Alligator Snapping Turtle Species Biological Status Review Report

March 14, 2017

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
620 South Meridian Street
Tallahassee, Florida 32399-1600

Biological Status Reviews
for
Alligator Snapping Turtles
(*Macrochelys* spp.)

EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) directed staff to evaluate all species listed as Threatened or Species of Special Concern as of September 1, 2010. In accordance with rule 68A-27.0012 Florida Administrative Code (F.A.C.), the biological review group (BRG) was charged with evaluating the biological status of the alligator snapping turtle (*Macrochelys temminckii*) using criteria included in definitions in 68A-27.001(3) F.A.C. and following protocols in the *Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0)* and *Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1)*. The original BRG concluded in 2010 that the alligator snapping turtle met criterion B2ab(iii), citing severe fragmentation of the population as part of the criterion (FWC 2011). However, FWC staff later evaluated the concept of "severely fragmented" and concluded that it did not apply to the alligator snapping turtle. When conducting the Regional Assessment, the BRG discussed that a rescue effect from turtles outside of Florida could occur if a catastrophic event in Florida eliminated populations of alligator snapping turtles. In these situations, the listing guidelines consider downgrading the initial listing finding. Taking into consideration both of these factors, staff recommended delisting the alligator snapping turtle (FWC 2011).

Since the original biological status review, Thomas et al. (2014) described 2 new species of alligator snapping turtle based upon genetic and skeletal differences, necessitating new biological status reviews of all 3 species. The Suwannee species (*M. suwanniensis*) is the most distinct and is apparently restricted to the Suwannee River basin. The Apalachicola species (*M. apalachicolae*) occurs from the Ochlockonee River basin west to the Choctawhatchee River basin. The nominate species (*M. temminckii*) occurs west of the Choctawhatchee River basin. On 11 November 2015, a second BRG met that consisted of Kevin Enge (FWC lead), Dale Jackson (Florida Natural Areas Inventory), Peter Meylan (Eckerd College), Paul Moler (independent consultant), and Travis Thomas (Nature Coast Biological Station) (Appendix 1). This new BRG concluded from the biological assessment that *M. suwanniensis* met 2 criteria. Because the Georgia portion of the Suwannee River has a small population of alligator snapping turtles (Jensen and Birkhead 2003), rescue effect from *M. suwanniensis* outside of Florida would be minimal, except possibly from the Withlacoochee River, a tributary. The BRG decided that the rescue effect from Georgia is unknown. Taking into consideration both of these factors, staff recommends listing *M. suwanniensis* as Threatened. The BRG concluded from the biological assessment that *M. apalachicolae* did not meet any criteria. Staff recommends not listing *M. apalachicolae*. The BRG concluded from the biological assessment that *M. temminckii* met 1 criterion. The BRG decided that potential colonization of some Florida waters may be possible from *M. temminckii* outside of Florida, because populations occur upstream in the Escambia (called Conecuh River in Alabama) and Yellow River. The extent of immigration of turtles from Alabama is unknown, however, therefore the BRG was unsure whether the Florida population experiences sufficient immigration of propagules to constitute a rescue effect (see Appendix 2).

However, staff reviewed these findings and felt that the criteria did not accurately reflect the biological status of *M. temminckii* as being at risk of extinction, because the species is at the edge of its extensive range, is protected from take throughout its range, and any continuing population decline from sea level rise in Florida would be mitigated by the length of most of the rivers occupied and relatively high land elevations. Staff therefore recommends not listing *M. temminckii*.

Independent scientific review of the biological assessment was sought and received from 7 scientists (6 reviews). All reviewers agreed that *M. suwanniensis* was distinct and warranted listing as Threatened based upon the listing criteria. Five reviews questioned the validity of *M. apalachicolae* as a separate species from *M. temminckii* based upon a rebuttal by Folt and Guyer (2015), but 3 of these 5 reviews were in favor of assessing *M. apalachicolae* separately for management purposes. If these 2 species were combined in the BSR, the staff recommendation to not list *M. apalachicolae* or *M. temminckii* as Threatened would be even more warranted. Three reviews questioned the potential for any significant rescue effect from Georgia or Alabama; rescue effect is considered unknown for all 3 species, meaning no alteration of the initial findings. Staff gratefully acknowledges the assistance of the members of the Biological Review Group and of the Independent Reviewers.

BIOLOGICAL INFORMATION

Taxonomic Classification – Thomas et al. (2014) described 2 new species of alligator snapping turtle, *M. apalachicolae* and *M. suwanniensis*, based upon genetic differentiation and differences in skull and carapace morphology. This taxonomic arrangement recognizes the 3 genetic lineages previously identified by Roman et al. (1999) using mitochondrial DNA (mtDNA). However, Folt and Guyer (2015) reviewed the population phylogenetic knowledge of *Macrochelys* and evaluated the morphological and molecular data presented by Thomas et al. (2014) to reclassify *M. temminckii* as 3 species, and they recommended that *M. apalachicolae* not be recognized as a separate species. Folt and Guyer (2015) recommended recognition of only *M. suwanniensis* and *M. temminckii* based upon morphological and microsatellite data that showed a pattern of drainage-specific divergence for the central (Apalachicola lineage) and western clades (Echelle et al. 2010, Murray et al. 2014). An analysis of 7 microsatellite DNA loci by Echelle et al. (2010) showed fixation or near fixation for otherwise rare microsatellite alleles in the distinct Suwannee River population, but 5 other evolutionarily significant units were recommended for more westerly drainages based on reciprocal mtDNA and high levels of microsatellite DNA divergence. Microsatellite DNA is in the nuclear genome and detects male-mediated dispersal, whereas mtDNA is inherited maternally. Thomas et al. (2014) found Roman's eastern clade (Suwannee lineage) to be the most distinct both genetically and morphologically, and this was supported by a subsequent analysis of cranial shape by Murray et al. (2014). Folt and Guyer (2015) cited the cranial shape variation found by Murray et al. (2014) as providing support for not recognizing *M. apalachicolae* as being distinct from *M. temminckii*. Murray et al. (2014) found greater variation and overlap in cranial shape in the central clade (Apalachicola lineage), and they cautioned against taxonomic separation of the central and western clades. However, Murray et al. (2014) incorrectly assigned a specimen from Callaway Creek in the Choctawhatchee drainage (central clade) to the western clade, which may invalidate their findings. According to Murray et al. (2014), the specimen from Callaway Creek clustered

most closely with specimens from the Apalachicola River in both principal component and canonical variates analyses; that result is not surprising given that the Apalachicola lineage occurs in the Choctawhatchee drainage. The taxonomic status of *M. apalachicolae* is still in dispute, but employing the precautionary principle, we are considering it to be a separate species for the purpose of this biological status review.

Life History and Habitat Requirements – Life history and habitat requirements of alligator snapping turtles (*Macrochelys* spp.), which are restricted to rivers and associated permanent freshwater habitats, have been summarized by Ewert et al. (2006), Pritchard (2006), and Ernst and Lovich (2009). Habitats include channels and deep holes in rivers and the numerous streams in floodplain swamp forests characterized by tannic or turbid waters, bald cypress and tupelo (Ewert and Jackson 1994). The only lakes that typically support the species are either impounded sections of large rivers (Lake Seminole: Apalachicola, Lake Talquin: Ochlockonee) or natural lakes with at least occasional connection to a river (e.g., Lake Iamonia, Leon County). However, Johnston et al. (2015) trapped a turtle in an isolated sinkhole lake. *Macrochelys* can inhabit surprisingly small sand-bottomed streams, such as the seepage streams on Eglin Air Force Base, provided abundant logs and deep bends with undercut banks are present (Moler 1996). A few adults have been taken from brackish water habitats (e.g., Ochlockonee and Apalachicola bays), with some individuals even supporting barnacles, but movements into salt water are extremely rare (Ewert et al. 2006, Pritchard 2006).

All 3 species presumably have similar life history and habitat requirements in Florida, and Moler (1996) found similar habitat use during a distributional survey conducted in Florida. Recent population studies have been conducted on *M. suwanniensis* in Florida in the Suwannee River from White Springs to the mouth (Enge et al. 2014b) and in the Santa Fe River, a major tributary (Johnston et al. 2015). Turtles were most abundant in the middle section of the Suwannee River, where input of ground water from springs and riverbed leakage increased the productivity and changed the water chemistry of the blackwater stream; only 1 turtle was captured at the 2 estuarine sites (Enge et al. 2014b). Ewert and Jackson (1994) studied *M. apalachicolae* in the Apalachicola River. No population studies have been conducted on *M. temminckii* in Florida, but numerous studies have been conducted in other states.

The alligator snapping turtle is the largest North American freshwater turtle, with males (up to 250 lbs, 29 inch carapace length [CL]) growing considerably larger than females (maximum ≈62 lbs, 22 inches CL) (Ewert et al. 2006, Pritchard 2006). Upper and lower reaches of the Suwannee River had an equal observed sex ratio, whereas males outnumbered females more than 4:1 in the 3 middle reaches, which also had significantly more large male turtles (Enge et al. 2014b). Johnston et al. (2015) divided the Santa Fe River into upper and lower sections that are separated by a natural limestone bridge where the river flows underground for ≈5 km. The upper river is a blackwater stream, but input of clear, thermally stable, mineral-rich water from numerous artesian springs affects the lower section of the river. The upper Santa Fe River had a female-biased observed sex ratio, but the lower river had an equal observed sex ratio (Johnston et al. 2015). Juveniles comprised 21%, adult females 17%, and adult males 61% of the sample (N = 161) in the Suwannee River. Juveniles comprised 24%, adult females 44%, and adult males 32% of the sample (N = 109) in the Santa Fe River. Thirty-three of 81 (41%) adult males in the Suwannee River weighed at least 45 kg, and the largest male weighed 57 kg. Adult females were significantly larger in the upper Santa Fe River than the lower Santa Fe River, but

male size did not differ between river sections, although the 6 largest males (> 600 mm CL) came from the lower section. Compared to other studies on *Macrochelys*, the study in the Suwannee River is the only one with an observed sex ratio biased towards males and with a preponderance of large adult males, possibly because commercial harvest was limited. An unharvested *M. apalachicolae* population from Spring Creek in southwestern Georgia had an observed adult sex ratio of 1.25:1.00 (male: female), which did not deviate from 1:1 (Folt et al. 2016).

Sonic telemetry of 20 turtles at 1 site in the upper reach and 1 site in the middle reach of the Suwannee River found that males had a much larger mean minimum linear home range (3,986 m) than females (2,061 m), but the difference between sexes or reaches was not statistically significant (Enge et al. 2014b). Adjusted linear home ranges, which eliminate the outlier locations, were more similar between sexes. Turtles primarily used woody debris, which was the most available cover, but undercut banks were preferentially selected. During low water levels, woody debris in the river channel became more important. During high water levels, turtles often foraged in inundated floodplains, and some turtles continued moving between the floodplain and river channel after water levels fell and they had to travel over land. All turtles in the Suwannee River had a mean of 4 core activity sites (range 2–8) ≈300 m apart. Turtles were sedentary during the day and became active at night, exhibiting year-round activity.

Dobie (1971) found that both sexes in Louisiana attained sexual maturity in 11–13 years, but other researchers have suggested maturity requires 13−21 years in females and 11−21 years in males (Sloan et al. 1996, Tucker and Sloan 1997). Life span in the wild is unknown, but a turtle caught as an adult lived 70 years in captivity (Snider and Bowler 1992). Based on these data, a conservative estimate of average age of parents (generation time) is 30−40 years. Reed et al. (2002) estimated generation time at 49 years, but any generation times >33 years are treated equally by IUCN (2010), which sets a maximum value of 100 years for the time period encompassed by 3 generations. All studies (e.g., Allen and Neill 1950, Dobie 1971, Ewert and Jackson 1994) indicate that females produce only 1 clutch per year, and some may occasionally skip years (Dobie 1971). The nesting season is correspondingly short, extending from late April to mid-May in Panhandle Florida (Ewert and Jackson 1994). Nests along the Apalachicola River were constructed in sandy soils when available, normally within 20 m of water but sometimes as far as 200 m (Ewert and Jackson 1994). Natural berms 2−3 m high were favored along the lower Apalachicola River, but these have been supplemented and in part replaced by man-made deposits of sandy dredged spoil, which are warmer and tend to produce more female hatchlings as a consequence of temperature-dependent sex determination (Ewert and Jackson 1994). Clutch sizes of *M. apalachicolae* along the lower Apalachicola River, the best studied site, averaged ≈36 eggs (range 17−52). Two salvaged *M. suwanniensis* clutches contained 43 and 47 eggs (Travis Thomas, unpubl. data). Hatching along the Apalachicola River occurred in the second half of August after 100−110 days of incubation, followed a few weeks later by hatchling emergence (Ewert and Jackson 1994).

Macrochelys has been reported to eat fish, crustaceans, mollusks, insects, aquatic salamanders, snakes, turtles, small alligators (*Alligator mississippiensis*), birds, mammals, and plant material, which may include quantities of grapes, acorns, and palmetto and tupelo fruits (Allen and Neill 1950, Dobie 1971, Sloan et al. 1996, Harrel and Stringer 1997, Elsey 2006, Pritchard 2006). Adults apparently are opportunistic scavengers (Elsey 2006), but juveniles feed

predominantly upon small fishes, which are often lured into striking distance by wriggling a pink, worm-like structure that extends from the tongue (Spindel et al. 1987, Pritchard 2006).

Population Status and Trend – Enge et al. (2014b) used mark-recapture data to derive an estimate of population abundance of *M. suwanniensis* for each ecological reach of the Suwannee River and then determined a rough population estimate excluding the estuary, which had too few captures. They estimated 780−1,171 adult turtles (95% Confidence Interval) inhabit the Suwannee River, not including its tributaries, between White Springs and the estuary. Estimated population densities in the Suwannee River ranged from 1.68 adults/km in the reach farthest upstream to 4.33 adults/km in one of the middle reaches. Excluding the estuary, an average of 0.25 turtles were captured per trap night. Identical trapping methods for *M. apalachicolae* in 2014 (≈100 trap nights per river) yielded 0.35 turtles per trap night at 2 sites along the Apalachicola River, 0.53 turtles per trap night at 2 sites along the Ochlockonee River, and 0.01 turtles per trap night at 2 sites along the Choctawhatchee River (Mays et al. 2015). The Choctawhatchee River appeared to have suitable habitat for *M. apalachicolae*, but Moler (1996) failed to trap the species there in 12 trap nights. The species has never been found in the Alabama portion of the Choctawhatchee drainage (Folt and Godwin 2013). However, 1 juvenile turtle was observed basking in 2014 along the Choctawhatchee River (Mays and Hill 2015), and Moler (1996) trapped 2 turtles in 41 trap nights in Holmes Creek, the major Florida tributary of the Choctawhatchee River. The most productive trapping sites that Moler (1996) recorded for *M. temminckii* were in the upper Escambia River (1.25 turtles per trap night).

Based upon abundance and an age structure that includes a high percentage of large turtles, particularly males, the Suwannee River drainage in Florida apparently experienced relatively little historical harvest (Enge et al. 2014b, Johnston et al. 2015). Large *M. apalachicolae* are present in the Apalachicola and Ochlockonee rivers (Moler 1996, Mays et al. 2015), and large *M. temminckii* are present in the Escambia River (Moler 1996). Population studies in rivers where *Macrochelys* were heavily harvested showed female-biased or equal observed sex ratios and a preponderance of juveniles (Jensen and Birkhead 2003, Boundy and Kennedy 2006, Riedle et al. 2008, Howey and Dinkelacker 2013, Lescher et al. 2013). After periods of heavy harvesting effort, declining yields typically forced commercial trappers to move on to other sites (Pritchard 2006). This is not unexpected given the long generation time of alligator snapping turtles and the normally low rates of recruitment of virtually all turtles. The *M. apalachicolae* population in the Flint River in Georgia has apparently not increased despite 22 years of protection from commercial harvest (King et al. 2016).

Beginning in 1973, enactment of a series of protective rules by FWC (then the Florida Game and Fresh Water Fish Commission [GFC]) likely reduced the species' rate of decline in Florida, although harvest (legal and illegal) still occurred. Recent FWC rule changes (2009) prohibited take of all snapping turtles and ended legal harvest, although incidental (mortality from bush hooks or trotlines set for catfish) and some illegal harvest persist. *Macrochelys* populations are apparently secure in most Florida rivers, because harvest is now prohibited; water management areas and other conservation lands preserve habitat and restrict development along rivers and in floodplains. Population recovery in some rivers may be slow because of life-history characteristics and possible ongoing mortality from illegal harvest or drowning due to abandoned bush hooks or entanglement in fishing lines (King et al. 2016).

Geographic Range and Distribution – *Macrochelys suwanniensis* is restricted to the Suwannee River basin (Fig. 1), which includes the Withlacoochee and Santa Fe/New rivers in Florida (Fig. 2, Table 1). Its range extends into southern Georgia as far north as the Okefenokee Swamp. A few alligator snapping turtles have been reported from the Aucilla, St. Marks, and Wakulla rivers between the Suwannee and Ochlockonee rivers, but there is no evidence that viable populations occur in these rivers (Jackson 2002, Enge et al. 2014a). The Florida range of *M. apalachicolae* extends from the Ochockonee River basin west to the Choctawhatchee River basin (Fig. 1). Besides these 2 rivers, it is found in 7 discrete streams: Apalachicola River, Econfina Creek, New River, Sandy Creek, Sopchoppy River, Turkey Creek, and Wetappo Creek. It also occurs in 4 major tributaries: Chipola River, Holmes Creek, Juniper Creek, and Telogia Creek (Fig. 3, Table 1). The range of *M. apalachicolae* extends north into Alabama and Georgia. The Florida range of *M. temminckii* is west of the Choctawhatchee River basin as far as the Perdido River (Fig. 1), and its entire range extends as far west as the Trinity River in eastern Texas and north in the Mississippi River drainage to southeastern Iowa. This species inhabits 6 discrete Florida rivers: Blackwater River, East Bay River, Escambia River, Perdido River, Pond Creek, and Yellow River. It also inhabits 2 major tributaries: Big Coldwater Creek and Shoal River (Fig. 4, Table 1).

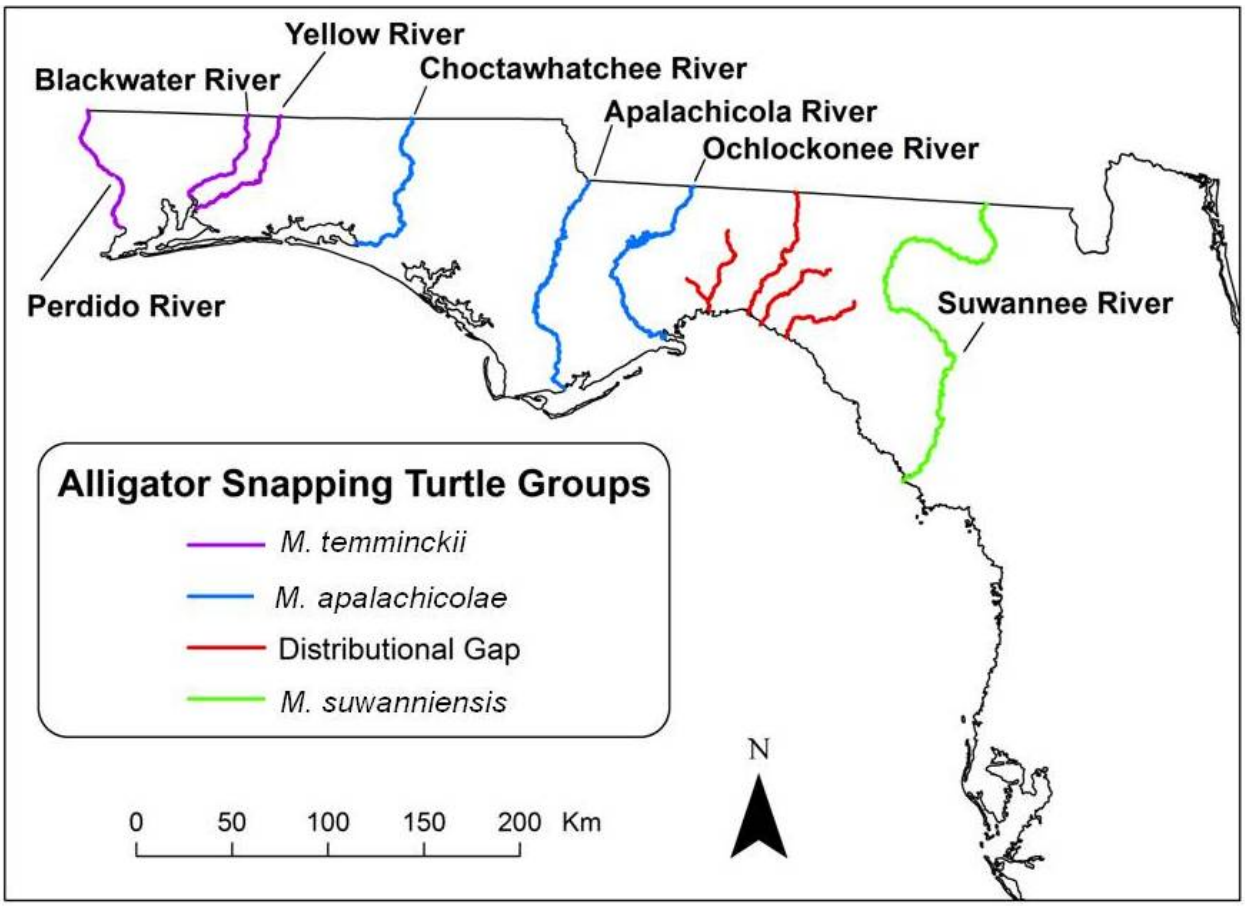

Fig. 1. Distribution of *Macrochelys* spp. in Florida (from Enge et al. 2014b).

Quantitative Analyses – Reed et al. (2002) modeled population demography of the alligator snapping turtle and evaluated population effects of changes in life-history parameter.

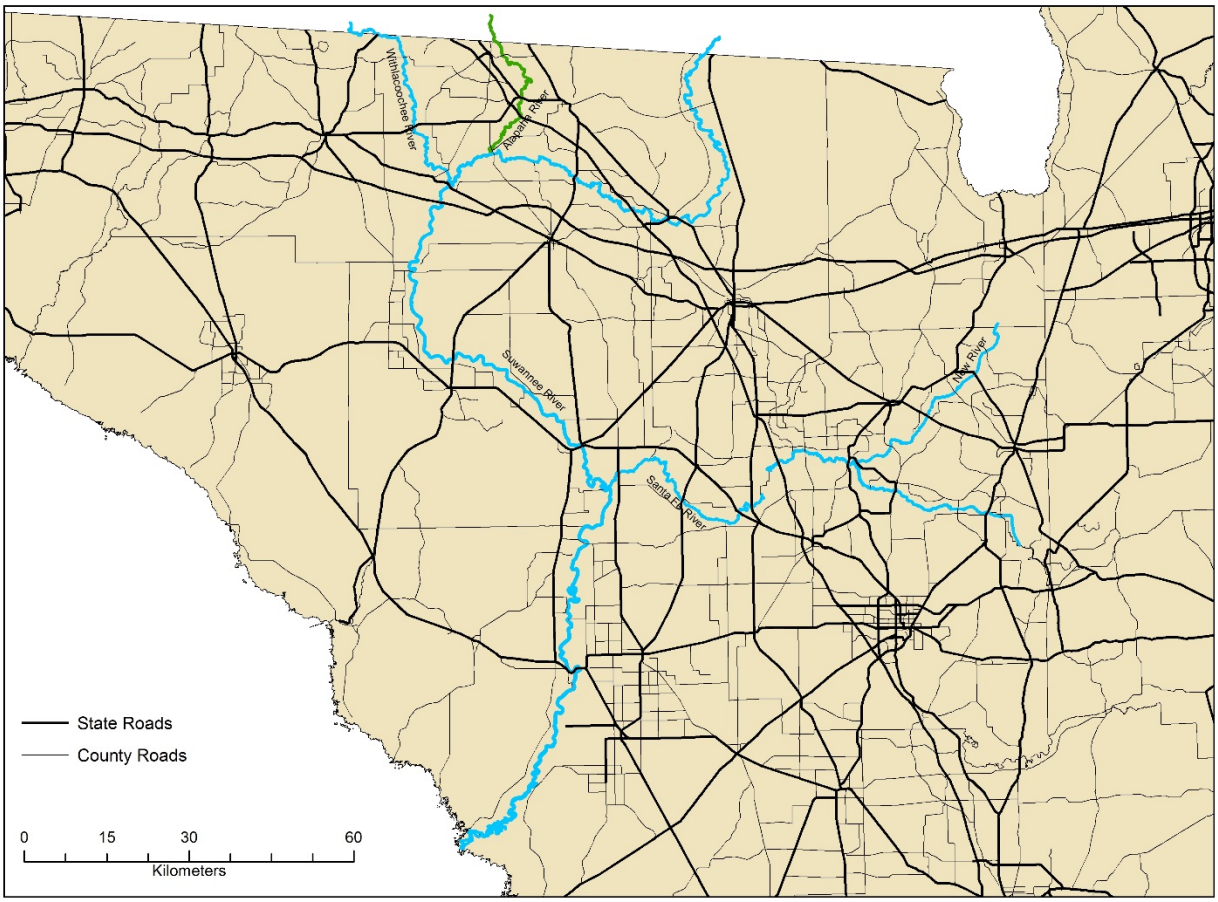

Fig. 2. Rivers and streams that are considered locations for *Macrochelys suwanniensis* (blue) or are possible locations, if enough turtles are present for long-term viability (green).

Because empirical data for many *Macrochelys* population parameters were lacking at the time, Reed et al. (2002) built a stable life table using estimates from the common snapping turtle (*Chelydra serpentina*). They concluded that 1) annual survival rate of 98% for adult females was necessary for population stability, 2) any lesser rate would lead to long-term population decline and eventual extirpation, and 3) even successful efforts to increase egg and juvenile survival would be unlikely to compensate for continued loss of adult females. Ewert et al. (2006) thought that this model underestimated nest survival and that it underestimated juvenile survivorship by holding it steady until 12 years of age instead of increasing it at 6 years of age, when animals would presumably be large enough to escape some predators, thereby changing survivorship. Modeling with increased juvenile survivorship "would show population stability with lower adult survival and would accommodate take at a very low level" (Ewert et al. 2006).

Folt et al. (2016) modeled an unharvested, growing population in southwestern Georgia and impacted, declining populations in Arkansas and Oklahoma. A population viability analysis found that the Georgia population grew over the next 50 years in 100% of simulations, whereas the Oklahoma population had a high risk of extirpation and the Arkansas population had a slow rate of decline but approached stability. Folt et al. (2016) obtained estimates of fecundity and

Fig. 3. Rivers and streams that are considered locations for *Macrochelys apalachicolae* (blue) or are possible locations, if enough turtles are present for long-term viability (green).

nest success from recent *Macrochelys* literature and used survival parameters derived from their analyses of mark-recapture studies in Georgia, Arkansas, and Oklahoma populations. The unharvested Georgia population had higher estimates of survival for adults (0.98 for males and 0.95 for females) than for juveniles (0.86). In contrast, survival of adult males and females in declining populations was 0.96 and 0.88 in Arkansas (Howey and Dinkelacker 2013) and only 0.59 and 0.31 in Oklahoma (East et al. 2013).

BIOLOGICAL STATUS ASSESSMENT

Threats –The alligator snapping turtle has a long history of both commercial and personal harvest for meat throughout its range, including in Florida (Dobie 1971, Sloan and Lovich 1995, Reed et al. 2002, Ewert et al. 2006, Pritchard 2006, King et al. 2016). Beginning in the 1970s, rules enacted by the GFC to limit take likely slowed the rate of mortality in Florida, though both legal and illegal harvest still occurred. Legal take of alligator snapping turtles was prohibited by rule changes enacted by FWC in July 2009. Anecdotal evidence and trapping data

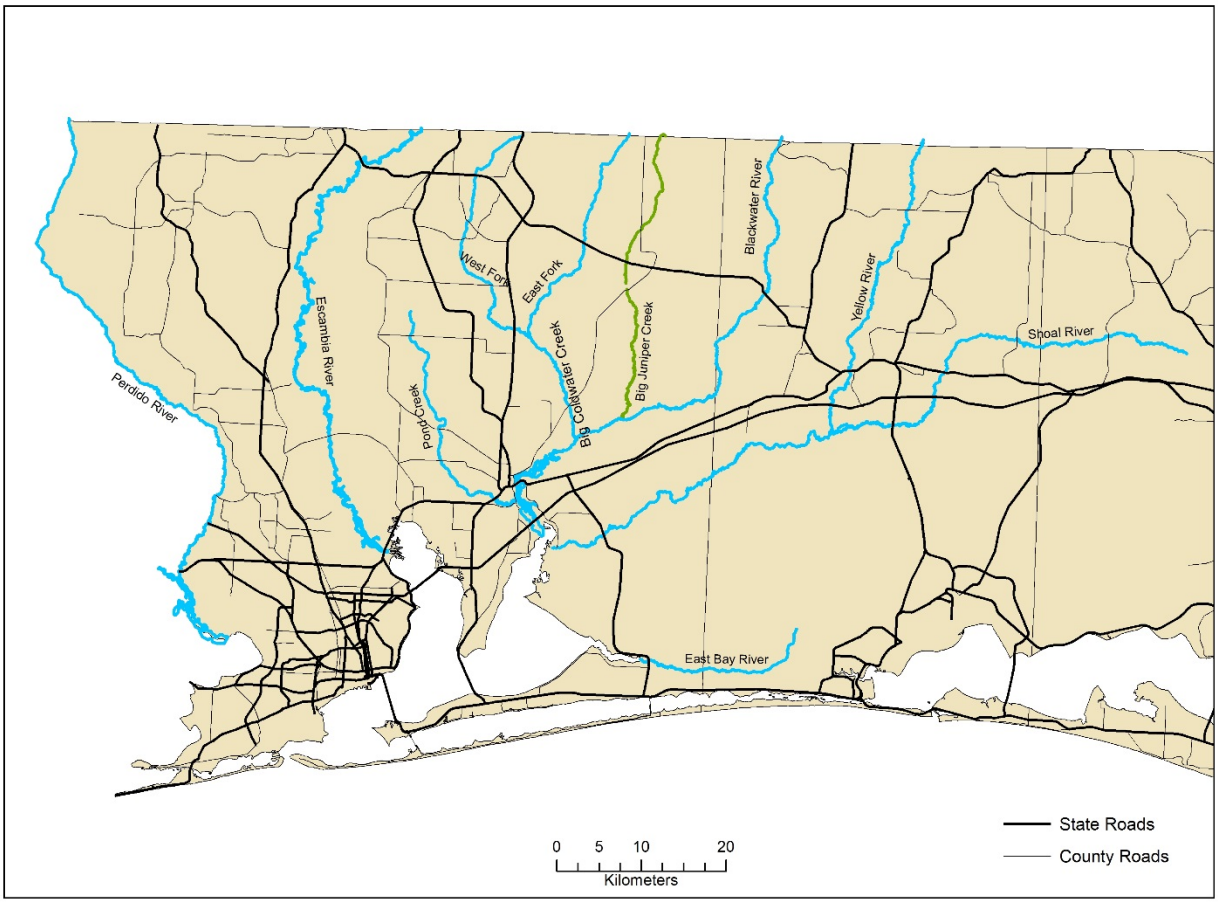

Fig. 4. Rivers and streams that are considered locations for *Macrochelys temminckii* (blue) or are possible locations, if enough turtles are present for long-term viability (green).

suggest that the Suwannee alligator snapping turtle was not heavily harvested in Florida. However, bycatch mortality on lines set for nongame fish, especially catfish, remains a problem. These include both trotlines (long lines of submerged baited hooks), setlines (single hooks moored to the bank), and bush hooks (single hooks suspended from tree branches) (Ewert et al. 2006, Pritchard 2006). The latter fishing method may be more widely used in rivers and hence likely present a greater problem for the alligator snapping turtle. Three of 25 radiographed turtles from the Suwannee River had ingested fish hooks, and 1 turtle contained 3 hooks (Enge et al. 2014b). May et al. (2015) found 2 drowned turtles entangled in fishing line. The impact of these hooks and their attached fishing lines on turtle survival is unknown.

Because rivers tend to be relatively stable and persistent systems compared to most Florida habitats, outright habitat destruction is not a major threat to this turtle. Nonetheless, various human-generated insults to the integrity of lotic systems, including their floodplains, can and do affect Florida's riverine turtles (Jackson 2005). Chemical pollution (from industries such as pulp mills, and waste products from cities and agricultural activities, including those in Alabama and Georgia) poses a potential threat to riverine fauna, though even a major spill along one

Table 1. Rivers and large streams presumably inhabited by *Macrochelys* spp. in Florida from east to west. A stream is considered a "location" if a major road crossing is present near its headwaters that would make it susceptible to a toxic spill or if it has its own subpopulation. If the presence of *Macrochelys* in a stream is suspected but not confirmed or if sufficiently large numbers of turtles may not be present for long-term viability, the stream is considered an "unknown" location.

Species	Discrete Drainage	Tributary	Location?
M. suwanniensis	Suwannee River		Yes
		Santa Fe River	Yes
		New River	Yes
		Alapaha River	Unknown
		Withlacoochee River	Yes
M. apalachicolae	Sopchoppy River		Yes
	Ochlockonee River		Yes
		Little River	Unknown
		Telogia Creek	Yes
	New River		Yes
	Apalachicola River		Yes
		Chipola River	Yes
		Juniper Creek	Yes
	Wetappo Creek		Yes
	Sandy Creek		Yes
	Bear Creek		Unknown
`	Econfina Creek		Yes
	Choctawhatchee		Yes
		Holmes Creek	Yes
		Wrights Creek	Unknown
	Black Creek		Unknown
	Alaqua Creek		Unknown
	Rocky Creek		Unknown
	Turkey Creek		Yes
M. temminckii	East Bay River		Yes
	Yellow River		Yes
		Shoal River	Yes
	Blackwater River		Yes
		Big Juniper Creek	Unknown
		Big Coldwater Creek	Yes
	Pond Creek		Yes
	Escambia River		Yes
	Perdido River		Yes

Panhandle river would not endanger a species' statewide population (Ewert et al. 2006). As for all turtles, predation (particularly by raccoons [*Procyon lotor*]) accounts for the loss of most alligator snapping turtle eggs (about 2/3 along the lower Apalachicola River). Additional potential predators include wild hogs (*Sus scrofa*), fish crows (*Corvus ossifragus*), striped skunks (*Mephitis mephitis*), eastern kingsnakes (*Lampropeltis getula*), and red imported fire ants (*Solenopsis invicta*). Nest flooding following very heavy regional rains also destroys entire clutches in some years (Ewert and Jackson 1994).

Statewide Population Assessment – Findings from the BRG are included in the Biological Status Review Information tables, but the pertinent information is summarized below.

Macrochelys suwanniensis assessment:

The BRG found that *M. suwanniensis* has a limited geographic range (Criterion B) both in extent of occurrence (B1) and area of occupancy (B2). The Suwannee River basin occurs in 11 counties that have a total area of 15,581 km^2, which is less than the 20,000 km^2 limit for extent of occurrence. The area of rivers inhabited is < 2,000 km^2, which is the limit for area of occupancy. In order to meet the criterion of being threatened due to geographic range (B), a species also has to meet at least 2 of 3 subcriteria. The Suwannee alligator snapping turtle does not meet the subcriterion of being severely fragmented, because it probably consists of 2 subpopulations, which are defined as "*geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)*" (IUCN 2010). Freshwater species occurring in more than 1 body of water have naturally fragmented distributions, but the BRG did not interpret this as being "severely fragmented." The 5-km land bridge between the upper and lower Santa Fe River probably divides subpopulations, whereas frequent gene flow probably occurs between the Suwannee River and its tributaries. Alligator snapping turtles have limited terrestrial mobility, and the land bridge probably restricts gene flow between the subpopulations except during extreme flood events. Johnston et al. (2015) reported a secondhand observation of an adult turtle walking in shallow water over the land bridge during flooding.

Macrochelys suwanniensis meets Subcriterion B(a) by occurring in $\leq$ 10 locations. A location is defined as "*a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present*" (IUCN 2010). The Suwannee species inhabits the Suwannee River and 3 major tributaries, the New, Santa Fe, and Withlacoochee rivers, which total 4 locations (Fig. 2). The BRG did not include the Alapaha River, another tributary, as a location (Table 1) because portions of the river periodically dry up and the species has not been documented in Florida. The species has been documented from the Alapaha River in Georgia, but trapping rates were low (0.04 turtles/trap night) (Jensen and Birkhead 2003), and relatively few turtles may be present in the Florida portion of the river. This species apparently does not inhabit the 7 rivers in the Big Bend region between the Suwannee and Ochlockonee rivers (Jackson 2002, Enge et al. 2014a), but even if viable subpopulations occurred in most of these rivers, the total would still be 10 locations or fewer. "*Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat(s).*" (IUCN 2010).

The BRG decided that the most serious plausible threat would be a toxic chemical spill at a highway/railroad crossing or in a city near the headwaters that would rapidly affect all downstream turtles. Tanker transport of chemicals would be most likely to occur on paved roads

or major dirt roads, so a road crossing by a minor dirt road would not pose a plausible potential threat. A huge toxic spill would be unlikely to affect an entire population, particularly in large riverine systems like the Suwannee and Apalachicola rivers. *Where the most serious plausible threat does not affect all of the taxon's distribution, other threats can be used to define and count locations in those areas not affected by the most serious plausible threat*" (IUCN 2010). Alternative population threats, such as long-term poaching and incidental take by trotlines or bush hooks, are more plausible but do not have the potential to rapidly affect all turtles in the population. When parts of a taxon's distribution are not affected by any threat, other options are available to determine the number of locations. The most appropriate option for streams not threatened by toxic spills is the "*number of locations in the unaffected areas is set to the number of subpopulations in those areas*" (IUCN 2010). A discrete stream without a road crossing near its headwater can be counted as a location, whereas a major tributary without a road crossing would not meet the definition of a location because its subpopulation is shared with the main river. Turtles occur in small tributaries with road crossings that could be considered locations, but the BRG elected not to include these tributaries if too few turtles were suspected to be present to constitute a viable subpopulation if all turtles in the main river were extirpated. Similarly, small discrete streams were not counted as locations if the presence of turtles were unknown or if the BRG suspected that numbers were too low to allow long-term survival of the subpopulation if adjacent subpopulations were extirpated (i.e., rivers draining into the same bay). "*The area for a viable population should be based on rudimentary estimates of population density, and on the ecology of the taxon. For example, for many vertebrates, patches that can support fewer than a hundred individuals may be considered too small to be viable*" (IUCN 2010). Because *Macrochelys* is long lived and has high adult survivorship, smaller populations than 100 adult turtles can probably be considered viable, provided that individuals are not too dispersed to find each other to breed.

Macrochelys suwanniensis meets the Subcriterion B(b)(iii), a continuing decline is inferred or projected in area, extent, and/or quality of habitat. No timeframe is given for such declines for Criterion B, unlike the 3 generations (100 years for alligator snapping turtles) specified for population declines for Criteria A and C. Projections of sea level rise causing increased salinity near the Gulf of Mexico and future declines in water quality (pollution) and quantity (increased human demand for water from the Suwannee River or the Floridan Aquifer) could result in declines in area and quality of habitat. For each 1°C rise in air temperature, sea level is projected to rise 2.3 m (Levermann et al. 2013). By the year 2100, most projections forecast that global mean sea level will rise by 0.5 to 2.0 m (see Parkinson et al. 2014). A sea level rise of 2.3 m would inundate 18% of Levy County (Parkinson et al. 2014), which is the location of the mouth of the Suwannee River. Tidal influence would extend farther upstream.

Macrochelys suwanniensis also meets Criterion D regarding a very small or restricted population. The species meets Subcriterion D2 because it has 5 or fewer locations (Suwannee, New, Santa Fe, and Withlacoochee rivers) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future.

Macrochelys apalachicolae assessment:

The BRG found that *M. apalachicolae* has a limited geographic range (Criterion B) both in extent of occurrence (B1) and area of occupancy (B2). The approximate range of the species extends from Holmes Co. and half of Walton Co. east to Leon and Wakulla counties, which totals 13,714 km^2 (< 20,000 km^2 limit for extent of occurrence). The area of rivers inhabited is < 2,000 km^2, which is the limit for area of occupancy. In order to meet the criterion of being

threatened due to geographic range, a species also has to meet at least 2 of 3 subcriteria. The species does not meet Subcriterion B(a) because it occurs in > 10 locations. It inhabits 9 discrete rivers and 4 major tributaries that can be considered locations (Fig. 3, Table 1). Turkey Creek lacks a road crossing near its headwaters and would not be susceptible to a toxic spill, but it is considered a location because it is a discrete stream with its own subpopulation. Turtles probably occur in additional smaller streams and tributaries that could be considered locations, such as the Little River and Bear, Wrights, Black, Alaqua, and Rocky creeks (Fig. 3, Table 1), but the BRG was either unaware whether turtles were present or whether sufficient numbers were present to ensure long-term subpopulation viability. Although alligator snapping turtles have limited ability to make overland movements between river drainages or saltwater movements between bays, the population is not severely fragmented because the Apalachicola and Ochlockonee subpopulations (and possibly others) are large.

Macrochelys apalachicolae meets Subcriterion B(b)(iii), a continuing decline is inferred or projected in area, extent, and/or quality of habitat. Projections for sea level rise causing increased salinity near the Gulf of Mexico and future declines in water quality and quantity (increased human demand for water and increased pollution from cities, industries, and agriculture) could result in declines in area and quality of habitat. The low-lying coastal area where the mouth of the Apalachicola River is located would experience at least 27% cumulative land loss if global mean sea level rose by 2.3 m (Parkinson et al. 2014), which corresponds to a 1°C increase in atmospheric temperature (Levermann et al. 2013). By the year 2100, most projections forecast that global mean sea level will rise by 0.5 to 2.0 m (see Parkinson et al. 2014).

Macrochelys temminckii assessment:

The BRG found that *M. temminckii* has a limited geographic range (Criterion B) in Florida both in extent of occurrence (B1) and area of occupancy (B2). The approximate range of the species encompasses Escambia, Santa Rosa, Okaloosa, and half of Walton Co., which totals 8,145 km^2 (< 20,000 km^2 limit for extent of occurrence). The area of rivers inhabited is < 2,000 km^2, which is the limit for area of occupancy. In order to meet the criterion of being threatened due to geographic range, a species also has to meet at least 2 of 3 subcriteria. The species meets Subcriterion B(a) by occurring in ≤ 10 locations. It inhabits 6 discrete rivers and 2 major tributaries that have paved road crossings near their headwaters and are thus susceptible to toxic spills (Fig. 4, Table 1). Turtles occur in additional smaller streams and tributaries that could be considered locations, such as Big Juniper Creek (Fig. 4), but the BRG elected not to include these tributaries because either the presence of turtles was unknown or sufficient numbers may not be present for long-term survival of the subpopulation if all turtles in the main river were extirpated.

Although turtles have limited ability to make overland movements between river drainages or saltwater movements between bays, the population is not severely fragmented because some of the subpopulations, such as the Escambia and Blackwater rivers are presumably large based upon trapping results (Moler 1996) and river size. The Subcriterion B(b)(iii), which is a continuing decline is inferred or projected in area, extent, and/or quality of habitat, was met for the other 2 species because of projections for sea level rise causing increased salinity near the Gulf of Mexico and future declines in water quality and quantity (i.e., increased human demand for water and increased pollution from cities, industries, and agriculture). The BRG found that

this criterion was also met for *M. temminckii* primarily due to projected sea level rise. However, during staff review, this subcriterion was questioned for *M. temminckii*, because coastal counties at the mouths of Florida rivers inhabited by it have higher elevations and would experience only 2−6% cumulative land loss if global mean sea level rose by 2.3 m (Parkinson et al. 2014), which corresponds to a 1°C increase in atmospheric temperature (Levermann et al. 2013). By the year 2100, most projections forecast that global mean sea level will rise by 0.5 to 2.0 m (see Parkinson et al. 2014). In addition, all the locations identified, except the East Bay River and Pond Creek, are long rivers that extend northward into highland areas (Fig. 4), making them less likely to be affected by sea level rise. In contrast, at least 4 locations for *M. apalachicolae* are short, coastal rivers (Fig. 3). Staff further noted that if a rescue effect were possible for any of the *Macrochelys* species, *M. temminckii* would be the species most likely impacted (see text below on the rescue effect).

Rescue effect assessment:

In accordance with Guidelines for Application of IUCN Red List Criteria at Regional and National Levels (IUCN 2003), the BRG discussed whether a rescue effect from turtles outside Florida could occur if a catastrophic event in Florida eliminated populations of *Macrochelys* (Appendix 2). In these situations, the listing guidelines consider downgrading the initial finding. *Macrochelys suwanniensis* is apparently scarce in the Georgia portion of the Suwannee River (Jensen and Birkhead 2003), so any rescue effect may take a long time. Pritchard (1989), citing mainly park naturalists in Florida and Georgia, reported *Macrochelys* was scarce in the Suwannee River and its headwaters, the Okefenokee Swamp. Intensive trapping in Georgia failed to detect the species in the upper Suwannee River, possibly due to natural rarity, low pH and its effect on prey items, or impacts associated with commercial harvest (Jensen and Birkhead 2003). *Macrochelys* was protected in Georgia in 1992. A rescue effect from the Georgia portion of the Withlacoochee River might occur for *M. suwanniensis*.

Macrochelys apalachicolae might experience a rescue effect from Georgia in the Ochlockonee River. Jensen and Birkhead (2003) captured 0.15 turtles per trap night in the Georgia portion of the Ochlockonee River. Any rescue effect from Georgia in the Apalachicola River is compromised by the Jim Woodruff Dam that is located on the Florida/Georgia border ≈300 m downstream of the river's origin at the confluence of the Chattahoochee and Flint rivers. A trapping study in Georgia in the Apalachicola drainage found them to be abundant (0.45 turtles per trap night) in the Chattahoochee River and a tributary, Spring Creek (Jensen and Birkhead 2003). However, populations were apparently low (0.08−0.09 per trap night) in the Flint River, which experienced heavy commercial harvest in the past (Jensen and Birkhead 2003, King et al. 2016). Records are lacking from the Alabama portion of the Choctawhatchee River (Folt and Godwin 2013), and any rescue effect would be nonexistent or negligible.

Some Florida rivers inhabited by *M. temminckii* do not extend into Alabama, but a rescue effect might occur in the Escambia (named Conecuh River in Alabama) and Yellow rivers, but the BRG did not know whether a sufficient number of turtles would immigrate. A recent distributional survey in southern Alabama trapped turtles in the Conecuh River (0.30 turtles per trap night) (Folt and Godwin 2013). Folt and Godwin (2013 did not trap the Yellow River in Alabama but noted the existence of historical records, and a population occurs in Five Runs Creek, a tributary of the Yellow River located in Conecuh National Forest (Brian Folt, pers. commun.). The species also occurs in the Perdido River, which comprises the Alabama/Florida

border (Moler 1996, Pritchard 2006, Folt and Godwin 2013). The species has been protected as a nongame animal in Alabama since 1990 (Folt and Godwin 2013).

Because relatively little is known regarding *Macrochelys* movements, and only a few rivers for each *Macrochelys* species might provide a rescue effect, the BRG decided that the rescue effect is unknown for all 3 species and the initial findings should not change. The chance of a rescue effect might be highest for *M. temminckii*, because populations occur upstream in Alabama in at least 3 rivers, all of which are undammed.

LISTING RECOMMENDATION

Staff reviewed the findings for the Suwannee alligator snapping turtle (*M. suwanniensis*) and agree that it met criterion B (limited extent of occurrence (B1) and area of occupancy (B2)) and D2 (population with a very restricted area of occupancy), and recommends listing the species as Threatened. *Macrochelys apalachicolae* does not meet any listing criteria, and staff recommends not listing this species. The BRG found that *Macrochelys temminckii* met criterion B, with limited extent of occurrence and area of occupancy (B1,2), fewer than 10 locations (a), and projected decline in extent or quality of habitat (b)(iii). Rule 68A-27.0012(c)(1)(c), F.A.C. allows staff to provide a biologically justified opinion that differs from the criteria-based finding. Staff reviewed these findings and had several areas of concern. The coastal counties in which *M. temminckii* occurs have higher elevations than counties for the other *Macrochelys* species, and staff believes that *M. temminckii* would be the least affected by projected sea level rise (Parkinson et al. 2014). In addition, all but 2 rivers defined as locations for *M. temminckii* are relatively long and extend considerable distances into higher elevation areas. In Florida, this species is at the very edge of its wide geographic range, which extends westward to Texas and northward up major river drainages to southern Illinois and Iowa. These rivers extend farther north than those inhabited by *M. apalachicolae* or *M. suwanniensis*, so habitat loss from sea level rise is less of a factor contributing to continuing decline. Likewise, threats associated with take are limited because the species is now protected in every state (Folt et al. 2016). FWC criteria are triggered when there is a high risk of extinction in the wild, but this species is at the edge of its range in Florida, and trapping data suggest that populations remain relatively abundant in Florida. Moler (1996) had his highest trapping success for *Macrochelys* in Florida in the Escambia River. A 1996 review by IUCN ranked *M. temminckii* (all 3 species combined) as Vulnerable (http://www.iucnredlist.org/details/full/12589/0), which corresponds to FWC's Threatened status. An updated IUCN assessment is needed, however. According to the 1996 assessment, take was still permitted in 6 states, and Florida was erroneously included as a state prohibiting take. Staff suspects that an updated IUCN assessment across its entire range would no longer rank it as Vulnerable. Finally, *M. temminckii* would not meet any listing criteria if *M. apalachicolae* were not recognized as a valid species, as recommended by Folt and Guyer (2015). For these reasons, staff recommends that *M. temminckii* should not be listed as a Threatened species.

Staff concurs with the findings of Regional Assessments that a rescue effect is unknown for all 3 *Macrochelys* species. In some cases, such as for *M. suwanniensis* in the Suwannee River, population sizes are apparently small north of Florida. In all cases, too little is known regarding movements of individual *Macrochelys* between metapopulations, if these even exist.

In situations where rescue effect does not exist or is unknown, the listing guidelines recommend no change in the initial findings (IUCN 2003).

SUMMARY OF THE INDEPENDENT REVIEW

Independent scientific review of the biological assessment was sought and received from 7 scientists (6 reviews). All 6 reviews agreed that *M. suwanniensis* was distinct and warranted listing as Threatened based upon FWC criteria. Five reviews questioned the validity of *M. apalachicolae* based upon a rebuttal by Folt and Guyer (2015), but 3 of these 5 reviews were in favor of assessing *M. apalachicolae* separately for management purposes. Staff added information from Folt and Guyer (2015) and Murphy et al. (2014) but continued to recognize 3 separate species. The recommendation by staff to not list *M. apalachicolae* or *M. temminckii* as Threatened would be even more warranted if these 2 species were combined, because no criteria would be met. Three reviews questioned the potential for any significant rescue effect from Georgia or Alabama. Input from independent reviewers supported the staff's decision that rescue effect from Alabama or Georgia is unknown for *Macrochelys* spp., despite turtles being present in some rivers and protected in both states.

The complete scientific reviews and responses by the staff are provided in Appendix 3. Staff of the FWC gratefully acknowledges the assistance of the members of the Biological Review Group and of the Independent Reviewers.

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Biological Status Review Information Findings	
Species/taxon:	Suwannee Alligator Snapping Turtle
Date:	
Assessors:	Kevin Enge, Dale Jackson, Peter Meylan, Paul Moler, and Travis Thomas
Generation length:	30-40 years (ca. 35 years)

Criterion/Listing Measure	Data/Information	Data Type*	Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]	Limited harvest has occurred throughout the past 90 years, but commercial harvest was minimal or nonexistent, and recent sampling data suggest that a 50% decline is unlikely.	I	N	Enge et al. 2014b
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	Insufficient data to make determination of 30% decline.	I	N	Enge et al. 2014b
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	Projections for sea level rise during the next 90 years may increase the salinity of the waterways which could result in habitat loss and reduction of the population, but unlikely that the reduction would be at least 30%.	I	N	
(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible.[1]	We suspect that there has not been a 30% decline although there was some historic harvest and current incidental harvest plus the potential for additional decline due to projected sea level rise.	I	N	
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				

(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	15,581 km^2	E	Y	A GIS analysis could be conducted, but the approximate range encompasses 11 counties that have a total area of 15,581 km^2
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	< 2,000 km^2	E	Y	The area of rivers inhabited is < 2,000 km^2
AND at least 2 of the following:				
a. Severely fragmented or exist in ≤ 10 locations	a. Severely fragmented or exist in ≤ 10 locations	Occurs in 4 locations: Suwannee River and 3 major tributaries, the New, Santa Fe, and Withlacoochee rivers. Trapping has failed to find turtles in 7 rivers in the Big Bend region between the Suwannee and Ochlockonee rivers. The most plausible threat is a toxic chemical spill at a highway/railroad crossing or in a city near the headwaters that would rapidly affect all downstream turtles. The Ichetucknee R., a springfed tributary of the Santa Fe R., is not included as a location because a paved road crossing is lacking near its headwaters.	Y	Enge et al. 2014a, Thomas et al. 2014, Johnston et al. 2015
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals	Projections for sea level rise during the next 90 years may increase the salinity of the waterways which could result in habitat loss and a corresponding decline. Future water quality decline and increased human demand for the water could also result in decline of the population.	I/S	Y	
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	No; extreme fluctuations unlikely in long-lived species; rivers relatively stable.	O	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	The population size in the Suwannee R. downstream of White Springs is estimated at ≈1,000 adult turtles, and the population size in the entire drainage is far less than 10,000 turtles	E	Y	Enge et al. 2014b, Johnston et al. 2015

(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR	Defer to Cc2.			
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	With strong enforcement of 2009 FWC rules prohibiting take, population is likely to grow.	P	N	
a. Population structure in the form of EITHER	The Suwannee/lower Santa Fe/Withlacoochee River/ subpopulation has > 1000 adults.			Enge et al. 2014b, Johnston et al. 2015
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR		E	N	
(ii) All mature individuals are in one subpopulation	No; occurs in 2 subpopulations. One subpopulation is upstream of the land bridge in the Santa Fe R.; limited terrestrial mobility limits gene exchange between these subpopulations, except during floods.	O	N	Johnston et al. 2015
b. Extreme fluctuations in number of mature individuals	No; extreme fluctuations unlikely in long-lived species; rivers provide relatively stable habitat.	O	N	Jackson 2005, Ewert et al. 2006
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	The Suwannee R. downstream of White Springs contains an estimated 1,000 adult turtles; the population is > 1,000 when the Santa Fe R. and other tributaries are included.	E	N	Enge et al. 2014b
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	Estimated area of occupancy exceeds this, but the number of locations is only 4 (Suwannee, New, Santa Fe, and Withlacoochee rivers).	S	Y	Thomas et al. 2014
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	Uncertain; Reed et al. (2002) model assumptions questionable, but suggests possible with even moderate take.	P	N	Reed et al. 2002

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)

Threatened	B1,2ab(iii), D2
Is species/taxon endemic to Florida? (Y/N)	N
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Threatened	B1,2ab(iii), D2

Regional Assessment

1	Biological Status Review Information Regional Assessment	Species/taxon: Suwannee Alligator Snapping Turtle
2		Date:
3		Assessors: Kevin Enge, Dale Jackson, Peter Meylan,
4		Paul Moler, and Travis Thomas
5		
6		
7		
8	Initial finding	
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	N
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	Do not know
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the regional population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	No change
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	Threatened

Biological Status Review Information
Findings

Species/taxon: Apalachicola Alligator Snapping Turtle
Date:
Assessors: Kevin Enge, Dale Jackson, Peter Meylan, Paul Moler, and Travis Thomas
Generation length: 30-40 years (ca. 35 years)

Criterion/Listing Measure	Data/Information	Data Type*	Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]	Limited harvest has occurred throughout the past 90 years, but commercial harvest was apparently restricted, and recent sampling data suggest it is unlikely that there has been a 50% decline.	I	N	Moler 1996; Ewert et al. 2006; Pritchard 2006; Thomas, unpubl. data
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	Insufficient data to make determination of 30% decline.	I	N	Ewert et al. 2006, Pritchard 2006
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	Projections for sea level rise during the next 90 years may increase the salinity of the waterways which could result in habitat loss and reduction of the population, but group is uncertain that the reduction would be at least 30%.	I	N	
(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible.[1]	We suspect a that there has not been a 30% decline although there was historic and continuing harvest and potential for additional decline due to projected sea level rise.	I	N	Ewert et al. 2006, Pritchard 2006
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				
(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	13,714 km^2	E	Y	Area of Holmes and half of Walton Co. east to Leon/Wakulla counties
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	< 2,000 km^2	E	Y	
AND at least 2 of the following:				

a. Severely fragmented or exist in ≤ 10 locations	Occurs in at least 13 locations: Apalachicola R., Ochlockonee R., Choctawhatchee R., Sopchoppy R., Telogia Cr., New R., Chipola R., Juniper Cr., Wetappo Cr., Sandy Cr., Econfina Cr., Holmes Cr., and Turkey Cr.	O	N	Ewert et al. 2006, FL Natural Areas Inventory (FNAI)
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals	Projections for sea level rise during the next 90 years may increase the salinity of the waterways which could result in habitat loss and a corresponding decline. Future water quality decline and increased human demand for the water could also result in decline of the population.	I/S	Y	
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	No; extreme fluctuations unlikely in long-lived species; rivers relatively stable.	O	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	Population size likely < 10,000 adults	S	Y	Moler 1996, Ewert et al. 2006 offer catch-per-unit-effort data, but no population numbers.
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR	Defer to Cc2.			
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	With strong enforcement of 2009 FWC rules prohibiting take, population likely to grow.	P	N	
a. Population structure in the form of EITHER	No suitable quantitative population size data but likely > 1000 in the Apalachicola drainage subpopulation.	S	N	Ewert et al. 2006
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation	No; occurs in several independent drainages.	O	N	Ewert et al. 2006
b. Extreme fluctuations in number of mature individuals	No; extreme fluctuations unlikely in long-lived species; rivers provide relatively stable habitat.	O	N	Jackson 2005, Ewert et al. 2006
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	Few quantitative data available, but trapping surveys on several rivers and a nesting study on the Apalachicola River suggest > 1,000 adults.	S	N	Ewert and Jackson 1994; Moler 1996; FWC, unpubl. data

(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	Both estimated area of occupancy (440 km2) and number of inhabited rivers (1@; each river is at least one location) exceed this.	S	N	Ewert et al. 2006
(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	Uncertain; Reed et al. (2002) model assumptions questionable, but suggests possible with even moderate take.	P	N	Reed et al. 2002

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Not Threatened	None
Is species/taxon endemic to Florida? (Y/N)	N
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Not Threatened	None

Regional Assessment

1	Biological Status Review Information Regional Assessment	Species/taxon: Apalachicola Alligator Snapping Turtle
2		Date:
3		Assessors: Kevin Enge, Dale Jackson, Peter Meylan,
4		Paul Moler, and Travis Thomas
5		
6		
7		
8	Initial finding	
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	N
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	Do not know
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the regional population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	No change
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	Not Threatened

Biological Status Review Information
Findings

Species/taxon: Alligator Snapping Turtle (*M. temminckii*)
Date:
Assessors: Kevin Enge, Dale Jackson, Peter Meylan, Paul Moler, and Travis Thomas
Generation length: 30-40 years (ca. 35 years)

Criterion/Listing Measure	Data/Information	Data Type*	Criterion Met?	References
*Data Types - observed (O), estimated (E), inferred (I), suspected (S), or projected (P). Criterion met - yes (Y) or no (N).				
(A) Population Size Reduction, ANY of				
(a)1. An observed, estimated, inferred or suspected population size reduction of at least 50% over the last 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible and understood and ceased[1]	Has been harvest throughout the past 90 years however due to historic harvest pressures and existing sampling data it is unlikely that there has been a 50% decline.	I	N	Pritchard 2006
(a)2. An observed, estimated, inferred or suspected population size reduction of at least 30% over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased or may not be understood or may not be reversible[1]	Insufficient data to make determination of 30% decline.	I	N	Pritchard 2006
(a)3. A population size reduction of at least 30% projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years) [1]	Projections for sea level rise during the next 90 years may increase the salinity of the waterways which could result in habitat loss and reduction of the population, but group is uncertain that the reduction would be at least 30%.	I	N	
(a)4. An observed, estimated, inferred, projected or suspected population size reduction of at least 30% over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible.[1]	We suspect a that there has not been a 30% decline although there was historic and continuing harvest and potential for additional decline due to projected sea level rise.	I	N	Pritchard 2006
[1] based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate to the taxon; (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; (d) actual or potential levels of exploitation; (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.				
(B) Geographic Range, EITHER				
(b)1. Extent of occurrence < 20,000 km^2 (7,722 mi^2) OR	8,145 km^2	E	Y	Area of Escambia, Santa Rosa, Okaloosa, and half of Walton Co.
(b)2. Area of occupancy < 2,000 km^2 (772 mi^2)	> 2,000 km^2	E	Y	
AND at least 2 of the following:				

a. Severely fragmented or exist in ≤ 10 locations	Occurs in 8 locations: Blackwater R., East Bay R., Escambia R., Perdido R., Pond Cr., Yellow R., Coldwater Cr., and Shoal R.	O	Y	
b. Continuing decline, observed, inferred or projected in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent, and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals	Projections for sea level rise during the next 90 years may increase the salinity of the waterways which could result in habitat loss and a corresponding decline. Future water quality decline and increased human demand for the water could also result in decline of the population.	I/S	Y	
c. Extreme fluctuations in any of the following: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals	No; extreme fluctuations unlikely in long-lived species; rivers relatively stable.	O	N	
(C) Population Size and Trend				
Population size estimate to number fewer than 10,000 mature individuals AND EITHER	Population size likely < 10,000 adults	S	Y	Moler 1996
(c)1. An estimated continuing decline of at least 10% in 10 years or 3 generations, whichever is longer (up to a maximum of 100 years in the future) OR	Defer to Cc2.			
(c)2. A continuing decline, observed, projected, or inferred in numbers of mature individuals AND at least one of the following:	With strong enforcement of 2009 FWC rules prohibiting take, population likely to grow.	P	N	
a. Population structure in the form of EITHER	No suitable quantitative population size data but likely no subpopulation contains > 1000 adults based upon the much longer Suwannee River containing ≈1,000 adults.	S	Y	Moler 1996, Enge et al. 2014b
(i) No subpopulation estimated to contain more than 1000 mature individuals; OR				
(ii) All mature individuals are in one subpopulation	No; occurs in several independent drainages.	O	N	
b. Extreme fluctuations in number of mature individuals	No; extreme fluctuations unlikely in long-lived species; rivers provide relatively stable habitat.	O	N	Jackson 2005
(D) Population Very Small or Restricted, EITHER				
(d)1. Population estimated to number fewer than 1,000 mature individuals; OR	Few quantitative data available, but a trapping survey of several rivers suggest > 1,000 sdults.	S	N	Moler 1996
(d)2. Population with a very restricted area of occupancy (typically less than 20 km^2 [8 mi^2]) or number of locations (typically 5 or fewer) such that it is prone to the effects of human activities or stochastic events within a short time period in an uncertain future	Both estimated area of occupancy (8,145 km^2) and number of locations (8) exceed this.	S	N	

(E) Quantitative Analyses				
e1. Showing the probability of extinction in the wild is at least 10% within 100 years	Uncertain; Reed et al. (2002) model assumptions questionable, but suggests possible with even moderate take.	P	N	Reed et al. 2002

Initial Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Threatened	B1,2ab(iii)
Is species/taxon endemic to Florida? (Y/N)	N
If Yes, your initial finding is your final finding. Copy the initial finding and reason to the final finding space below. If No, complete the regional assessment sheet and copy the final finding from that sheet to the space below.	
Final Finding (Meets at least one of the criteria OR Does not meet any of the criteria)	Reason (which criteria are met)
Threatened	B1,2ab(iii)

Regional Assessment

1	Biological Status Review Information Regional Assessment	Species/taxon: Alligator Snapping Turtle
2		Date:
3		Assessors: Kevin Enge, Dale Jackson, Peter Meylan,
4		Paul Moler, and Travis Thomas
5		
6		
7		
8	Initial finding	
9		
10	2a. Is the species/taxon a non-breeding visitor? (Y/N/DK). If 2a is YES, go to line 18. If 2a is NO or DO NOT KNOW, go to line 11.	N
11	2b. Does the Florida population experience any significant immigration of propagules capable of reproducing in Florida? (Y/N/DK). If 2b is YES, go to line 12. If 2b is NO or DO NOT KNOW, go to line 17.	Do not know
12	2c. Is the immigration expected to decrease? (Y/N/DK). If 2c is YES or DO NOT KNOW, go to line 13. If 2c is NO go to line 16.	
13	2d. Is the regional population a sink? (Y/N/DK). If 2d is YES, go to line 14. If 2d is NO or DO NOT KNOW, go to line 15.	
14	If 2d is YES - Upgrade from initial finding (more imperiled)	
15	If 2d is NO or DO NOT KNOW - No change from initial finding	
16	If 2c is NO or DO NOT KNOW- Downgrade from initial finding (less imperiled)	
17	If 2b is NO or DO NOT KNOW - No change from initial finding	No change
18	2e. Are the conditions outside Florida deteriorating? (Y/N/DK). If 2e is YES or DO NOT KNOW, go to line 24. If 2e is NO go to line 19.	
19	2f. Are the conditions within Florida deteriorating? (Y/N/DK). If 2f is YES or DO NOT KNOW, go to line 23. If 2f is NO, go to line 20.	
20	2g. Can the breeding population rescue the Florida population should it decline? (Y/N/DK). If 2g is YES, go to line 21. If 2g is NO or DO NOT KNOW, go to line 22.	
21	If 2g is YES - Downgrade from initial finding (less imperiled)	
22	If 2g is NO or DO NOT KNOW - No change from initial finding	
23	If 2f is YES or DO NOT KNOW - No change from initial finding	
24	If 2e is YES or DO NOT KNOW - No change from initial finding	
25		
26	Final finding	Threatened

Appendix 1. Biological Review Group Members Biographies

Kevin M. Enge received his M.S. in Wildlife Ecology and Conservation from the University of Florida and B.S. degrees in Wildlife and Biology from the University of Wisconsin–Stevens Point. He is currently an Associate Research Scientist in the Reptile and Amphibian Subsection of the Wildlife Research Section, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission (FWC). He has worked for FWC since 1989, serving as a nongame survey and monitoring biologist and the Herp Taxa Coordinator. He has conducted numerous surveys of both native and exotic amphibians and reptiles, and he has > 100 scientific papers and 45 reports.

Dr. Dale R. Jackson received his Ph.D. degree in Zoology from the University of Florida and his B.S. degree in Zoology from Eastern Illinois University. He serves as Senior Research Zoologist of the Florida Natural Areas Inventory (FNAI), which he helped found in 1981. At FNAI, he oversees database development for rare amphibians, reptiles, and aquatic invertebrates and is a principal advisor to the Florida Forever land acquisition program. Since moving southward from Illinois to pursue graduate studies, he has spent 44 years studying and conserving Florida's herpetofauna, with research emphasis on freshwater turtles, and has published more than 70 scientific papers and book chapters.

Dr. Peter A. Meylan received his Ph.D. from the University of Florida. He is currently R.R. Hallin Professor of Natural Sciences at Eckerd College in Saint Petersburg, FL. His research interests include the evolutionary history, ecology, and conservation biology of amphibians and reptiles, especially turtles. Current research includes two sea turtle projects: an investigation of the ecology and migrations of sea turtles of Bocas del Toro Province, Panama (funded by the Wildlife Conservation Society) and the Bermuda Turtle Project, which is a cooperative project with the Bermuda Aquarium and the Sea Turtle Conservancy. He studies the biology of freshwater turtles in Florida with the Eckerd Herpetology Club mostly on the Rainbow River in Marion County. He has published nearly 100 scientific articles on turtles and is the editor of a book on the biology and conservation of all Florida turtles that was published in 2006.

Paul E. Moler received his M.S. in Zoology from the University of Florida in 1970 and his B.A. in Biology from Emory University in 1967. He retired in 2006 after working for 29 years as a herpetologist with FWC, including serving as administrator of the Reptile and Amphibian Subsection of the Wildlife Research Section. He has conducted research on the systematics, ecology, reproduction, genetics, and conservation biology of a variety of herpetofaunal species in Florida, with primary emphasis on the biology and management of endangered and threatened species. He served as Chair for the Florida Committee on Rare and Endangered Plants and Animals in 1992–94, Chair of the Committee on Amphibians and Reptiles since 1986, and editor of the 1992 volume on amphibians and reptiles. Paul has > 90 publications on amphibians and reptiles.

Travis M. Thomas received his M.S. in Wildlife Ecology and Conservation and Bachelor's Degree in Natural Resources Conservation from the University of Florida. Travis was hired by FWC in 2008, and he has worked on numerous projects concerning reptile and amphibian ecology. Travis now works for the Nature Coast Biological Station. He has published several notes on the ecology and distribution of reptiles and has published on the taxonomy of *Macrochelys* and on the population ecology of *M. suwanniensis* in the Suwannee and Santa Fe rivers.

Appendix 2. Interpretation of Rescue Effect in the Regional Assessment (Question 2b)

Guidelines for Application of IUCN Red List Criteria at Regional Levels (Version 3.0) defines rescue effect as the "*process by which immigrating propagules result in a lower extinction risk for the target population*." Furthermore, the guidelines state that "*if immigration does occur, it is important to consider whether the numbers arriving in the region are sufficient to rescue the regional population, and whether the immigration occurs regularly and over a time period relevant to the threats facing the regional population, such that rescue is feasible*" (IUCN 2003). However, no specific timetable is given for this recolonization period.

The ability of a rescue effect to lessen the effects of a catastrophic event implies that new individuals would need to migrate to the affected area and colonize the area while reaching a stable population size. Currently, the best estimates of a stable and growing population is 12−14 alligator snapping turtles/river km (Folt et al. 2016). Juvenile alligator snapping turtles had the highest probability of entry into the population (0.072), females had a moderate probability (0.021–0.023), and males had the least probability (0.005–0.009) (Folt et al. 2016). IUCN (2003) provides no criteria on a timeline for a recolonization, although it would undoubtedly take several generations. Because of long generation times, low recruitment, and virtually unknown immigration or emigration rates from populations, we conclude that a rescue effect (Question 2b) is unknown for all 3 species of alligator snapping turtle.

Appendix 3. Summary of the 6 independent scientific reviews of the Alligator Snapping Turtle Species Biological Status Review Report.

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Dept. of Biological Sciences
331 Funchess Hall
Auburn, Alabama 36849

Brian Folt
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334.844.8770

17 November 2016

Dear members of the Florida Fish and Wildlife Conservation Commission:

I recently read the Biological Status Review (BSR) Report for Alligator Snapping Turtles (ASTs) in Florida, and, in summary, I found the BSR report to provide a reasonable assessment of the conservation status for Alligator Snapping Turtles (*Macrochelys* sp.) in Florida. The review team provided a detailed summary of the knowledge surrounding the turtles, primarily for the state of Florida, but relevant details from other areas were included. Generally speaking, I commend the authors on providing a nice synthesis of information to date, which included a quality blend of both published and very interesting unpublished information. However, no mention of some important papers from outside Florida was somewhat puzzling, particularly three relatively detailed population studies. Below here I provide some comments – some broad, some specific – much of which are derived from my specific background and experience studying *Macrochelys*.

The review team adopted a *Macrochelys* taxonomy which utilized a working hypothesis that there are three different species of ASTs. Species delimitation will influence the abundance and number of discrete populations available for species – an important criterion used in to evaluate the conservation status of species. Only brief mention is given to a recent paper questioning the diagnosability and existence of one of the recently described species, and no rationale is provided as to why this alternative viewpoint is neglected. Hypothetically, this might be troubling, if the review team is incorrect and this stance caused an incorrect conservation listing decision. For example, if the team was to have found that either *M. apalachicolae* or *M. temminckii* was imperiled in Florida and suggested input of resources toward management of said species, then this might have been a situation to appropriately question potentially dubiously delimited species. However, the team concluded that both of these population clusters do not currently warrant greater conservation listing. So, regardless of whether these populations are considered as 1) two distinct species or 2) two evolutionary significant [management] units within one species, there is little risk involved associated with being "incorrect" about whether *M. temminckii* is one wide-ranging or actually two separate species in Florida. At the end of the day, I think the evaluation of these populations as two distinct units is appropriate, either as species or evolutionary significant [management] units. I also think the topic is clearly still in need of more data to guide a careful resolution.

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The 'Quantitative Analysis' section on pg. 7 and discussion of population demography throughout the document are both notably out of date and rely heavily on an oft-cited but unpublished report (Reed et al. 2002). While I greatly appreciate the Reed et al. report for providing a fine summary of AST demography in 2002, that document did not undergo peer review and contains a number of questionable assumptions and conclusions. I have tremendous respect for those authors, but, to be frank, I think that discussion points in that report are cited so frequently in the literature is inappropriate. For the Biological Status Review here, I think discussion of population demography throughout the paper could have generally benefited from examination of three recently published papers which describe population demography in greater details – Howey and Dinkelacker (2013) *Copeia*, East et al. (2013) *Wildlife Research*, and Folt et al. (2016) *Herpelogical Monographs*. By integrating data from first two papers into a comprehensive analysis, the third paper provides helpful estimates of various demographic parameters from declining and stable populations. Our manuscript from Georgia also provides discussion of the Reed et al. report, and describes some problems associated with the model interpretation and arguments presented therein. Parameters in the three aformentioned papers which may be of interest for the Florida BSR include juvenile and adult survival, population size, sex ratios, generation time, and maybe others! To credit the review team, they did note in the tables toward the end of the report (e.g., page 20) that the "Reed et al. (2002) model assumptions [are] questionable" – I agree.

A lot of consideration is given to the possibility of a 'rescue effect', which implicitly assumes that individuals from outside of Florida could disperse down rivers and provide recruitment to populations in the state. While I think this is a nice idea, I think that application of a metapopulation context here is useful and questions how helpful this concept might actually be. Rivers are a two-way street: dispersal could provide recruitment to Florida, but Florida populations could also serve as 'source' populations which provide recruits to populations in Georgia/Alabama. At best, the exchange could be equivocal; at worst, less ideal population conditions in Alabama and Georgia could represent 'sink' populations, which might not produce as many recruits to disperse back to Florida. To bring this into reality, existing data also question how much recruitment potential would benefit Florida populations in certain situations. For example, for each hypothetical species: 1) the Choctawhatchee drainage in Alabama has ~no turtles, which questions the presence of a viable source population in that drainage; 2) there is a major dam in the Apalachicola River, separating populations between Georgia and Florida and preventing dispersal; and 3) John Jensen caught few (if any?) *M. suwanniensis* in Georgia, which also questions the presence of viable source populations for that species in Georgia. Alternatively, viable populations likely occur in the unimpounded Conecuh and Yellow Rivers, which could serve as sources for recruitment in that situation. However, in conclusion, I wouldn't bank heavily on recruits from outside the state in this conservation listing protocol.

Specific comments pertaining to the document:

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Page (pg.) 3, paragraph (par. 2) – The three genetic lineages identified by Roman et al. (1999) are not corroborated by Echelle et al. (2010); see Folt and Guyer (2015) for details.

Pg. 3, par. 3 – "movements into salt water are extremely rare"; I would argue that there are no data to indicate how common or rare such events occur. However, observations of 1) barnacles on specimens and 2) individuals in small, isolated rivers which are tidally influenced both suggest that marine dispersal may be more common than previous recognized.

Pg. 3, par. 5– It's worth including metric conversion of measurements, for those more metrically inclined. "equal sex ratio" – equal observed sex ratio*; if detection probably varies sex, then the observes sex ratio will not equal the true sex ratio.

Pg. 4, par. 1 – After reading Johnson et al. (2015) and this report, the hypothesis of how artesian vs. blackwater habitat in the Sante Fe River influences the population demography of ASTs is still unclear to me.

Pg. 4, par. 1 – Like most *Macrochelys* papers, discussion of human take and commercial harvest lacks rigorous data and generally strikes me as speculative. This comment applies to areas throughout the paper which mention potential effects of harvest. Without better models, I frequently find these discussions to be lacking substance.

Pg. 4, par. 2 – These are absolutely fascinating data!

Pg. 4, par. 3 – "Dobie (1971) ~~claimed~~ found* both sexes in Louisiana to attain* sexual […], but other researchers ~~claim~~ have suggested* maturity requires […]" I often wonder how growth and age of sexual maturity varies, given food availability and population density.

Pg. 4, par. 3 – "Reed et al. (2002) estimate generation time at 49 years." See Folt et al. 2016 *Herpetological Monographs*; a model estimate from a viable population in Georgia suggested a generation time of ca. 31 yr (28–34, 95% CI).

Pg. 4, par. 3 – Warmer microhabitats producing female-biased ratios – nice implications given climate change and human-modification of habitat – more females should only help population sizes, even if at an unnatural sex ratio.

Pg. 5, par. 2 – It may be worth noting that estimates of population size here are somewhat lower than comparable estimates of adult abundance from a population modeled to be viable in Spring Creek, Georgia (~9 adults/river km).

Pg. 5, par. 3 – The topic sentence of this paragraph is highly speculative, in my opinion.

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Pg. 5, par. 3 – "low rates of recruitment of ~~virtually all~~ turtles in general*.

Pg. 6, par. 3 – Ochlochonee*

Pg. 8, par. 1 – I think ingestation of fish hooks is a huge and underappreciated problem. I imagine snagging and drowning initially is the greatest cause of mortality, but if individuals get free they probably have pretty high survival. (speculation.) This topic deserves future study for *Macrochelys* and other turtles in the Southeast.

Pg. 10, Table 1 – Such few observations of individuals in the Choctawhatchee cause me to question evaluation of this river as possessing viable populations. There are zero records from Alabama, and very few (2? 3?) individuals from Florida.

Pg. 11 – I am confused as to why the Ichetucknee River is being discussed here? I was unaware that relevant populations of *Macrochelys* occurred there.

Pg. 12, par. 2 – Potential removal of the Choctawhatchee River ticks the number of *Macrochelys apalachicolae* locations down one; even if there are a few individuals in that river, I still question the viability.

Pg. 13, par. 2 – If *M. temminckii* is absent in the Alabama Choctawhatchee and tributaries, then don't expect a rescue effect. Recent observations of *M. temminckii* in Five Runs Creek, a tributary of the Yellow River, indicate a nice little population that would be ~protected by being within the Conecuh National Forest.

Sincerely,

Brian Folt

Brian Folt

From: Riedle, Daren
To: Imperiled
Subject: Alligator Snapping Turtle Biological Status Review
Date: Friday, November 04, 2016 4:03:34 PM

I have reviewed the Biological Status Reviews for the three species of Alligator Snapping Turtle occurring in Florida. I am not very familiar with the multitude of aquatic habitats and their stressors in Florida, so can not comment directly on those aspects of the review. I do agree with the distributional and demographic assessments as summarized within the document. Based on my work within the extreme western edge of the distribution for *M. temminckii,* populations appear to recover, and/ or remain stable when any additive mortality above and beyond natural death rates is removed. Provided that the risk of incidental or intentional take is removed as much as possible, then I would agree that no-listing is required for *apalachicolae* and *temminckii*. I also understand that the taxonomic status of *M. apalachicolae* may be in a bit of flux, but regardless of whether it remains a valid taxon or not I encourage FWC to continuing managing populations of *apalachicolae* and *temminckii* as distinct population segments.

Thank you for the opportunity to review, and please do not hesitate to contact me should you have additional questions.

Daren Riedle

--
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Comments on "Alligator Snapping Turtle Species Biological States Review Report"

Richard A. Seigel and Hunter Howell

General Comments:

This was a well-written and informative review of the biology and status of Alligator Snapping Turtles in Florida. However, we have several reservations about the review and, especially, the conclusions and status recommendations.

1) Based on a reading of both the Thomas et al (2014) paper and the rebuttal to that paper by Folt and Guyer (2015), it appears that the taxonomic status of this species complex (especially that of *M. apalachicolae*) is, at best, uncertain. The detailed rebuttal of Folt and Guyer (2015) to the conclusions of Thomas et al (2014) merits a much more detailed consideration and discussion then is provided in the single line of text on page 3, especially since this potentially affects the conclusions of this status assessment. If the FWC staff wish to reject the criticisms of Folt and Guyer, they should do so in detail, with appropriate supporting data and analysis.

2) We have serious reservations regarding the rather casual way the concept of the "rescue effect" is used to justify some of the status recommendations made here. This is made especially puzzling since the comment on pp 13 seems to dismiss the effectiveness of a rescue effect for this species (" Because relatively little is known regarding *Macrochelys* movements, and only 1 or 2 rivers for each *Macrochelys* species might provide a rescue effect, the BRG decided that the rescue effect is unknown for all 3 species and the initial findings should not change")

   Metapopulation theory predicts that population extinctions are offset through recolonizations of depopulated habitats by conspecifics of other populations within the metapopulation structure. The rescue effect portrayed here suggests that individuals move from one population into another either extinct or depleted population patches and are able to effectively recolonize that specific habitat patch. Given the acknowledgement made in the current text regarding the low population recruitment and long generation times of turtles (see pp. 5), this seems highly unlikely to occur. Furthermore, the rescue effect assumes that these dispersing individuals are able to overcome whatever caused the original population to go extinct in the first place.

   Researchers have long realized that individual chelonians move within populations. However, there are very few quantitatively documented metapopulations of turtles. It took a 26 year spatially extensive mark recapture study on slider turtles (*Trachemys scripta*) to document a metapopulation and the study still did not document any evidence of a rescue effect (Burke et al. 1995).

   3) Despite the ban on commercial harvesting, *Macrochelys* is still faced with trotline fishing, pollution, dredging, impounding, channelization, and nest predation by mesopredators. Since it

has been concluded that an annual adult female survival of 98% is necessary to maintain population viability (Reed et al. 2002), these threats will most likely continue to cause decreasing populations over a very long time period. Therefore, it is imperative to continue focusing on reducing threats to species as a whole, not relying on individual inputs from other populations (that are also most likely declining). Overall, using a hypothetical rescue effect (that has not been documented in the relevant literature) as a proxy for determining a species conservation standing in a state is overly optimistic and ignores the factors that continue to cause range-wide population decline.

Specific Comments:

1) Noting the number of locations or populations would be more informative if these populations had been studied and represented viable populations, rather than relying on capture rates as a surrogate for population viability. The presence of multiple individuals within a particular river's watershed does not signify a viable population. The report refers to multiple populations as being abundant or rare based on the catch rate (per trap night). However, catch rates are highly variable and can vary based on time of year, location of trap, temperature, bait choice, trap type, etc. and are often biased toward specific demographic groups (see Ream and Ream 1966; Ryan et al. 2002; Bluett 2011; Tesche and Hodges 2015). Therefore, it is imperative that high recapture rates are attained to effectively assess population size (Roff 1973).

2) If Reed et al. (2002) estimated a generation time of 49 years, why was a generation time of 30 years used in the text? This leads to a time frame of only 90 years for three generations, which may be potentially outlasted by a single long-lived individual. Estimating generation time at 49 years relates to three generations equaling about 150 years, which will display more biologically significant changes in the population sized of such a long lived species.

3) In each of the figures, there are possible localities of each species (blue) and long-term localities with viable populations (green). However, there is no data referenced in the report to substantiate the claims of **viable** populations within those rivers. Perhaps a more informative figure would have included those populations for which population estimates and viability analysis had been conducted.

References:

Bluett, R. 2011. Sampling assemblages of turtles in central Illinois: A case study of capture efficiency and species coverage. Trans. Illinois State Acad. Sci. 104:127–136.

Burke, V. J., J. L. Greene, and J. W. Gibbons. The effect of sample size and study duration on metapopulation estimates for slider turtles (*Trachemys scripta*). Herpetologica 51(4):451-456.

Ream, C., and R. Ream. 1966. The influence of sampling methods on the estimation of population structure in painted turtles. Amer. Midl. Nat. 75:325–338.

Reed, R. N., J. D. Congdon, and J. W. Gibbons. 2002. The alligator snapping turtle [*Macroclemys (Macrochelys) temminckii*]: a review of ecology, life history, and conservation, with demographic analyses of the sustainability of take from wild populations. Report to: Division of Scientific Authority, United States Fish and Wildlife Service.

Roff, D. A. 1973. On the accuracy of some mark-recapture estimators. Oecologia 20:15–34.

Ryan, T. J., T. Philippi, Y. A. Leiden, M. E. Dorca, T. B. Wigley, and J. W. Gibbons. 2002. Monitoring herpetofauna in a managed forest landscape: effects of habitat types and census techniques. Forest Ecol. Manag. 167:83–90.

Tesche, M. R., and K. E. Hodges. 2015. Unreliable population inferences from common trapping practices for freshwater turtles. Global Ecol. Conserv. 3:802–815.

From: Jensen, John
To: Imperiled
Subject: Alligator Snapping Turtle Biological Status Review
Date: Thursday, October 20, 2016 2:07:43 PM

To FWC:

I have thoroughly reviewed the Alligator Snapping Turtle Biological Status Review and found the analyses and conclusions regarding recommended listing status sound and appropriate. However, I do not feel that the taxonomic disagreement by Folt and Guyer (2015) was adequately addressed. Rather, there was only a mention that a published disagreement exists without any discussion on why the Biological Review Group Members dismissed the argument made by Folt and Guyer. It is not surprising that the Members chose not to accept that argument since three of them were co-authors of the description of the two new taxa (one of which was invalidated by Folt and Guyer), but I think it is important to present their case against acceptance in this review. Regardless, if *M. apalachicolae* is not treated as a valid taxon as suggested by Folt and Guyer, *M. temminckii* would rank out as even less imperiled and the recommendation not to list the alligator snappers occurring in the Ochlockonee River and all those drainages to the west of it would remain so.

Specific comments on the information within the review:

1. Page3, 4th paragraph: "No population studies have been conducted on *M. temminckii* in Florida" – what about Moler 1996?
2. Page 4, 3rd paragraph: "Life span in the wild is unknown". Perhaps this paper was published after the team completed their review, but the following uncited paper provides data on longevity in the wild, as well as quite a bit of additional useful data/information: Folt, B., J. B. Jensen, A. Teare, and D. Rostal. 2016. Establishing reference demography for conservation: A case study of *Macrochelys temminckii* in Spring Creek, Georgia. Herpetological Monographs 30:21-33.
3. Page 5, 2nd paragraph: "...but Moler (1996) **also** failed to trap the species there (Choctawhatchee River) in 12 trap nights." The previous sentence that "also" refers to indicates that Mays et al. yielded a CPUE of 0.01 per trap night, which would suggest that at least one turtle was captured there or else it would have been a CPUE of 0.00. Thus, the word "also" is not appropriate unless the 0.01 figure is in error.
4. Page 5, 2nd paragraph, last sentence: need to add "in" – "...were **IN** the upper Escambia River"
5. Page 5, 4th paragraph: A statement is made that a series of protective rules by FWC reduced the species' rate of decline in Florida, but provides not supportive information/data on this. Without such, this is an unfounded assumption. If info/data does indeed exists to support this claim, then cite it.
6. Page 6, 2nd paragraph: the range of *M. temminckii* outside of Florida is mentioned, but why for this species but not the other two?
7. Page 9: "...even a major spill along one Panhandle river would not endanger the species' statewide population". If all ASTs are treated as a single species then that is a valid statement, but if a major spill occurred in the Suwannee or Sante Fe rivers an argument could certainly be made for endangerment of *M. suwanniensis*.
8. Page 9: Wild hogs and fire ants are mentioned as potential predators. I think it is appropriate to add fish crows, skunks, and kingsnakes as potential predators.
9. Page 13, 2nd paragraph: A trapping study in Georgia found them to be abundant "in the Apalachicola and 2 of its tributaries". The Apalachicola was not trapped in this study and it doesn't exist in GA. This suggests that they were found to be abundant in three streams (Apalachicola and two of its tributaries). Rather, this was the case in only two streams (the two tribs – Chattahoochee and Spring Creek).

Sincerely,

John Jensen
Senior Wildlife Biologist, Nongame Conservation Section

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From: lithasia@gmail.com on behalf of Chris Phillips
To: Imperiled
Subject: Re: Alligator Snapping Turtle Biological Status Review
Date: Monday, October 17, 2016 4:25:54 PM
Attachments: AST Florida Review.docx

Please see my attached review.

--
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(1) The completeness and accuracy of the biological information and data analyses in the BSR, including the evaluation of how the BRG applied the listing criteria.
I don't see any data analysis in the BSR, only reference to previously analyzed data, so I'm not sure how to answer this section. Concerning completeness, the BRG did not include data from the 2016 paper by Folt et al in Herpetological Monographs. Perhaps the paper did not appear until after the BGR met, but these data should now be incorporated into the BSR.

(2) **The reasonableness and justifiability of our assumptions (e.g., taxonomy validity), interpretations of the data, and conclusions.**
As with any threat assessment, there is necessarily much subjectivity in this BSR. I could pick at every conclusion drawn by the BRG because most aren't explained in the narrative. I would much rather see the threats tables and then an appendix of explanations concerning how the BRG arrived at their conclusions for each threat and sub-threat, especially when the conclusion was reached by inference. For example, how did the BRG arrive at the conclusion that it is unlikely that projected sea level rise would reduce population sizes at least 30% (a-3)? I understand that they coded that as inference, but can we get some insight concerning how they inferred this? This issue is repeated for all three taxa numerous times. Just because it's an inference doesn't mean you can't explain your reasoning. In addition, if inference (or worse) was required because data are lacking to make it observed or estimated, which in the case of *suwanniensis*, occurs 44% of the time (7 of 16 threats were either inferred, suspected, or projected), why not just admit that there are insufficient data to make a decision?

In addition to the issue explained above, I have picked two instances where there is some explanation of the reasoning used by the BRG to arrive at a "Y" or "N", but the inference is flawed or based on incomplete or questionable data.

Applies to all three taxa:

In the BSR Information Findings table, under **e1: Quantitative Analysis, Showing the probability of extinction in the wild is at least 10% within 100 years**, the entry in the Data/Information column is: "Uncertain; Reed et al. (2002) model assumptions questionable, but suggests possible with even moderate take". The committee based this statement on the comments in Ewert et al. 2006 (p. 7 of BSR). The statement on p. 7 of the BSR reads "The model may have underestimated the rates of nest and/or juvenile survival in the wild, leading to an overestimate of necessary female survival rate (Ewert et al. 2006)". However, Ewert et al. (2006) did not say that the nest survival estimated by Reed et al (2002) was too high. Rather, they said Reed's model *underestimated* nest survival. What Ewert et al. (2006) *did* say was that Reed's model underestimated juvenile survivorship, because they held it steady until 12 years of age, and that it would be more realistic to increase survivorship at year 6. Ewert et al. (2006) went on to say that modeling with increased juvenile survivorship "would show population stability with lower adult survival and would accommodate take at a very low level." However, there is no re-modeling with higher juvenile survivorship given in the Ewert et al. paper, so this is, at best, a guess, and does not substantiate a conclusion of "no" for this criterion. What is needed is re-modeling with increased juvenile survivorship, or a sensitivity analysis varying juvenile

survivorship, both of which would take 10 minutes given the original model parameters are given in Reed et al. (2002). In addition, Reed et al. (2002) stated in their introduction: "Wherever possible, we erred on the side of an assumption of population stability (discussed below). This type of conservatism means that our results probably underestimate the importance of adult survivorship for population stability."

Applies to *suwanniensis*:
In the BSR Information Findings table, under **d1: Population very small or restricted, Population estimated to number fewer than 1,000 mature individuals**, the entry in the Data/Information column is: "The Suwannee R. downstream of White Springs contains an estimated 1,000 adult turtles; the population is > 1,000 when the Santa Fe R. and other tributaries are included." The committee based this entry on the report by Enge et al (2104b). However, this report did not state that the Suwannee R. downstream of White Springs contained 1,000 individuals. The abstract states "We estimate approximately 867 adult turtles inhabit the Suwannee River, not including its tributaries, between White Springs and the estuary." The confidence intervals around this estimate are 780−1,171 adults, so it is not accurate to use the estimate of 1,000. The conservative estimate is 867, which is under 1,000. Where did 1,00 come from? In addition, the Enge et al. report does not state which abundance estimation model they used, just that it was a closed model and they "tested several population models". The more robust approach to this issue would be to use AIC to choose the best fitting model, and go with that estimate. This is easily done in the program MARK (which Enge et al. used). The entry also states that when the Santa Fe and other tributaries are included the population is greater than 1,000. The problem with this statement is that there is no abundance estimate for the Santa Fe or other tribs. The Johnston et al. (2015) paper states that they trapped/captured 109 individuals, only 82 of which were mature. This is not a large number of turtles, especially given that they trapped for 7-8 years. In addition, there is no statement of trapping effort in Johnston et al. 2105. Therefore, when estimating the number of mature individuals of *suwanniensis* it is more prudent to use the 867 from Enge et al. It is nearly impossible to put a number on how many there are in the Santa Fe, but even if you assume that all 82 of the animals they detected between 2004 and 2011 are still in the Santa Fe, that results in an overall estimate of 949, clearly less than 1,000. You should change this decision to "Y" and also change the entry in the "Data" column to I, as you cannot consider this an estimate because of the unknown number of turtles in the Santa Fe.

Alligator Snapping Turtle Species Biological Status Review Report

Peer Reviewer: Day B. Ligon, Associate Professor, Missouri State University

I appreciate the opportunity to review and comment upon this status review report. The contributors to the report did an excellent job of integrating the information that is available for the species, and in most cases I agree with their interpretations of some of the poorly understood aspects of the species' biology. However, I think that some assumptions deserve additional consideration, as getting them wrong could lead to insufficient protection of the species. Additionally, I hope that this report serves to highlight aspects of the species' ecology that need more focused research to support more robust conservation decisions.

My concerns can be encapsulated by just a few points, so I'll be brief:

1) I'm concerned about the decision to use an extremely conservative estimate of generation time for alligator snapping turtles. Historically speaking, annual survival of females is expected to be very high in a stable or growing population (98%), and because the species is slow to mature, I'm concerned that estimating the average age at recruitment at 30–40 years is too low. As noted by the authors, previous estimates were closer to 50 years, and this discrepancy could have a huge impact on the trajectories for populations. I strongly suspect that the number of generations in 90 years is much closer to 2 than 3 in a stable, unimpacted population.
2) On a similar note, I feel that the authors may not be giving sufficient weight to the population-level impacts of harvest. Poaching almost certainly happens, and even low levels of chronic poaching can drive a population toward inviability or extirpation. Perhaps more concerning, though, are the potential impacts of bycatch on trot lines and limb lines. Unfortunately, I'm unaware of reliable data to back up my concerns, so this criticism will be easy to dismiss if you so choose. However, my experience working with USFWS Special Agents on an alligator snapping turtle poaching case, and my first-hand experience witnessing the high mortality rates that fishing lines can incur lead me to believe that these issues are incredibly important but under-appreciated for conservation of the species. Documenting the impacts of human harvest of protected species is incredibly challenging, but I hope that efforts to do so range-wide will occur.
3) The BRG identified toxic chemical spills as the most likely scenario for a population being decimated in a short period of time. That could happen, but seems unlikely given the pretty lousy conditions under which aquatic turtles can persist. I'm concerned that the Group is taking too narrow a view of what can constitute "a single threatening event that can rapidly affect all individuals…" I would argue that such events need not transpire over the course of days or weeks, but could instead remain undetected even as they unfold over years. From this perspective, poaching and bycatch may well constitute the kind of threatening event that could effectively wipe out a population. This has very likely happened elsewhere in the species' range. I am concerned that, because the impacts of these activities are so difficult to quantify, biologists and policy makers have a tendency to dismiss them to the detriment of species conservation.
4) I subscribe to the camp that supports folding *M. apalachicolae* back into *M. temminckii*. Nonetheless, this taxonomic group clearly represents an evolutionarily significant unit, so I strongly support giving it independent consideration, as the authors have done.