Painted Snake Coiled Forest Snail
(Anguispira picta)

5-Year Review:
Summary and Evaluation


Photo credit David Withers, TDEC

U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services Field Office
Cookeville, Tennessee

5-YEAR REVIEW

Painted snake coiled forest snail / *Anguispira picta*

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on available information pertaining to historic and current distributions, life history, and habitat of this species. Our sources include the final rule listing this species under the Endangered Species Act; the recovery plan; unpublished field observations by Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. We published an announcement in the *Federal Register* requesting information on this species on March 25, 2014 (79 FR 16366), and a 60-day comment period was opened. No comments were received that provided new information concerning *Anguispira picta*. We distributed a draft of this document for peer review to the author of the species' Recovery Plan, a biologist for the Tennessee Division of Natural Areas, and a private biological consultant, all of whom have experience working with *Anguispira picta* (see Appendix A). Comments received were evaluated and incorporated into this final document as appropriate (see Appendix A).

B. Reviewers

Lead Region – Southeast Region: Kelly Bibb, 404-679-7132

Lead Field Office – Tennessee Ecological Services: Geoff Call, 931-525-4983

C. Background

1. Federal Register Notice citation announcing initiation of this review: March 25, 2014, 79 FR 16366

2. Species status: Stable. Available data, collected from a portion of the species' range during 2008 – 2010, summarized herein, indicate that large populations of the species persist in Crow Creek Valley. And, recent acquisition by The Conservation Fund (TCF) of lands on the east side of Crow Creek Valley ensures that approximately half of the species' total population is permanently protected from incompatible land uses.

3. Recovery achieved: 2 (2 = 26 – 50% species' recovery objectives achieved)

4. Listing history

Original Listing
FR notice: 43 FR 28932
Date listed: July 3, 1978
Entity listed: species
Classification: threatened

5. Review History:
Each year, the Service reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we did a recovery data call that including showing status recommendations, such as "Stable" for this snail. We continue to show that species status recommendation part in our 5-year reviews. The most recent evaluation for this snail was completed in 2015.
Recovery Plan: 1982

Five Year Review: November 6, 1991 – In this review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this snail in the review.

Five Year Review: September 20, 2005 – In this review (70 FR 55157), which was approved on January 16, 2008, no changes were proposed for the listing status, which remained threatened. The species recovery priority number was changed from 8 to 8C to reflect the fact that conservation of the species resulted in conflict with economic development related to operation of a limestone quarry on a property occupied by the species.

6. Species' Recovery Priority Number at start of review (48 FR 43098): 8C (degree of threat is moderate, potential for recovery is high, and taxonomy is at the species level; conservation efforts conflict with economic development)

7. Recovery Plan
Name of plan: Recovery Plan for Painted Snake Coiled Forest Snail
Date issued: October 14, 1982

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy: Not applicable. The painted snake coiled forest snail is an invertebrate, and therefore not covered by the DPS policy; and other DPS related questions will not be addressed in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? The plan contains a recovery objective, but does not articulate recovery criteria. However, the plan stipulates that "unless significant populations of *A. picta* are found outside Buck Creek Cove and preclude the need for further protection of the species, it shall not be considered recovered until…" certain conditions are met. For the purposes of this review, those conditions are listed and treated as recovery criteria below.

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No – The recovery objective and related criteria in the Recovery Plan for *A. picta* were developed at a time when the species was thought to be restricted to approximately 325 acres (ac) in the vicinity of Buck Creek Cove. Withers (2003, 2004) extended the known range to occupy approximately 1,950 ac, distributed in a narrow vertical band along approximately 9.8 miles of Cumberland Plateau escarpment in Crow Creek Valley (Figure 1). The Recovery Plan lists timber harvesting, limestone quarrying, and forest fire as potential threats to the species. Limestone quarrying is an ongoing threat, within a portion of the species' range on lands owned by the Sherwood Mining Company, but the magnitude of this threat has been reduced since the last 5-year review. Timber harvesting and forest fire remain as potential threats, and habitat modification due to residential development remains a potential threat that was identified during the last 5-year review.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? No

3. Recovery Criteria:

a. *Anguispira picta* and its habitat are protected from human-related threats and/or modifications that would endanger the species' existence.

This criterion, which addresses listing factor A (present or threatened destruction, modification or curtailment of its habitat or range), has been partially met. In 2016, TCF purchased approximately 3,895 ac on the east side of Crow Creek Valley from the Sherwood Mining Company (SMC) (Figure 1). This purchase was made possible by awards to the State of Tennessee from the U.S. Forest Service's Forest Legacy and the Service's Recovery Land Acquisition (RLA) grant programs, funding from TCF, and a grant from the Open Space Institute. SMC agreed to sell this parcel after determining it would pursue development and operation of an underground limestone mining operation, requiring ownership of less surface area than would have been needed for the open-pit quarry that SMC had previously intended to develop. The State of Tennessee will purchase the property from TCF and designate the lands where *A. picta* occurs as a State Natural Area.

The Service's biological opinion for the RLA grant covered the following three interrelated and interdependent components of the action, to be undertaken by SMC, which would not have been possible but for sale of the lands above to TCF: (1) development and operation of above-ground infrastructure to support an underground limestone mine within an area totaling approximately 194 ac, (2) construction of five, ventilation shafts, including surface disturbance within a 1,000-square foot area around each, and maintenance of 25 ac (7 miles) of existing roads to provide access to these shafts outside of the 194-ac area, and (3) donation of an approximately 172-ac parcel to

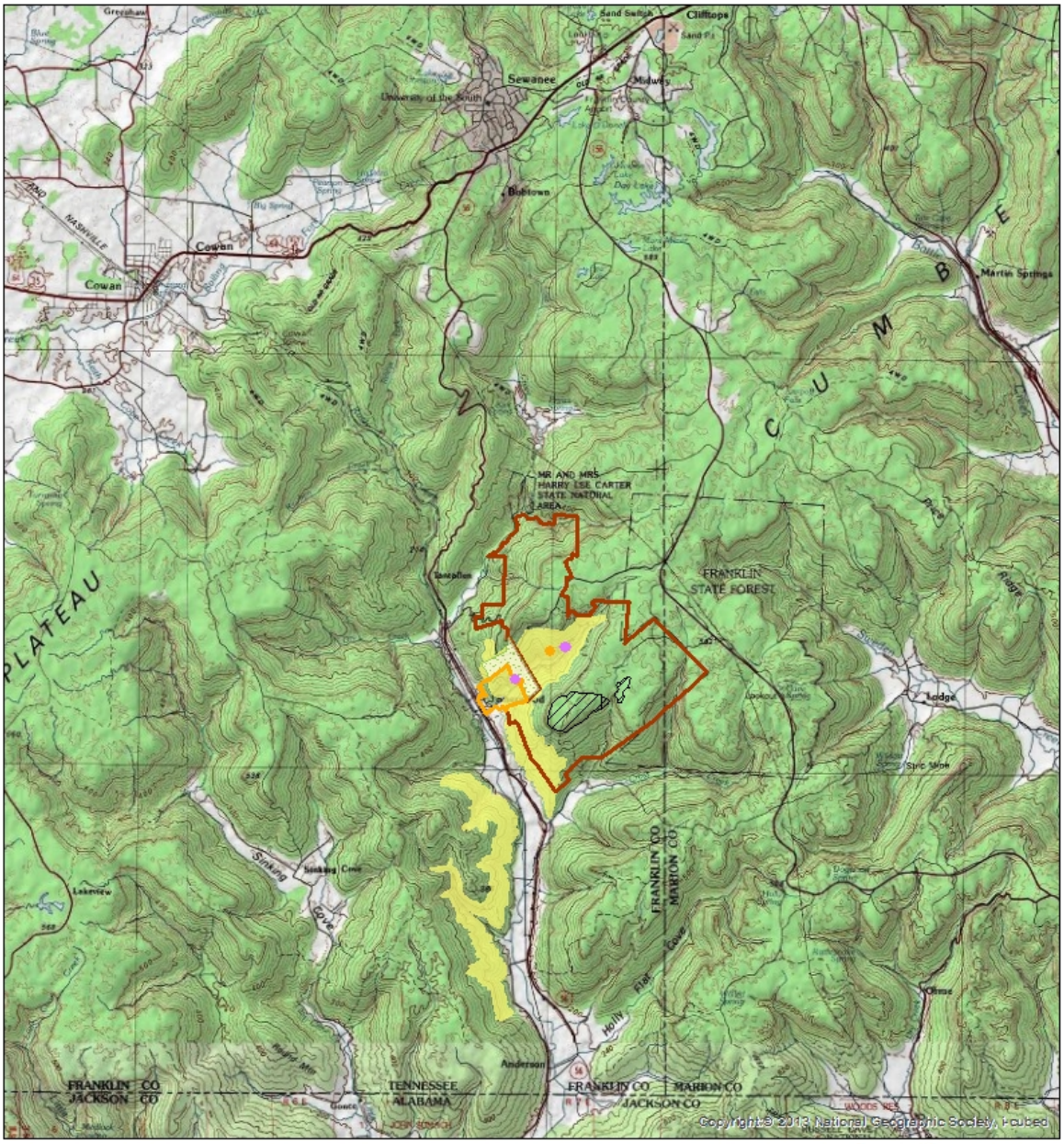

Figure 1. Map depicting known range of painted snake coiled forest snail (*Anguispira picta*) and known locations of listed and recovered plant species in relation to lands acquired from SMC by TCF.

TCF to be transferred to the State of Tennessee (Figure 2), which will be designated as a State Natural Area and managed to conserve listed species and their habitats. The donation took place simultaneously with closing of the TCF purchase in April 2016.

Within the 3,895-ac parcel that TCF purchased, there are approximately 593 ac of habitat of varying quality occupied by *A. picta*, including 118 ac that are excellent quality (Table 1). Based on snail density estimates by Eco-South, Inc. (2010), this habitat supports an upper estimate of 646,518 *A. picta* individuals, or approximately 41 percent of the snails' entire estimated population (See Section II.C.1.a below for discussion of population estimate). In the area to be donated, there are approximately 162 ac of occupied habitat, with an upper estimate of 133,416 *A. picta* individuals, or approximately 9 percent of the snails' total population. Within the 194-ac parcel where SMC plans to conduct above-ground activities for mine operation purposes, there are approximately 81 ac of habitat occupied by *A. picta*, the majority of which is poor quality. This habitat supports an upper estimate of 49,613 *A. picta* individuals, or approximately three percent of the snails entire estimated population as of 2010 (see below Section II.C.1.a).

Table 1. Estimated acres of *A. picta* habitat, by suitability class, and estimated number of *A. picta* individuals within lands to be sold to State of Tennessee (Sherwood Forest), retained by SMC for mining operations, and donated to State of Tennessee for conservation. Data source is Sherwood Mining Company, from data produced by Eco-South, Inc.

	Sherwood Forest (3,89 ac)	SMC (194 ac)	Mitigation Unit (172 ac)	Total
	Acres by Habitat Class			
Excellent	118.1	0.02	11.7	129.82
Good	80.4	9.3	27.7	117.4
Moderate	175.6	20.7	26.2	222.5
Poor	219.1	51.1	96.3	366.5
TOTAL ACRES	593.2	81.12	161.9	836.22
	Estimated Number of Anguispira picta			
Excellent	312,203	47	30,975	343,225
Good	135,588	15,754	46,653	197,995
Moderate	108,672	12,808	16,196	137,676
Poor	90,055	21,004	39,592	150,651
TOTAL SNAILS	646,518	49,613	133,416	829,547

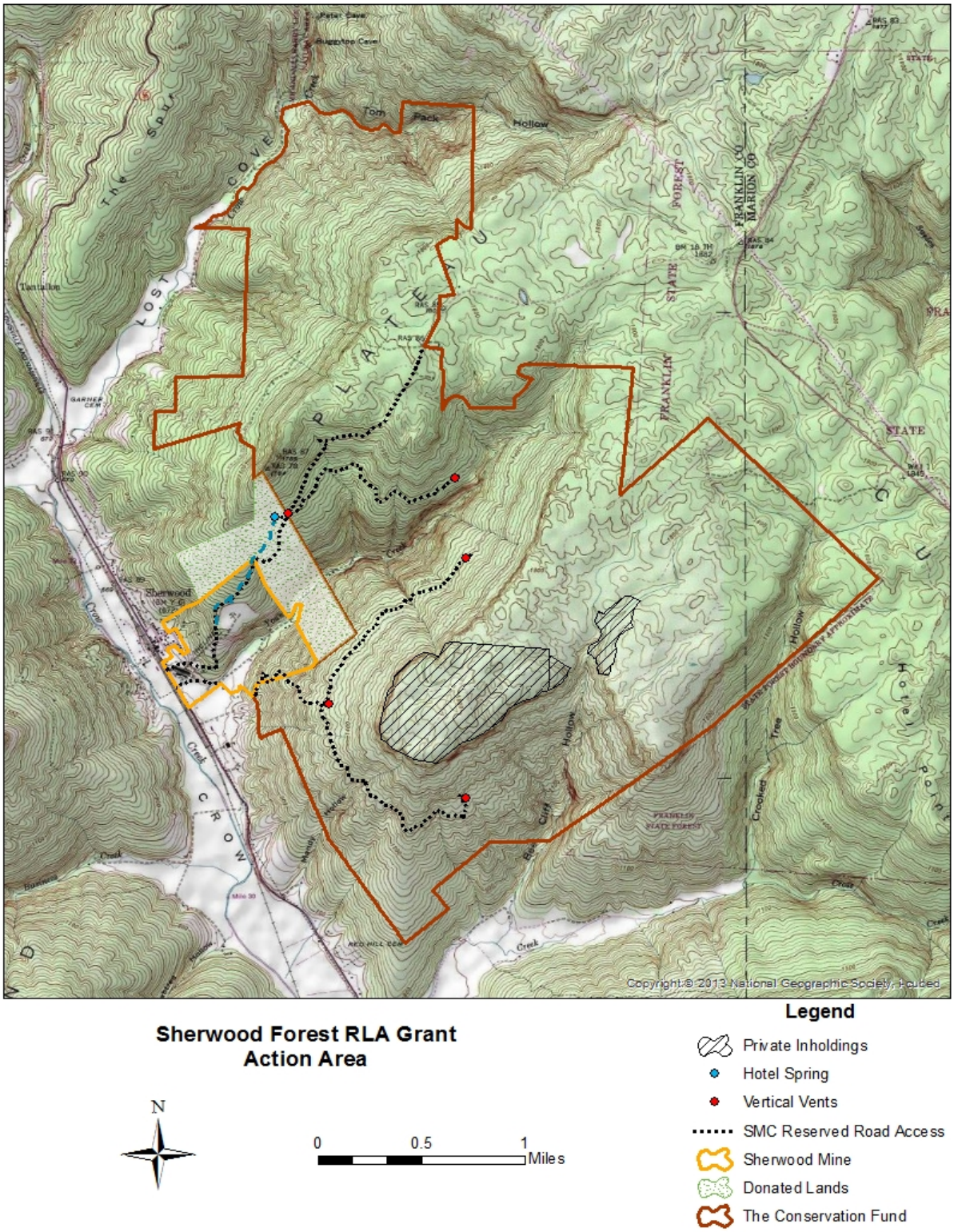

Figure 2. Locations of tract acquired by TCF in relation to tracts donated and retained by SMC, along with locations of roads and future ventilation shafts.

b. No evident natural threats exist which would likely endanger the species' existence.

This criterion addresses listing factor C, disease or predation, and listing factor E, other natural or manmade factors threatening its continued existence. Neither of these listing factors is relevant based on current knowledge. No natural threats that would likely endanger the species existence were evident at the time the Recovery Plan was completed, and none are currently evident. Predicted climate change could alter forest stands and microhabitats occupied by A. picta, but we cannot predict how the species would be affected by such changes (see discussion in Section II.C.2.e below).

c. A population monitoring program is established and conducted for 4 to 5 years to establish "normal" distribution and abundance for the species and no downward trend is evident.

No monitoring program has been established for *A. picta*.

d. A means is established to assure that population monitoring will be conducted periodically after delisting.

No monitoring program has been established for *A. picta*.

e. Collection of the species for scientific or other purposes is controlled or is proven not to threaten the species' continued existence.

This criterion addresses listing factor B: overutilization for commercial, recreational, scientific, or educational purposes. Collection of *A. picta*, beyond that which is permitted by the Tennessee Wildlife Resources Agency or the Service, is not known to pose a threat to *A. picta*. Requests for collecting permits submitted to either of these agencies are reviewed with consideration for the scientific benefits they would provide and for the potential of the desired collections to adversely affect the species' status. Shells of A. picta are offered for sale on the internet from at least one source, but we are not aware of the extent to which illegal collection occurs in support of this activity, nor are we aware of effects from this activity on population trends.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Withers (2003, 2004) found *A. picta* to be locally abundant in its historic known range within Buck Creek Cove, near the town of Sherwood, Tennessee. Based on occurrence

data from the Recovery Plan, Withers' (2003) report, and data from Eco-South, Inc. (2010), the species appears to have remained stable; though, quantitative analysis of trends is not possible. The Recovery Plan reported the snail population to have been estimated at 2000 individuals by a prior researcher, but also speculated, based on available habitat within the range known at that time, that the population could have been as much as 10 times greater. Withers (2003) provided no population estimate, rather his work focused on documenting the species' distribution, which he found to extend well beyond the previously known range (see Section II.C.1.d).

Eco-South, Inc., consultants for SMC, conducted an investigation to (1) characterize relative suitability and abundance of various habitat types within the portion of SMC's property occupied by *A. picta* and (2) estimate the species' density in each habitat suitability class as well as its overall abundance within SMC lands. Based on their estimates of abundance in relation to habitat factors measured in each of 24 plots, Eco-South, Inc., developed criteria for assessing habitats of varying suitability (Table 2).

Table 2. Habitat suitability criteria developed for habitats occupied by *Anguispira picta* on SMC lands (Eco-South, Inc., 2010).

Habitat Suitability Class	Outcrop Height (m)	Habitat Continuity	Forest Canopy	Microhabitat (crevices/overhangs)
Excellent	>2.4	Contiguous	Fully forested, uneven-aged, mature	Abundant
Good	1.2 – 2.4	Contiguous	Fully forested, uneven-aged, mature	Present
Moderate	0.6 – 1.2	Somewhat broken	Fully forested, even-aged, mature	Present
Poor	<0.6	Broken or isolated	Even-aged, mid - successional	Deficient
Absent	--	--	Any	--

Eco-South, Inc., used these criteria to map the spatial extent of each habitat suitability class within SMC lands to determine the number of acres present in each class. They next established plots to estimate average density of *A. picta* in each of the habitat suitability classes. From this, Eco-South, Inc., generated a map of habitat suitability for the lands owned by SMC on the eastern side of Crow Creek Valley. During 2010, Eco-South, Inc., sampled transects within *A. picta* habitat on the western side of Crow Creek Valley to estimate acres of habitat in each of the suitability classes. Using these data, Eco-South, Inc. (2010) estimated the total population of the species to be 2,938,733 individuals; however, this estimate included a population of snails, later determined to be an undescribed species (Haskell and Pan 2013), in Dry Creek Cove to the north of the range mapped by Withers (2003).

Because of the inclusion of habitats in Dry Creek Cove and because GIS data were not available to determine the exact boundaries to which Eco-South, Inc., extrapolated their data concerning proportions of habitats of varying suitability, the Service calculated a conservative estimate of the total *A. picta* population based on best available data. To estimate the number of individuals of *A. picta*, the Service used the polygons from Withers (2004) to circumscribe the species' range. Within this range, we applied the proportions of acres in varying habitat suitability classes that Eco-South, Inc., mapped for the east and west sides of Crow Creek, respectively, to the polygons that Withers mapped for the east and west sides of the species' range. Using Eco-South's data on snail densities within varying habitat suitability classes and the proportion of each class present within the eastern and western portions of the species' range, the Service estimates that the total population of *A. picta* was approximately 1,568,221 snails as of 2010 (Table 3).

Table 3. Estimated acres of *A. picta* habitat in varying suitability classes, on the east and west sides of Crow Creek Valley, and corresponding estimates of abundance within those habitat classes.

Habitat Suitability Class	East	West	Total	Snails/Acre[a]	Estimated Snails
Excellent	146	44	190	2,643	502,170
Good	132	178	310	1,687	522,970
Moderate	250	221	471	619	291,549
Poor	412	200	612	411	251,532
Absent	--	371	371	0	0
Total	**940**	**1014**	**1954**		**1,568,221**

[a]Conversion factors for estimating number of snails/ac are from Table 2 of Eco-South, Inc. (2010).

The Recovery Plan reported that a survey of undisturbed areas revealed several size classes of snails, ranging from 4 – 20 millimeters (mm), indicating recent reproduction and presumed population viability. In at least one location, Withers (2003) also observed three distinct age (i.e., size) classes of *A. picta* on what he termed "nursery rocks". Eco-South, Inc. (2010) also commented on their observations of multiple size classes, especially in optimal habitats, including observation of shells as small as 2 mm diameter. Consistent observations over time of multiple size classes in populations of *A. picta* indicates that recruitment is occurring; but, no data are available on vital rates and their influence on population trends for this species.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

We have no new information on genetic variation or structure of populations of *A. picta*.

c. Taxonomic classification or changes in nomenclature:

There have been no changes in nomenclature for this species. Recent molecular and phylogenetic analyses support the recognition of *A. picta* as a distinct species (Clutt 2008,

Haskell and Pan 2013), which had previously been determined from morphological data (Solem 1976), and provide evidence that the limestone-associated *Anguispira* taxa (*A. picta*, *A. cumberlandiana*, *A. Alabama*, undescribed taxon from Dry Creek) evolved from a common ancestor and diversified over time, producing the taxa seen today (Haskell and Pan 2013). Despite considerable overlap in shell morphology among many members of the genus, *A. picta* is one of a few species of *Anguispira* that can be easily distinguished by shell characteristics alone (Clutt 2008, Haskel and Pan 2013).

d. Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range:

The Recovery Plan for *A. picta* describes the species' range as restricted to Buck Creek Cove, southwest of Sherwood, Franklin County, Tennessee. Within Buck Creek Cove, *A. picta* was reported to occur primarily between the elevations of 750 to 930 feet, with at least one specimen found in a well-watered, protected spot on a north-facing slope at 1,500 feet elevation. Suitable habitat within the cove was estimated to include approximately 325 ac.

Surveys conducted by Withers (2003, 2004) expanded the known range of *A. picta* to include an estimated 5.3 miles and 4.5 miles of Cumberland Plateau escarpment on the west and east sides of the Crow Creek Valley, respectively (Figure 1). The range documented by Withers (2003) on the west side of Crow Creek Valley extends approximately 1 mile further south and 3 miles further north than the range depicted in the species Recovery Plan, which was restricted to the vicinity of Buck Creek Cove. Withers found *A. picta* to be most densely populated in Crabtree Hollow, the mouth of which is approximately 2 air miles north of the mouth of Buck Creek Cove on the west side of Crow Creek Valley. Withers found that *A. picta* occurred between 800 and 1300 feet elevation.

e. Habitat:

We analyzed land cover data to determine the extent of forested habitat within the range of *A. picta* (Table 4). This analysis was based on the Multi-Resolution Land Characteristics Consortium's (MRLC) National Land Cover Data for the years 2001 and 2011 (www.mrlc.gov). We calculated the number of acres existing in broad cover classes in each of the two years and assessed changes in the amount of each class over the entire range of the species between 2001 and 2011. The range of the species was defined using polygons delineated by Withers (2003) to represent the population boundaries on the east and west sides of Crow Creek Valley and includes approximately 1,950 acres (Figure 1).

Table 4. Number of acres of forested habitats within range of *Anguispira picta* based on analysis using MRLC National Land Cover Dataset, 2001 and 2011.

Cover Class	2001	2011	Change
Deciduous Forest	1821	1815	-6
Evergreen Forest	13	15	2
Mixed Forest	96	96	0

Forested habitat is currently abundant within the known range of *A. picta* and remained relatively stable during the period between 2001 and 2011, with a slight decline in acres of deciduous forest (Table 4). Data for both 2001 and 2011 depict a landscape that was at least 98% forested habitat within the known range of *A. picta*. Within forested habitats, deciduous forest cover dominated by a wide margin. The species' Recovery Plan describes the vegetation in which *A. picta* habitat is found as consisting of deciduous forest cover, and this cover type decreased less than one percent from 2001 to 2011.

Withers (2003) found evidence that populations of *A. picta* may tolerate limited forest canopy removal and a potentially wider range of humidity at the microenvironmental scale. *Anguispira picta* inhabits forests of multiple ages, indicating the species is able to either tolerate some level of timber harvest or to recolonize harvested areas once forest regeneration produces suitable conditions. The species was found in portions of Buck Creek Cove that were logged by mule circa 1980 and judged to have "recovered significantly since then" (Withers 2003). And, a portion of Crabtree Hollow, where Withers (2003) found *A. picta* to be most densely populated within its range, was timbered circa 1992. This harvest was done under a minimum diameter restriction, and was closely monitored by the property owner. Similarly, much of the SMC property was timbered circa 1980, and *A. picta* was found to be locally abundant in forested areas of the property. But, the highest quality habitats supporting the greatest densities of the species are located in mature, uneven-aged forests (Table 2) (Eco-South, Inc., 2010).

Withers (2003) observations of *A. picta* occurrences on west- and south-facing slopes indicate a potential tolerance of lower microenvironmental humidity than suggested in the Recovery Plan; though, he did comment that xeric conditions on slopes with limited cover and southwest aspects appeared unsuitable. Conversely, Withers found *A. picta* absent in areas containing apparently suitable habitat. Possible explanations for such absence could include differences in limestone mineralogy that prevent *A. picta* establishment and survival, absence of suitable forage, barriers to dispersal between patches of occupied and unoccupied suitable habitat, or failure to detect *A. picta* in spite of its presence. These observations demonstrate the need for investigations to determine how microhabitat characteristics, their arrangement on the landscape, trophic interactions, and dispersal ability of *A. picta* influence the species' distribution.

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

a. Present or threatened destruction, modification or curtailment of its habitat or range:

The threatened destruction, modification, or curtailment of habitat within the range of *A. picta* extends primarily from three land uses: timber harvest, residential development, and limestone quarrying. Much of the Cumberland Plateau escarpment forest in the vicinity of Sherwood has been logged in the past, as evidenced by current forest

structure; though, the timing and intensity of such activity are not well documented**.** Due to the fact that *A. picta* occurs mostly on private lands, where timber harvesting is not subjected to coordination with state or Federal agencies in Tennessee, destruction or modification of habitat through timber harvest is unregulated. Although the take prohibitions of section 9 of the Act do apply to timber harvest activities and their effects on *A. picta*, enforcement of these prohibitions has been, to date, unattainable. The Service is not informed when timber harvest activities are being considered, planned, or implemented; therefore, we have no opportunity to provide input into the design of the project or the need for a section 10 permit. Distribution data suggest some tolerance of canopy removal or an ability to recolonize areas following such disturbance, but the immediate effects of timber harvesting on *A. picta* or the duration of any such effects remain unstudied. As noted above, the greatest densities of *A. picta* are found in areas with mature, uneven-aged forests lacking evidence of recent timber harvest.

Residential development poses an indirect threat due to its potential to alter surface runoff patterns by increasing impermeable surfaces and reducing forest cover, potentially altering soil moisture and microenvironmental humidity regimes in down-gradient escarpment habitats. The consequences of such changes for forested escarpment habitats and potential alteration of microenvironmental conditions in snail-inhabited limestone outcrops are unknown. The population of Franklin County grew 4.5 percent from 2000 to 2010 and is projected to increase by 17 percent from 2010 to 2030, reaching a total of 48,035 residents (Tennessee Department of Environment and Conservation 2011). We could not find published data on the spatial distribution of development within the county, but it is likely that most development to accommodate population growth has been and will continue to be in the vicinity of the county's larger cities, such as Tullahoma and Winchester. The protection of the Sherwood Forest tract has eliminated the threat of future development on much, but not all, of the Cumberland Plateau surface above areas occupied by *A. picta* on the eastern escarpment of Crow Creek Valley. At this time, residential development poses little known threat to *A. picta*.

The potential threat of limestone quarrying exists throughout the range of *A. picta* and is imminent in one location as evidenced by the opening in 2007 of the Sherwood Quarry. In October 2004, an investor purchased a 3,234-ac tract containing the historic Gager Lime Mine for the purpose of establishing the Sherwood Mining Company. In December 2004, the Franklin County Board of Commissioners, with strong community support, approved 300 ac of this property for rezoning to allow operation of a limestone quarry. In November 2004, the Cookeville Field Office sent a letter notifying the landowner of the presence of *A. picta* within the property, explained take prohibitions included in section 9 of the Endangered Species Act, as amended, and suggested that the landowner develop a habitat conservation plan and apply for an incidental take permit as a remedy for seeking relief from prohibitions imposed by section 9.

Through a series of surveys for *A. picta* in the proposed mine site and meetings with the Service that occurred during 2005, the landowner identified a 5-ac unit in which mining could be initiated without threat of take occurring. The quarry owner acquired air quality and storm-water runoff permits for operations in this parcel and began extraction in 2007.

The limestone supply available from this 5-ac unit is nearing depletion, and SMC has committed to limiting future development to subsurface mining of a limestone stratum located at sufficient depth to prevent impacts to surface habitats. Limited impacts to surface habitats are expected from development of infrastructure, including ventilation shafts and service roads used to access these shafts, but are estimated to affect only three percent of the total population of *A. picta*. And, as noted above, SMC's continued operation of the underground mine was made possible by proceeds of their sale of approximately 3,895 ac to TCF, which along with an approximately 172-ac donated parcel, harbor approximately 50 percent of the total estimated population of the species.

While the conflict between conservation of *A. picta* and economic development, in the form of limestone quarrying at the SMC property, have been resolved, limestone quarrying remains a potential threat in occupied habitats on the western side of Crow Creek Valley.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

Collection of *A. picta*, beyond that which is permitted by the Tennessee Wildlife Resources Agency or the U.S. Fish and Wildlife Service, is not thought to pose a threat to *A. picta*. Requests for collecting permits submitted to either of these agencies are reviewed with consideration for the scientific benefits they would provide and for the potential of the desired collecting to adversely affect the conservation status of the species. Shells of A. picta are offered for sale on the internet from at least one source, but we are not aware of the extent to which illegal collection in support of this activity occurs, nor are we aware of effects from this activity on population trends.

c. Disease or predation: This is not a known threat to *A. picta*.

d. Inadequacy of existing regulatory mechanisms:

Inadequacy of existing regulatory mechanisms poses a threat to *A.picta* both with respect to timber harvest and limestone quarrying on private lands. In Tennessee, adherence to best management practices for forestry activities is voluntary and no Federal regulatory nexus exists for such activities. Given the prevalence of privately owned, forested habitat within the known range of *A. picta*, the likelihood for unauthorized incidental take to occur during timber harvest is high. As discussed previously, there is no mechanism through which the Service is informed about the planning of timber harvest activities; therefore, there is little opportunity for the Service to provide guidance regarding project design or section 10 permit requirements. The long-term consequences of such unauthorized incidental take with respect to survival and recovery of this species are unknown.

Limestone quarrying is not regulated by the federal Office of Surface Mining. In Tennessee, such activities are only subjected to State air and water quality regulations unless they would result in the discharge of fill materials into the waters of the United States, in which case they would require a section 404 permit from the Corps of

Engineers under the Clean Water Act. The opening in 2007 of an open-pit quarry by SMC threatened to cause the destruction of several hundred acres of habitat occupied by *A. picta*. As discussed above, the magnitude of this threat has been reduced by SMC's commitment to operate an underground mine with limited surface disturbance. And, SMC's sale of 3,895 ac to TCF, combined with donation of approximately 172 ac, has protected approximately 50 percent of the species' total population from habitat destruction. Because the species is restricted to limestone outcrops throughout its range in Crow Creek Valley, limestone quarrying poses a potential threat to the species in other parts of its range; though, we are not aware of any proposed quarry developments in Crow Creek Valley at this time.

Because areas within the lands acquired by TCF from SMC, where *A. picta* is present, will be designated as a State Natural Area once the lands are transferred to the State of Tennessee, approximately 50 percent of the species' total population will benefit from regulations protecting such lands. The Natural Areas Preservation Act of 1971 (T.C.A 11-14-101) provides for civil penalties of up to $10,000 per day for certain prohibited acts, including the removal or destruction of any rare, threatened, or endangered plants, but does not contain prohibitions related to animals. The prohibited acts also include damage or vandalism to any natural area, which could provide limited protections for *A. picta* or its habitat.

All prohibitions of Section 9(a)(1) of the Endangered Species Act, as implemented by 50 CFR § 17.21 apply to *A. picta*. These prohibitions would, in part, make it illegal for any person subject to the jurisdiction of the United States to take, import or export, transport in interstate or foreign commerce in the course of a commercial activity, or sell or offer the species for sale in interstate or foreign commerce. The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. It would also be illegal to possess, sell, deliver, carry, transport, or ship live individuals or shells of *A. picta* that were illegally taken. As a state-listed threatened species, it is unlawful for persons to take, harass, or destroy *A. picta* or to destroy knowingly the species' habitat "without due consideration of alternatives for the welfare of the species" (T.C.A 70-8-105). The availability of shells of *A. picta* for purchase on the internet is evidence that such prohibitions are not wholly effective at preventing prohibited activities. Similarly, the potential for unregulated timber harvest to occur without coordination with the Service or TWRA, which could result in take of *A. picta*, indicates that these regulations do not necessarily prevent otherwise legal activity from resulting in take of the species.

e. Other natural or manmade factors affecting its continued existence:

The Recovery Plan lists forest fire as a threat to *A. picta* habitat. Extensive forest fire poses a threat to *A. picta* habitat because of the possibility for severe fires to cause extensive mortality of canopy trees, disrupting microenvironmental regimes. Forest fires could also result in direct mortality of snails in some circumstances, though the crevice-dwelling behavior of *A. picta* might be effective in reducing such mortality. Despite the fact that severe fires are thought to pose a threat to the species, it should be noted that an

apparently robust population of *A. picta* was present in 2003 on the escarpment between Youngs Creek and Cross Creek, which had burned about 10 years prior.

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Fine-scale climate change predictions are not available for the region where *A. picta* is located, but Dale et al. (2009) modeled the effects of climate change, land use change, and invasive species on forests of the Cumberland Plateau and Mountains in northern Tennessee and southern Kentucky. They predicted that forest biomass on the Cumberland Plateau would initially decline, but then recover to baseline levels by 2150 to 2170. Predicted changes in percent biomass among individual species varied, with American basswood (*Tilia heterophylla*) and shagbark hickory (*Carya ovata*) increasing, while chestnut oak (*Quercus prinus*), black oak (*Q. prinus*), and yellow buckeye (*Aesculus octandra*) becoming less important. Models also predicted an increase in evapotranspiration from the region's forests through 2080, after which time the climate model projections were held constant through 2300 and, thus, no further changes in evapotranspiration were predicted. These predicted changes in forest composition and water use suggest that habitat changes could occur throughout the range of *A. picta,* both at the forest stand scale and at the scale of microhabitats the species occupies, but we cannot predict how the species will respond to these changes based on available data.

II.D. Synthesis

The Recovery Plan for *A. picta* reflects both the known status of the species and threats to it at the time the plan was prepared. Because significant changes have occurred in each of these factors since the plan was prepared in 1982, this five-year review provides a more current assessment of the species' status and the factors that should be addressed for recovering the species. Specifically, the species range is now known to encompass limestone outcrops within approximately 1,950 ac along 9.8 miles of the Cumberland Plateau escarpment in the Crow Creek drainage, rather than the 325 ac that were estimated in the Recovery Plan to be occupied in Buck Creek Cove. Microhabitat

characteristics for this species require investigation, as evidenced by observations of *A.* picta in habitats that have typically been considered unsuitable for the species. However, *A. picta* remains a narrowly distributed species. The species total population has been estimated to number greater than 1.5 million individuals, but the need for repeatable survey methods to monitor population trends remains.

While recovery of this species has been advanced considerably since the review completed in 2008, additional conservation work is needed to prevent the species from being at risk of becoming endangered. Developing a monitoring program to track population trends on recently acquired conservation lands and private lands where owners are willing to cooperate is a high priority. The monitoring program should also document and track trends in potential threats affecting the species. And, additional habitat protection is also a priority, to ensure that the population on the western side of Crow Creek Valley is protected from incompatible land uses.

Despite the increase in the documented range, approximately half of the total population of the species occurs on private lands where it is vulnerable to resource extraction, including limestone and timber. Studies of the ability of *A. picta* to tolerate limited canopy removal or to repopulate areas in which timber harvests have occurred are needed and should be accomplished through conservation agreements when the opportunity is available. Residential development on the Cumberland Plateau has emerged as an additional threat to *A. picta* habitat since the species' Recovery Plan was completed, but is not currently adversely affecting the species or its habitat. And, there is a potential threat of over utilization for commercial purposes, as shells of this species are available for purchase on the internet. Due to the potential for habitat destruction from limestone and timber extraction and over utilization for commercial purposes, and the inadequacy of existing regulatory mechanisms for abating these threats, *A. picta* still meets the definition of a threatened species.

III. RESULTS

A. **Recommended Classification**: No change is needed. *A. picta* should remain classified as a threatened species because it is narrowly distributed with approximately half of the species total population on private property, and an increase in timber harvest rates or extensive limestone quarry development within the species' range could cause the species to become endangered within the foreseeable future throughout all or a significant portion of its range. Potential habitat alteration resulting from residential development on the Cumberland Plateau also poses a threat to the species, but no adverse effects from residential development are currently known to be occurring.

B. **New Recovery Priority Number**: 8

The recovery priority should be changed from 8C to 8, to indicate that the degree of threat faced by the species is low to moderate, potential for recovery is high, and taxonomy is at the species level, but that conflicts with economic

development have been resolved with the protection of lands surrounding Sherwood Mining Company.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

A. Protect habitat on the west side of Crow Creek Valley through either property acquisition by a government agency or conservation organization or by securing conservation easements or other binding agreements with private property owners. Pursue opportunities for developing conservation enhancement agreements, habitat conservation plans, or safe harbor agreements when appropriate.

B. Develop and implement a monitoring program for *A. picta* that tracks fluctuations in patch occupancy in specific locations and incorporates measures of population abundance, density, and/or frequency of occurrence in those patches.

C. Investigate the influence of microhabitat factors, including but not limited to soil moisture, relative humidity, limestone mineralogy, leaf litter, and canopy cover on the distribution of *A. picta*.

D. Investigate life history, foraging behavior, and food preferences of *A. picta*. Recovery efforts for this species are hindered by a lack of basic information on reproductive biology, demographics, dispersal ability, and food habits.

E. Conduct an outreach and education campaign directed toward the residents of the town of Sherwood, Crow Creek Valley, and civic leaders in Franklin County. Such a program should familiarize the target audience with the knowledge that this endemic, federally protected species is dependent upon conservation of the forested ecosystem of the Cumberland Plateau escarpment in Crow Creek Valley.

V. REFERENCES

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Dale, V. H., K. O. Lannom, M. L. Tharp, D. G. Hodges, and J. Fogel. Effects of climate change, land-use change, and invasive species on the ecology of the Cumberland forests. Canadian Journal of Forest Research 39: 467-480.

Eco-South, Inc. 2010. Habitat Conservation Plan for the Expansion of the Sherwood Limestone Mine in support of an U.S. Department of the Interior, Fish and Wildlife Service, Incidental Take Permit Application for the Painted Snake Coiled Forest Snail (*Anguispira picta*). Unpublished draft document prepared by Eco-South, Inc., for Sherwood Mining Company. 57 pp. and appendices.

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IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K., and A. Reisinger (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

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Thurman, C. F., L. P. Shackleton, and D. G. Haskell. 2008. Does the density of dead shells predict the density of living *Anguispira cumberlandiana* Lea 1840 (Gastropoda: Discidae)?

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Withers, D. I. 2004. Distributional surveys for the painted snake coiled forest snail (*Anguispira picta*). Addendum to Final Report, Revenue Grant #1448-40181-02-G-051. 11 pp.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Anguispira picta*

Current Classification: **Threatened**

Recommendation resulting from the 5-Year Review: **No change is needed**

Review Conducted By: **Geoff Call, Tennessee Ecological Services Field Office**

FIELD OFFICE APPROVAL:

Acting **Lead Field Supervisor, Fish and Wildlife Service**

Approve T. B. Watt Date 7/29/16

APPENDIX A: Summary of peer review for the 5-year review of the painted snake coiled forest snail (*Anguispira picta*)

A. Peer Review Method: see below

B. Peer Review Charge: Request sent (email – dated July 23, 2015) to potential reviewers requesting comments on the 5-year review. Request was sent to Mr. David Withers (Tennessee Natural Heritage Program), Mr. Alton B. Owens (Eco-South, Inc.), and Mrs. Amy VanDevender (Recovery Plan author).

The U.S. Fish and Wildlife Service (Service) is conducting a 5-year review of the appropriateness of the current listing of the painted snake coiled forest snail (*Anguispira picta*) as a threatened species under provisions of the Endangered Species Act of 1973, as amended (Act). On March 25, 2014, we published a notice in the Federal Register announcing our intent to conduct this review on this species for which our office has the lead responsibility under section 4(c)(2)(A) of the Act. At that time, we requested any new information on the painted snake coiled forest snail since the time of its listing in 1990. In order to support the Service's interest in making its decision based on the best available science, portions of the draft review need to be subjected to an appropriate level of peer review. Due to your expertise regarding this species, we request you peer review the attached portion of the document. We must receive you comments within 30 days of the date of the email (August 22) in order to consider them in our final review document.

The goals of peer review during this process are (1) to ensure that the best available biological data, scientifically accurate analyses of those data, and the reviews of recognized experts are used in the decision-making process; and (2) to indicate to the public, to other agencies, to conservation organizations, and to personnel within the Service that the best available data and scientific analyses were used in the decision-making process.

The following materials are enclosed for use during your review:

Peer Review in Endangered Species Act Activities – This July 1, 1994, *Federal Register* notice established a peer review process for all listing and recovery actions taken under the authorities of the Endangered Species Act.

The Biological Portion of the Draft 5-Year Review – This is the draft material that we hope you will review.

The Literature Cited Section of the Draft 5-Year Review – The list is enclosed.

We appreciate your assistance in ensuring that this review is based on the best available science. If you have any questions or if we can provide additional information, please contact Geoff Call by telephone at 931/525-4983, or via email at *geoff_call@fws.gov*.

C. Summary of Peer Review Comments/Report: We received comments from Ms. Amy VanDevender in the form of an email, dated August 4, 2015:

I have had a chance to read over the 5-year review document and find it competent and fairly complete. You are making lots of progress with *Anguispira picta*; but as with so many land snails, there is so much we don't know. Long ago we checked areas outside of the original range but came up with nothing so I have been thrilled to know that the population is much larger than originally thought. Withers has done some great work with this species. I dug out some papers that were not included that you might want to consider. Stephanie Clutts from Southern Illinois did a Master's thesis on the systematics of *Anguispira* (2008) so we have some data on the DNA relationships within the genus. Jia Pan and David Haskell (2013) from University of the South published a much "better" and more complete analysis of the shell morphology and DNA of the genus including data on the Dry Creek specimens (but they did not propose a new name). You also might want to acknowledge the original work on the reproductive anatomy and features of the radula of *picta* done by Alan Solem in *The Nautilus* in 1976. Also it was my impression that Eco South did some more work on the biology

of the species. The conversation was about being at the Gager mine area at night doing movement studies. Has no one done any gut or fecal analysis to document feeding behavior? I still have concerns about human development at the **sources** of the creeks like Buck Creek Cove, etc. Change in the hydrology at higher elevations upstream in these coves could really make a change in the water quality, humidity levels and even forest cover in the lower portions of the coves. One other point: *Anguispira picta* shows up occasionally on shell sites for possible purchase or trade. Has this traffic been shut down?

Hope this helps with the review.

Amy Van Devender

P.S. Haskell put out a paper in 2008 on dead shells as an indicator of living specimens of another close by *Anguispira* species. I have not read it but it might give you some ideas on how to proceed with population estimates.

D. Response to Peer Review – We have incorporated information from the publications suggested by Ms. VanDevender into this review. To our knowledge, no one has done any work to effectively document feeding behavior. We have discussed concerns related to development and potential effects to habitat for *A. picta*, but we are not aware of adverse effects to the species that have resulted from development above the escarpment forests where it occurs. The draft document provided to peer reviewers included a recommendation to investigate whether presence of dead shells could be an indicator of relative abundance in this species. Because of the relevance of the Haskell publication (i.e., Thurman et al. 2008) referenced by Ms. VanDevender for developing a monitoring program for *A. picta*, we have removed this suggested action from this review.

Thurman, C. F., L. P. Shackleton, and D. G. Haskell. 2008. Does the density of dead shells predict the density of living *Anguispira cumberlandiana* Lea 1840 (Gastropoda: Discidae)?