alert brochure for this species. This brochure was intended to be circulated internally among the City of New Braunfels employees and recreational outfitter employees, but it was deemed that additional public outreach was not warranted based on one observation. In conjunction with the field surveys, a comprehensive literature review was conducted to assess the risks that apple snails pose to the Comal system and other similar spring systems of central Texas.



Figure 1. Apple snail images. A) The adult apple snail found in the Comal River (image by BIO-WEST). B) An adult and pink egg masses on a tree in Houston (B is a public domain image by Brady Reed).

Survey Areas

Following contract execution, surveys for apple snails were conducted on the following ten days during summer 2025: June 27; July 7, 18, 29; August 6, 19, 28; and September 9, 19, and 30. On each day, a team of two biologists traversed the Comal system on foot and kayak in search of apple snails (Fig. 2).



Figure 2. Biologists on kayaks surveying the lower New Channel of the Comal River, with an expected egg-laying site on the right (the vertical concrete wall).

The primary areas and methods used for surveys were largely consistent throughout the project period and ranged from Spring Run 3 downstream to the confluence with the Guadalupe River and up to Cypress Bend Park (Fig. 3). The focal areas of the surveys were selected based on the initial discovery location and because these were sections of waterways with artificial vertical channel walls and/or a large amount of aquatic vegetation. All survey efforts were on kayak or foot, with the exception of limited surveys with mask and snorkel that were performed when retracing through sections previously surveyed by kayak the same day. Our expectation was that searching for eggs would be the most efficient method of locating snails, while searching with mask and snorkel for adults, which might be hidden among vegetation, would be less likely to locate snails, more time-consuming, and thus less likely to cover as much area during each survey. The objective was to stop the establishment and growth of a population, which most effectively would be accomplished by finding and destroying eggs.

Additional areas of the system were surveyed as time permitted on one or more, but not all, occasions to expand the survey area in the event snails were living in non-focal areas. Surveys during most of the

summer began at 7:00 am in the New Channel to inspect surfaces before recreational activity in the river intensified. BIO-WEST biologists were also on alert for apple snails during other work conducted in the Comal system throughout summer 2025. The primary extent of surveys is illustrated in Fig. 3 and described below:

Section A: Surveys began at the confluence of the Old and New Channels, and surveyors kayaked up the New Channel to Landa Falls and Dry Comal Creek, back down to Clemens Dam, and then up the Old Channel to the crossing with Hinman Island Drive.

Section B: Next, surveyors kayaked from Cypress Bend Park down the Guadalupe River to its confluence with the Comal River, up the Comal River to the East San Antonio Street Bridge, and back to Cypress Bend Park.

Section C: Then, surveyors walked along the upper New Channel from Landa Falls to Landa Park Drive and continued along the southwestern end of Landa Lake (including Spring Runs 1, 2, and 3). This section also often had considerable floating vegetation mats that were closely inspected as there were often other snails, particularly *Marisa cornuarietis* (the invasive giant ramshorn snail), in these mats.

Additional areas surveyed in whole or in part on some but not all occasions were as follows:

Section D: Landa Lake above Pecan Island to the Upper Spring Run and Blieders Creek

Section E: Old Channel from Landa Lake to Hinman Island Drive

Section F: Comal River between Clemens Dam and the San Antonio Street Bridge

Section G: Guadalupe River from the downstream end of Cypress Bend Park to the Common Street Bridge

Section H: Guadalupe River from its confluence with the Comal River to the Mission Valley Dam directly upstream of the Faust Street Bridge

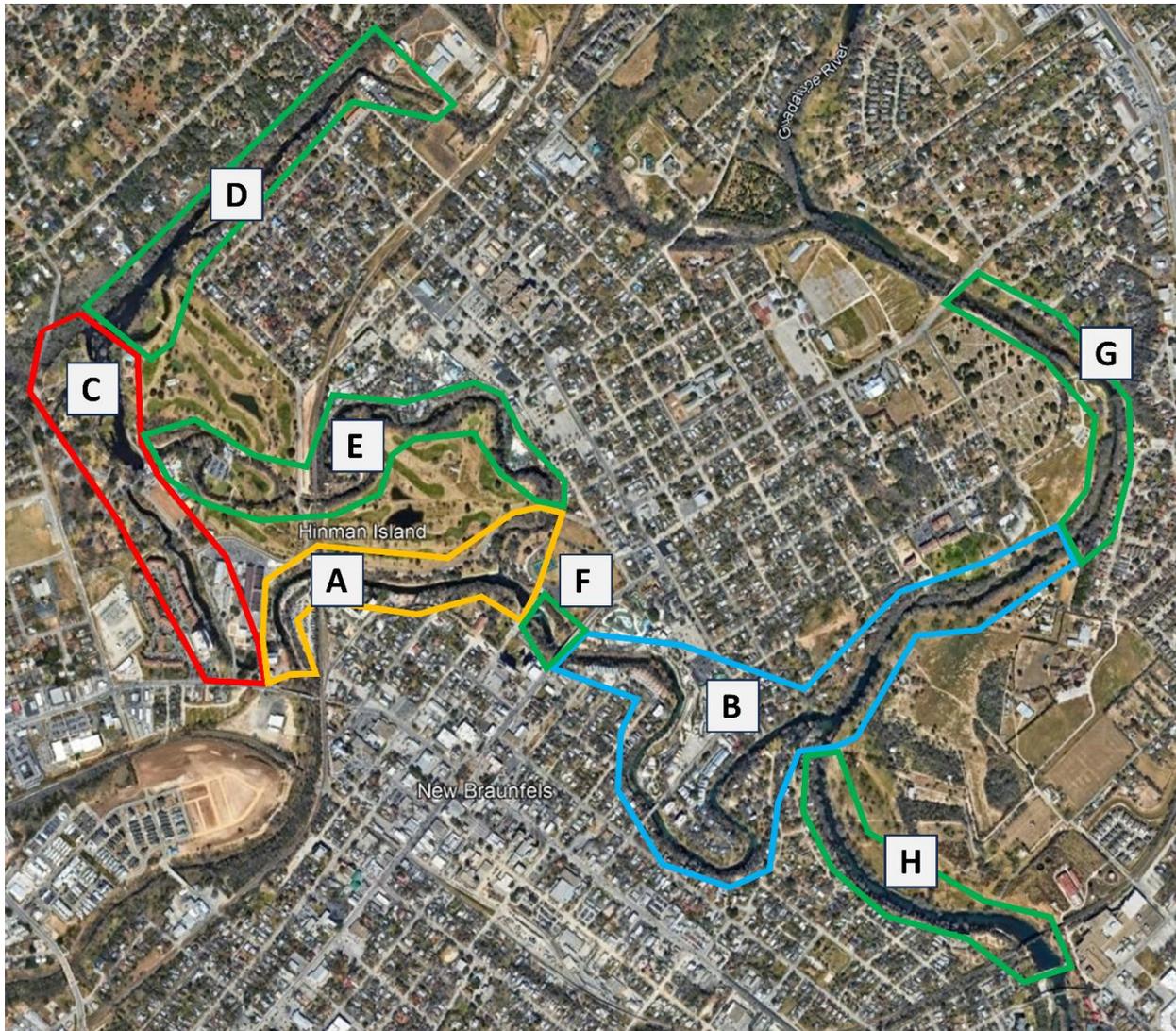


Figure 3. Map of sections of the Comal system surveyed for apple snails. Primary areas surveyed were in the order of A (orange polygon), B (blue), and then C (red) during each survey event; other sections (all green polygons) were surveyed on a limited number of occasions. See text for further descriptions of sections.

Survey Findings

No apple snail adults or eggs were found during any of the surveys. Potential explanations for these results include:

1. The adult found in May was an isolated occurrence. This could possibly be the result of a person who released a pet or an individual snail (likely as a small juvenile) that had been accidentally transported to the system through a pathway such as being attached to recreational equipment, transported aquatic vegetation, or a bird.
2. At the time of the surveys there was not a reproductive population of apple snails in the system. This could be because there was only one snail or that there were too few snails dispersed throughout the system that they could not reproduce and surveys could not find them.
3. Multiple high water flow events and flooding during June and early July reduced aquatic vegetation coverage and possibly disturbed and/or removed any snails that were in the system at the time. The peak flow of the Comal River was ~6,000 cfs on June 12, prior the commencement of surveys.
4. There is some unknown limiting environmental factor that renders the habitat insufficient and/or recreation is too excessive for supporting apple snail populations.

Although evidence for 1 and 2 above is simply the lack of snails found throughout these surveys, results of the literature review below suggest that habitat disturbance from extreme flows, vegetation coverage, and suitable habitat type and quality currently seem to be unlikely explanations for the lack of findings, if there were more snails in the system. However, existing literature does not include recreation as a potential inhibitor of apple snail populations, while other potential factors or combinations of factors cannot be ruled out as reasons why apple snails have seemingly not established in the Comal system. These possible explanations are expanded on in the literature review below.

Literature Review

There have been a few reviews and syntheses on various aspects of apple snail biology over the past 20 years (e.g., Howells et al. 2006, Horgan et al. 2014, Burks et al. 2017, Martín et al. 2019). Rather than replicate the work that has already been done, the topics reviewed here focus on those particularly pertinent to the spring systems of central Texas while incorporating new work that has been completed since the reviews cited above.

Apple snails are large snails with native ranges in the tropics and subtropics of South and North America and have been introduced to several locations around the world (Howells et al. 2006, Lopes-Lima et al. 2025). In particular, the two species of primary concern in the United States, *P. canaliculata* and *P. maculata*, are native to parts of South America from northern Argentina into Brazil. These two species have long been confused (Rawlings et al. 2007, Hayes et al. 2012), with many studies having been conducted using one name or the other (including *P. insularum* = *P. maculata*). Because of this historical confusion and our aim of obtaining a full understanding of risk these related species pose, this review focuses on studies of any of the species of *Pomacea* that are not native to the Nearctic (only *P. paludosa* is native to Florida; Rawlings et al. 2007). Apple snails were originally introduced through the aquarium trade, though subsequent transport via transplanting of aquatic plants or other means remain possibilities (Karatayev et al. 2009).

Distribution in Texas

Pomacea maculata is the most widespread species of apple snail in the United States, commonly occurring across large areas of the coastal plain from South Carolina to eastern Texas. It was first found in southeastern Texas in 2004 (Karatayev et al. 2009), and this population has persisted and expanded over the following 20 years. There have been several other documented occurrences of apple snails ranging from Tarrant to Cameron counties (Perez et al. 2017); some of these populations have persisted while others have not. In central Texas, an isolated population in a pond south of Austin was apparently eradicated, while more recent observations posted to iNaturalist indicate reproducing populations in a pond north of Austin and in Gilleland Creek in Pflugerville. However, the most extensive population outside of southeastern Texas is in the San Antonio River through the city of San Antonio. The San Antonio population was first reported in 2019, and the San Antonio River Authority now has a volunteer-based program to remove thousands of adult snails and eggs each year in an attempt to manage this population, but formal analyses of the efficacy of this program have not been completed.

Water temperature

As Neotropical species with native ranges in South America reaching as far south as northern Argentina, *P. maculata* and *P. canaliculata* are both expected to be limited by temperature, though *P. maculata* may be less limited than *P. canaliculata* (Seuffert and Martín 2017, 2024, Qin et al. 2023). In a study by Deaton et al. (2016) in Louisiana, near-freezing water temperatures led to complete mortality after five days, while temperatures of 10°C led to 50% mortality after 10 days, and no mortality was found at 15°C. Similar results have been observed in other studies (Matsukura et al. 2009a, 2009b, 2016, Qin et al. 2025). Therefore, while apple snails can survive at low temperatures, it takes prolonged exposure to result in meaningful mortality (Bernatis 2014, Deaton et al. 2016). However, apple snails can be acclimatized to lower temperatures, resulting in higher survival rates (Yoshida et al. 2014). At upper temperature extremes, growth was observed at water temperatures up to 35°C, but higher temperatures that might induce mortality have not been examined (Ramakrishnan 2007, Gettys et al. 2008). High temperatures can also temporarily induce sterility (Manara et al. 2025).

The temperature extremes in these studies are generally above and below the temperatures experienced in central Texas springs. Several studies have shed light on potential optima within the more typical range of temperatures and generally show that activity increases with temperature (Heiler et al. 2008). Albrecht et al. (1999) found slightly higher reproductive activity at 24°C than at 18°C, but reproduction still occurred across that temperature range. Similarly, Bae and Park (2015) observed shifts in behavioral periodicity between 15–30°C and snails spent more time feeding at lower temperatures, but the total amount of feeding was not assessed (e.g., controlling for higher rates of activity at higher temperatures). Féola et al. (2025) found optimal thermal performance was at 22–28°C, but overall growth and survival was similar between snails kept outdoors in highly variable conditions versus in more stable indoor conditions over the course of one year. Similarly, Gettys et al. (2008) found the highest rates of growth were at 20–30°C. Generally, it appears that both the both the thermally stable conditions within the spring habitats and the increasingly more variable conditions as you move downstream of central Texas springs are suitable to apple snail growth and long-term survival.

Water flow, inundation, and drought

The effects of high-water levels have been best documented on eggs, which are laid above the water surface. Submersion in water has generally been known to reduce hatching success rates, but some still survive inundation (38–87%; Burks et al. 2017); another experimental study potentially saw no effect of submersion on eggs (Martin and Valentine 2014). Evidence is limited of the potential effects of flooding on apple snail adults or eggs, including the potential for flooding to act as a dispersal mechanism of eggs and how that might interact with the negative effects of submersion. In adult *P. canaliculata*,

displacement velocity (the water velocity needed to move a snail) was highly variable with a mean of around 1 m/s, with some snails able to withstand the strongest stream velocities within their native range (Seuffert and Martín 2012).

In systems with the potential to dry, adult apple snails are able to survive out of the water for extended periods of time (weeks to a year), but survival is dependent on there being consistently high relative humidity and moderate air temperatures (Ramakrishnan 2007, Bernatis 2014, Glasheen et al. 2017). Similarly, *P. maculata* is capable of moving over land for periods of at least three hours at rates of 2 m/hr (Mueck et al. 2018). The potential for desiccation to affect apple snails in spring systems is likely minimal, while the water velocities in the Comal and San Marcos systems seem unlikely to hinder apple snail establishment throughout these systems. However, there has been no assessment of how apple snails respond to prolonged or continuous exposure to flowing water conditions, as could be experienced in large sections of these riverine systems. High water flows through the lower New Channel during high flow events in early July 2025 scoured some of the substrate and subsequently removed a lot of the aquatic vegetation in the channel. Therefore, while snails may have been able to remain attached to the surface they were on, the high flows through the system may have affected any snails through disturbance of substrate and vegetation rather than directly affecting snail placement.

Calcium and pH

Calcium carbonate availability and pH have the potential to directly impact shell formation and degradation (Byers et al. 2013). Calcium is important for growing and maintaining shells (Lodge et al. 1987), but since central Texas springs are fed by a limestone aquifer, calcium levels in the springs (typically 80–90 mg/L; Guyton 1979) far exceed levels found to be limiting for *P. canaliculata* (~30 mg/L; Martín et al. 2001) and should provide strong support for snail growth and development. Conversely, low pH presents challenges for constructing and maintaining shells, with pH lower than 5.5 resulting in mortality of *P. maculata* hatchlings and thinner shells in adult *P. canaliculata* (Bernatis et al. 2016). The circumneutral pH (~7) of central Texas spring systems (Guyton 1979) should be highly conducive to shell growth and maintenance.

Other Abiotic Factors

There are a couple other abiotic factors that have been studied and are not expected to have any limiting impact on apple snail populations in the spring systems of central Texas. Salinity has the potential to negatively affect apple snails (Ramakrishnan 2007, Martin and Valentine 2014, Bernatis et al. 2016, Qin et al. 2020, 2022), but this is largely only applicable to coastal systems where occasional inundation from coastal waters may increase salinity (Jordan and Deaton 1999). The stable, low salt content of central Texas springs should in no way impact snails. Similarly, although dissolved oxygen levels of water coming straight out of the aquifer are relatively low (< 5 mg/L; but can vary across the system), there is no evidence that dissolved oxygen levels limit apple snail populations. This is because they possess both gills and lungs (Hayes et al. 2009) and are able to obtain oxygen from the air if dissolved oxygen levels are low (Seuffert and Martín 2009, 2010).

Attempts to model the projected distribution of *P. maculata* in the southeastern United States (Byers et al. 2013, Barbitta et al. 2020) poorly accounted for the potential to survive in spring systems and even completely excluded other localities where they currently occur, such as the San Antonio River. More detailed modeling efforts would be needed to better predict the ability of snails to establish and persist in spring systems relative to other habitats.

Preferred food and effects on vegetation

All species of apple snails and *Marissa cornuarietis* (the non-native giant ramshorn snail) have generally been observed to feed on nearly every type of aquatic vegetation available, both native and non-native, including macrophytes, bryophytes, and algae (Morrison and Hay 2011b, Horgan et al. 2014). They also commonly consume other material such as periphyton, snail eggs, carrion, detritus, and sediment (Qiu et al. 2011, Horgan et al. 2014, Saveanu et al. 2017, 2023). In its native range, one study found that *P. canaliculata* feeds primarily on detritus (Manara et al. 2024). When comparing effects of different snail species, rates of vegetation consumption by *P. maculata* and *P. canaliculata* were higher than *M. cornuarietis* (Morrison and Hay 2011b), while Monette et al. (2016) found that in Florida *P. maculata* consumed *Vallisneria* at higher rates than the native *P. paludosa*. Differential feeding has been found to shift the structure of plant communities, with some studies finding that apple snails eradicated certain preferred plants or otherwise reduced vegetation coverage and decreased macrophyte richness (Hidaka et al. 2007, Fang et al. 2010, Manara et al. 2019, He et al. 2024).

Preferred foods vary by study based on what plants were provided, and results of some studies conflict with each other (Carlsson and Lacoursière 2005, Boland et al. 2007, Gettys et al. 2008, Burlakova et al. 2009, Morrison and Hay 2011b, Yam et al. 2016, Liu et al. 2022). However, no studies have explicitly provided a comparison of the common aquatic vegetation types found in central Texas springs. For example, in a free-feeding trial in Florida, Gettys et al. (2008) found that apple snails fed at the highest rates on *Chara*, *Hydrilla*, and *Najas*. Intermediate feeding rates were observed on *Potamogeton* and *Vallisneria*, while *Myriophyllum* was the least consumed other than *Egeria*, which was completely avoided. Morrison and Hay (2011b) found highest rates of feeding on *Utricularia*, intermediate rates on *Bacopa*, *Sagittaria*, and *Nymphaea*, and low rates on *Eleocharis*, *Pontederia*, *Panicum*, and *Typha*. In a separate study, Morrison and Hay (2011a) found high rates of feeding on *Cabomba*, *Myriophyllum*, *Sagittaria*, and *Egeria*, and lower rates of feeding on a different *Myriophyllum* species, *Hydrocotyle*, and *Nymphaea*. When chemical defenses were induced in *Cabomba*, consumption rates by apple snails decreased from 60% to ~10% (Morrison and Hay 2011a). In another limited comparison, *Ludwigia* was more heavily consumed (large biomass reduction) than two other genera of Asian plants (Wong et al. 2009).

In China, where *Zizania latifolia* is a food crop, the introduction of *P. canaliculata* resulted in yield losses of 5–100% (Halwart 1994, Naylor 1996). However, there were not more detailed descriptions of consumptive effects on this rice species and no other studies on the effects of apple snails on any *Zizania* species were found. While explicit tests of consumption for several of the vegetation types commonly found in the Comal and San Marcos systems were also not found (e.g., *Hygrophila*, *Sagittaria*), it should be expected that all of these taxa are at least somewhat susceptible to apple snails given the wide range of aquatic plants they have been observed feeding on.

Effects on animals and ecosystem function

Through their consumptive effects on aquatic vegetation, apple snails have been found to affect other animals and ecosystem functioning. O’Neil et al. (2023) found that *P. maculata* affects nutrient cycling by increasing the total carbon, nitrogen, phosphorus, and dissolved solids in the water; similar results were found by Chen et al. (2024) in saline coastal wetlands. Higher total phosphorus levels have in turn been associated with higher growth rates of snails (Barrus et al. 2023).

In a mesocosm experiment in its native range, *P. canaliculata* presence was found to result in lower total macroinvertebrate abundance, including lower abundances of native snails and other macroinvertebrates that live at or above the substrate surface; subsurface invertebrates were not affected (Maldonado et al. 2019). However, most notable among taxa found to be unaffected by apple

snails is the invasive snail *Melanooides tuberculata* (Nguma et al. 1982, Maldonado and Martín 2019). Although no studies were found that assessed impacts on native fish populations or communities, it should be expected that if apple snails were to establish in central Texas spring systems and have negative effects on aquatic vegetation as documented in other studies, they should correspondingly negatively impact populations of native fish species dependent on this vegetation such as the Fountain Darter.

Invasions and expanding ranges of apple snails have been potentially associated with increasing abundances and ranges of two snail-specialist birds, the Limpkin (*Aramus guarauna*) and Snail Kite (*Rostrhamus sociabilis*) (Alam et al. 2024, Machado-Stredel et al. 2024). While Limpkins are uncommon in Texas and Snail Kites only occur as vagrants, the occurrence of either of these species may become more common in locations where apple snails establish. However, it seems unlikely that either species would meaningfully help to control an apple snail invasion.

Reproduction

Gooding et al. (2018) observed that in South Carolina *P. maculata* reproduced year-round, though the abundance of egg clutches was positively correlated with air temperature. While April through October is generally the most favorable time of year for apple snail reproduction in the southeastern United States, reproduction can occur whenever conditions are favorable; iNaturalist observations from central Texas also report eggs in late November, January, and March. Apple snails will lay their eggs on a wide array of materials, including trees, emergent vegetation, and virtually any artificial surface that emerges from the water. In South Carolina, culverts seemed to be the most preferred substrate for egg laying (Gooding et al. 2018), potentially due to perceived protection their coverage provides, while observations from the heavily artificially channelized San Antonio River typically show eggs on the vertical concrete walls that line the channel. Although there are many vertical walls (concrete or otherwise) throughout the Comal system, culverts or microhabitats resembling culverts are less common. There are several undercut areas behind walls along the river (Fig. 4A) that could provide sheltered egg-laying habitat. Smaller gaps behind wood along corrugated walls (Fig. 4B) often had small snail species, but some these gaps may be too small for some fully grown apple snails, and later in the summer water levels were typically well below these boards and the small enclosed spaces they create. The tunnel below Landa Falls is effectively a large culvert (Fig. 4C) but may be too big and water flow may be too consistently high and turbulent for apple snails.



Figure 4. Example of culvert-like habitats in the Comal system. A) enclosed area behind a wall along the lower New Channel, B) small enclosed space behind board on vertical wall, C) tunnel at Landa Falls.

Disease transmission

Apple snails are associated with several diseases that are mostly the result of consuming undercooked meat, though other transmission pathways through contact with the snails are possible (Damborenea et al. 2017, Griffin et al. 2025). The primary concern surrounds two species of *Angiostrongylus* nematodes (referred to as ‘rat lungworms’). One species, *A. costaricensis*, causes a gastrointestinal syndrome (abdominal angiostrongyliasis), but the other more concerning species, *A. cantonensis*, causes eosinophilic meningitis and meningoencephalitis (Damborenea et al. 2017). This nematode is present in apple snails across the southeastern United States and infections have been documented in children in Texas and Florida (Teem et al. 2013, Al Hammoud et al. 2017, Chance et al. 2024). While there do not appear to be any characteristics of central Texas spring systems that make them any more or less susceptible to supporting this disease, a large population of infected snails in the Comal or San Marcos River systems could pose a larger risk to public health than has been observed elsewhere that the parasite occurs in North America due to the to the high amount of recreation in these systems.

Population control

Various studies have investigated options for population control of apple snails through methods such as molluscicide application, manual removal, and biological control (Wong et al. 2009, Ip et al. 2014, Lucero and Wilson 2023). While multiple studies in Asia have suggested introduction of various species of carp to be an effective method for control of apple snail populations (Wong et al. 2009, Ip et al. 2014), given

the potential for these non-native fishes to have their own deleterious impacts in Texas waterways, this method should be avoided. Some turtles may prey on apple snails, and in China the densities of *P. canaliculata* were lower when native soft-shelled turtles were released in to rice fields (Dong et al. 2012); small native turtles have also been observed feeding on other non-native snails in Texas (Morrison et al. 2017). Various decapods are known to reduce the abundance of apple snails (Carlsson et al. 2004), including native crayfish in Florida that preferentially fed on non-native apple snails (Dorn and Hafsadi 2016, Davidson and Dorn 2017). However, in an experimental study, Gao et al. (2021) found that *P. canaliculata* and the crayfish *Procambarus clarkii* (which occurs in central Texas) mostly added to the negative effects of *P. canaliculata* rather than mediating their effects when they co-occurred. While crayfish can place some predation pressure on apple snails, it is unclear and perhaps unlikely that they can actually control or limit an invasion.

Limited reports of successful eradication of apple snails have mostly been in small, isolated water bodies, such as small ponds (Martin et al. 2012, Bernatis and Warren 2014). These eradication efforts have mostly been through manual removal of snails. No evidence of successful eradication of an established apple snail population from a riverine or open wetland ecosystem was found in the published literature. The best options for management are prevention, early detection, and removal of snails before they become established.

Comparison to *Marisa cornuarietis*

The giant ramshorn snail (*Marisa cornuarietis*) was first detected in the Comal system in 1984 with a reported decline in vegetation and boom and bust in their population (Horne et al. 1992). Although there is much evidence to suggest they also have negative impacts on various aquatic vegetation (Horgan et al. 2014), all evidence of their impacts in the Comal system has been anecdotal with no quantification of their actual impacts (Horne et al. 1992). *Marisa cornuarietis* have continued to persist in both Comal and San Marcos springs for the past 30+ years seemingly without any quantified impact. It has been suggested that *M. cornuarietis* is dependent on thermally stable spring systems (Karatayev et al. 2009), whereas *P. maculata* is tolerant of a wider range of conditions observed across the southeastern United States. *Marisa cornuarietis* reach smaller sizes (maximum shell height 60 mm) than *Pomacea* spp. (80 mm) and lays its eggs underwater (their eggs also apparently lack the toxins *Pomacea* eggs have); therefore, *M. cornuarietis* be more susceptible to predation by native fishes or crayfishes. Overall, it may seem that *Pomacea* present a larger threat to these spring systems than *M. cornuarietis*, but direct comparisons of their effects are lacking.

Conclusions and Recommendations

As of fall 2025, there is currently no evidence that apple snails have established themselves or have reproducing populations in the Comal system. However, review of the existing literature suggests that in the absence of some other unknown limiting factor or combination of factors, the environmental conditions of the Comal system, and other spring systems in central Texas, are highly suitable for apple snails. Therefore, the springs within the EAHCP plan area are at high risk if a population of apple snails were to become established. While continued surveys and monitoring are not recommended at this time, is important that scientists working in these EAHCP systems and the general public be aware of and vigilant for the occurrence of these snails. If eggs or additional adults are found in the future, efforts should swiftly be undertaken to stop their invasion and protect the species native to this ecosystem.

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