Flat-spired Three-toothed Land Snail
(*Tridopsis platysayoides*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
West Virginia Field Office
Elkins, West Virginia
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1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Field Office: West Virginia Field Office, Laura Hill, 304-636-6586

Lead Regional Office: Region 5, Hadley, Massachusetts; Mary Parkin, 617-876-6173

Cooperating Offices: None

1.2 Methodology Used to Complete the Review

This review has been conducted by the U.S. Fish and Wildlife Service's (USFWS) West Virginia Field Office (WVFO). We sought information on the status of the flat-spired three-toothed land snail (*Tridopsis platysayoides*) from individuals familiar with the species, its ecosystem, and/or other land snails. We also reviewed the status of, and threats to, the species in consultation with Craig Stihler, the species expert for the West Virginia Division of Natural Resources (WVDNR), during a meeting on March 22, 2007, and during several project reviews and site visits from Spring 2006 through Spring 2007. The new information that has been compiled since listing, in combination with coordination with the WVDNR species expert, provides the basis for this 5-year review.

1.3 Background

1.3.1 Federal Register (FR) Notice announcing this review: 71 FR 20717 (April 21, 2006)

1.3.2 Listing history:

FR notice: 43 FR 28932
Date listed: July 3, 1978
Entity listed: Species
Classification: Threatened

1.3.3 Associated rulemakings: not applicable

1.3.4 Review history:

The flat-spired three-toothed land snail was included in the following 5-year reviews conducted in 1983 and 1991:

- December 8, 1983, (48 FR 55100) – all domestic species listed in 1978, resulting in a notice of completion on July 22, 1985, (50 FR 29900).
- November 6, 1991, (56 FR 56882) – all domestic and foreign species listed before 1991.

In these cursory reviews, the status of many species was evaluated concurrently. The Federal Register notices solicited new or additional information on the various species under review to determine if significant data were available warranting any changes in classification. No change in the snail's listing classification was recommended from these 5-year reviews.

This assessment constitutes the first substantive, individual 5-year status review of *Tridopsis platysayoides* since its listing. Information that has become available since the 1978 rule has been used to evaluate and assess the current status of the snail.

1.3.5 Species' Recovery Priority Number at start of review: An overall moderate degree of threat, high recovery potential, and conflict with construction or other development projects, indicating recovery priority number 8c.

1.3.6 Recovery Plan:

Plan name : Flat-spired Three-toothed Snail (*Tridopsis platysayoides*) Recovery Plan

Date issued: May 9, 1983

Date(s) of revisions or updates: None

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review listed as a DPS? No. This species is an invertebrate and does not qualify for listing as a DPS.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

2.2.2 Adequacy of recovery criteria:

2.2.2.1 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 criteria were designed to protect a few isolated populations from catastrophic loss, and simple assumptions were made about population trends. We now know that the species is more widespread than previously thought and that it is very difficult to determine presence/absence or detect a population trend. Although we know of more occupied sites, we do not know the number of populations or if there is genetic interchange among population sites. We need to rethink the concept

of isolated populations and address connectivity issues.

2.2.2.2 Are all of the five listing factors that are relevant to the species addressed in the recovery criteria?

No. At the time of listing and development of the recovery plan, the only relevant listing factors were A (habitat impacts) and D (inadequacy of regulatory mechanisms). These factors are still relevant today. Predation (factor C) and other natural or man-made factors (factor E) have since been identified as potential threats; however, there is uncertainty about their significance. Factor B (overutilization) continues to be irrelevant. The recovery criteria focus exclusively on factor A.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, note which relevant listing factors are addressed.

The recovery plan states that *T. platysayoides* will no longer need Endangered Species Act protection when either of the following sets of criteria is met (USFWS 1983):

Recovery Option A: *T. platysayoides* is found at less than three additional sites.

1) All known habitat sites supporting *T. platysayoides* are protected from foreseeable human impacts by acquisition, easements or cooperative agreements and management plans. This requires protection of at least 80 percent of the snail's habitat at each of the sites from impacts of recreational usage, adverse management practices, land use changes, or other actions that would adversely affect the species.
2) A long-term management and monitoring program is established for the species.
3) The monitoring program shows that there is no downward trend in distribution, number and extent of populations, or habitat quality for a 10-year period.

Recovery Option B:

1) *T. platysayoides* is found at a minimum of three additional sites (i.e., in addition to the known sites in Cooper's Rock State Park and at Table Rock), each at least a mile from the other and from the known sites.
2) At least 60 percent of these sites are protected from foreseeable human impacts by acquisition, easement or cooperative agreements and management plans.
3) A long-term management and monitoring program is established for the species.
4) The monitoring program shows that there is no downward trend in distribution, number and extent of populations, or habitat quality for a 10-year period.

Option B applies because there are now 99 known sites for the species.

Criterion 1 appears to be satisfied. The 99 known sites are distributed across a

14-mile stretch of the gorge. At least 3 sites are ≥ 1 mile from known sites in Cooper's Rock State Park and at Table Rock and are ≥1 mile from other known sites (Stihler 2006).

Progress toward Criterion 2 has been made, but the criterion has not been satisfied. Roughly two-thirds of the 99 known occupied sites (element occurrences) are on public lands (Coopers Rock State Park, Tablerock, Snakehill Wildlife Management Area) (Stihler 2006), and thus are protected to some degree from foreseeable human impacts. These sites, however, face continuing threats from human impacts, especially increasing recreation (C. Stihler, pers. comm. 2007). Roughly one-third of the occupied sites are on private lands that face continuing threats from changes in land use, such as ongoing timber management (C. Stihler, pers. comm., 2007). The effectiveness of recently established habitat buffers and snail preserves on private timber lands (Quarles et al. 2007) for protecting the snail are currently unknown.

Progress toward Criterion 3 has been made, but this criterion also has not been met. A long-term management and monitoring program has not been established for the species. Coopers Rock State Forest (West Virginia Division of Forestry 2007) recently completed a fire plan and Coopers Rock State Park is working on a recreation plan which will address threats to the snail. In 2007, presence/absence survey protocols and protocols to delineate potential habitat for the species were completed (Dourson 2007). The overlook site in Coopers Rock State Park is monitored annually. Other sites have been monitored once or intermittently, as needed for assessment of impacts from proposed land use changes (C. Stihler, pers. comm., 2007).

Criterion 4 has not been met. While the known distribution of the species has increased, trend data on the number and extent of populations are largely unavailable (C. Stihler, pers. comm., 2007). Habitat quality is degrading as a result of recent and ongoing timber harvesting in a substantial portion of the range of the species.

2.3 Updated Information and Current Species Status

2.3.1 Biology and habitat

Overview

T. platysayoides is endemic to the Cheat River gorge of northern West Virginia. Little is known of the life history of this secretive animal. *T. platysayoides* typically are observed within 1 meter of a rock feature. They can be found in cool, moist, deep fissures in shale, sandstone and limestone outcrops and in talus. This snail occurs in outcrops from the river bottoms to the ridgetops. Rock outcrops one meter or more in height are considered potential habitat if there are cracks and crevices at least one meter deep. The snail appears to prefer rock talus but also is found in cliffline areas that contain deep, dark crevices. When the two habitats coincide (rock talus and cliffline), *T. platysayoides* is more often found in the talus. Dourson (2007) designated rock talus to fall into several categories. Type 1 rock or boulder talus is

optimal (boulders stacked). Type 2 rock or boulder talus is potential, although not optimal, habitat (boulders touching). Type 3 habitat is not suitable for *T. platysayoides* (scattered rocks or boulders not touching).

While plant associations and ages of trees occurring at known sites vary greatly, several plant species are commonly found at *T. platysayoides* sites: sweet birch, rhododendron, and red maple (Caldwell et al. 2006, Hotopp 2000). Some sites are covered in old growth while others are occupied by saplings, and in some cases, open grape arbors growing over talus (Dourson 2007). Dourson (2007) concluded that rock structure is more important than age of trees or vegetative composition growing on rocks. Slope aspect also is a factor. North and northeast slopes in the Cheat gorge provide naturally cooler and moister habitats than south and southwest facing slope aspects. Thus, heavy canopy cover may be more important on south and southwest facing slopes.

T. platysayoides is primarily active at night. Optimum snail activity occurs during spring and early summer, especially during cool, moist weather conditions when air temperatures are between 60-65 degrees Fahrenheit with relative humidity greater than 85 percent (Dourson 2007).

During daytime, the species primarily has been found on the ceiling, wall, or floor of rock structures. During the night, snails have been found equally on both rock and the leaf litter near rock features. The species has been observed foraging and resting under wet leaves (next to rock structure) and moving across the litter to a rock feature (Dourson 2007). It may also lay its eggs in soil or leaf litter but this has not been verified. A captive colony of *T. platysayoides* laid small clusters of 3 to 5 eggs in the soil under the leaf litter in the spring and summer (USFWS 1985).

T. platysayoides is thought to be a relatively long-lived land snail. Based upon shell growth rings, *T. platysayoides* in the wild reach maturity at 3 years, or at 2 years in captivity (Hotopp 2003). Hotopp (2000) reported that approximately 33 to 67 percent of the individuals located in the field were adults.

T. platysayoides has a varied diet of over 20 or so documented foods, including a variety of aged leaves and flower blossoms, fresh catkins, fresh and aged wood rat feces, lichens, mushrooms, and crickets (Dourson 2007, Hotopp 2000). Calcium may be a limiting factor, especially for snails living among sandstone habitats which are predominantly acidic. *T. platysayoides* has been observed feeding on aged beech leaves and catkins (good sources of calcium), as well on the shells of *Tridopsis denotata*, *Mesomphix cupreus*, and its own kind (Dourson 2007).

2.3.1.1 Abundance, population trends:

Little is known about population sizes or trends because the snail is so difficult to survey. Presence/absence surveys have been conducted at spotty locations throughout the gorge. The failure to detect a snail during a presence/absence survey does not prove absence, especially if surveys are conducted during suboptimal conditions (e.g., dry and hot).

Before 1981, only one very restricted population of *T. platysayoides* was known. Grimm (1972) observed 50 individuals on one occasion and estimated a population of "several hundred," whereas Solem (1974) estimated the population to be 300 to 500. Field surveys in 1984 at this same location located only 35 individuals. In 1984, 12 *T. platysayoides* were marked but no recaptures were obtained (USFWS 1985). Hotopp and Stihler observed increasing numbers of *T. platysayoides* at Coopers Rock State Park after the site was fenced to control human access (Dourson 2007; C. Stihler, pers. comm., 2007); however, Solem (1982) cautioned that observations of snail numbers cannot be used to deduce trends, as other snails show short-term fluctuations of 10 to 15 times a low number.

Dourson (2007) notes that *T. platysayoides* appears to be a relatively common snail species where it is found. Although many other species of snails have been documented coexisting with *T. platysayoides*, they generally do not exceed *T. platysayoides* numbers (Dourson 2007). In many cases, *T. platysayoides* was the most common snail, sometimes exceeding all other snail species combined.

2.3.1.2 Genetics, genetic variation:

Genetic data are being collected for the purpose of identifying *T. platysayoides* populations in the Cheat gorge, detecting differences in populations on both sides of the gorge, and to determine if these populations are isolated by the Cheat River or if there is evidence of mixing. When surveyors capture *T. platysayoides*, they are encouraged to take a genetic sample on an FTA Classic Card (also known as a slime card) and send it to the WVDNR for analysis. Funding constraints have precluded analysis of the samples to date.

2.3.1.3 Taxonomic classification:

T. platysayoides is a formally recognized species. It was first collected by Graham Netting at Coopers Rock and later described by Stanley Brooks (1933) as *Polygyra platysayoides* from the area of Coopers Rock State Forest (USFWS 1983, Watters 2006). Although the taxonomic status of the species was questioned, in 1940 Pilsbry considered it to be a distinct species and transferred it to the genus *Tridopsis* (Stihler 1994). Based on rather limited information, Vagvolgyi (1968) classified *T. platysayoides* as a subspecies of *T. complanata*. This reclassification was not widely accepted and in 1974 Solem concluded that available evidence supports full species status (USFWS 1985).

In 1988, Emberton (1988) confirmed that *T. platysayoides* was a valid species with a unique penal morphology. Emberton (1988) also used starch-gel electrophoresis of foot tissue to examine evolutionary relationships among 40 species of tridopsine snails in eastern North America. He divided populations into family trees showing the phylogentic relationships among 18 groups of species. Nine of these groups consisted of a single species, of which *T. platysayoides* was one group.

2.3.1.4 Spatial distribution, trends in spatial distribution:

At the time of listing in 1978, *T. platysayoides* was thought to be restricted to an area of less than 160 acres on the summit of Cooper's Rock, at the downstream end of Cheat Gorge, in Monogalia County, West Virginia. In 1981, the known range of the species was extended approximately 0.9 miles upstream (east) of Coopers Rock. The first population on the south side of the gorge was discovered in 1982. When the recovery plan was written in 1983, the known range included seven locations, all in close proximity to Coopers Rock. During surveys conducted from 1981 to 1991 surveys, 11 new localities were found, located south of Interstate-68 in Monogalia and Preston counties, West Virginia, encompassing an area of roughly 2.1 miles by 8.7 miles (Stihler 1994). Additional survey work through 2006 has resulted in many new localities. The present known range of the species includes 99 element occurrences, including a site at Cornwell Cave, approximately 6 miles south of Cooper's Rock. The snail occurs on both sides of the gorge within an approximately 14-mile stretch, including portions of the major tributary ravines. The range of the species begins near the mouth of Muddy Run near Ruthbelle in Preston County, and extends to the lower reaches of Cheat Lake near Tyrone in Monogalia County (WVDNR 2006). Although the range of the species has expanded since listing, it is still considered to be a narrowly ranging species endemic to scattered rock features within the Cheat Gorge.

2.3.1.5 Habitat or ecosystem conditions:

Based primarily upon a gross-scale analysis of underlying geologic formations, Jones and Stihler estimated a total of approximately 10,582 acres of potential habitat for *T. platysayoides* within and on the rim of the Cheat River gorge (USFWS 2003). Rock formations where the snail is found are usually Pottsville Sandstone, a relatively resistant rock which forms steep cliffs (mainly along the canyon rim), boulder fields, and talus slopes. The snail also occurs upon the Greenbrier Limestone formation formations at cave entrances (exposed in the lower levels of the gorge). Of the 10,582 acres of potential habitat, roughly 27 percent (2,861 acres) is currently in public ownership (Coopers Rock State Forest, Coopers Rock State Park, Table Rock, and Snakehill Wildlife Management Area), 43 percent (4,600 acres) is owned by Allegheny Wood Products, and 30 percent (3,121 acres) belongs to other private landowners (USFWS 2003). Of this acreage, approximately 50 percent of the forested acreage will be affected by timber activities between roughly 2005 and 2010 (approximately 1,100 acres of the WVDNR's Snakehill Wildlife Management Area and 4,450 acres of Allegheny Wood Product's property in Cheat gorge).

Like most of West Virginia, the gorge was logged extensively in the late 1800s and early 1900s, followed by widespread forest fires, then an era of fire suppression and forest diseases (J. Vanderhorst, WVDNR, pers. comm., 2007). A forest inventory and deed records show that the gorge was extensively logged, including clearcutting, several times in the 20th century (Riddle 2006). Several logging companies operated in the Cheat Canyon between 1900 and 1945. The dominant cutting practice at that time was harvest of all merchantable trees. Selection harvests were done in portions of the gorge in the 1960s and 1970s, again in 1993-1994, and will continue for the

foreseeable future.

Today the gorge is forested primarily by mature second-growth forest. It contains large blocks of relatively unfragmented forest habitat, notable for relict old growth patches, functioning natural disturbance regimes, structural integrity, and high biodiversity (USFWS 2003).

The sandstone/limestone forested ecosystem in the gorge has unique plant communities associated with acidic soils (J. Vanderhorst, pers. comm., 2007). The lands are forested primarily with dry, oak-dominated forest communities, sometimes underlain by dense stands of mountain laurel and rhododendron (USFWS 2003, Caldwell 2006). A great variety of plant associations are found in the gorge, too numerous to mention here, including oak-hickory and maple-beech-birch forest associations (Hotopp 2000).

Oak-dominated communities, such as those in the gorge, are thought to be in general decline today due to high mortality from gypsy moth invasions, selective harvesting of oak over other species, and deer herbivory (Widmann 2004). In addition, oaks are fire-adapted and in some areas are being replaced by more shade-tolerant trees, such as maple, through fire suppression (USFS 2006) (J. Vanderhorst, pers. comm., 2007). The introduction of exotic pests and diseases will continue to affect forest composition in the gorge.

2.3.2 Five-factor analysis

To facilitate an analysis of the snail's appropriate listing classification under the Endangered Species Act, a threats assessment that conforms to the five listing factors was conducted in March 2007. Identified threats were analyzed for the spatial magnitude, severity, and immediacy of their effect on the long-term survival of *T. platysayoides*. That assessment, as well as additional information used in the following five-factor analysis, is provided in the appendix to this review.

2.3.2.1 Factor A. Present or threatened destruction, modification or curtailment of habitat or range:

At the time of listing, the species was thought to be restricted to isolated patches of deep undisturbed litter and sheltered retreats among rocks in a small area less than 0.25 square mile near Coopers Rock, a popular spot for sightseeing and rock climbing in West Virginia. Recreational impacts at Coopers Rock State Park were believed to be a primary threat. High visitor use was thought to be resulting in crushing of snails and habitat degradation resulting from the loss of leaf litter on the forest floor (USFWS 1978). Smoking by persons standing on the caprock, or the boardwalk which passes over the type locality, and throwing cigarettes into the leaf litter, was thought to be a serious fire hazard.

Since then, *T. platysayoides* has been found at 99 locations throughout its historic range. Rock climbing at Coopers Rock has been banned on rock formations at or near known snail sites, and in 1997 sections of chain-link fence were erected on either side of a large crevice beneath the overlook walkway. Both Hotopp and Stihler

have observed increasing numbers of *T. platysayoides* since the fence was installed (Dourson 2007).

Much of the potential habitat within the Coopers Rock State Park has not yet been accurately mapped, and threats from recreational impacts continue. Recently, a group requested permission to host a rock "bouldering" event at the park. This event could cause trampling of individual snails (with up to 400 people climbing over boulder fields) and, possibly, disturbance of snail foraging and breeding habitat (participants also would rake leaves away from the base of boulders) (C. Stihler, pers. comm., 2007)

While fires have not occurred in known occupied snail habitat in the 30 years since listing, State land managers recently prepared a fire management plan, as they are concerned about the threat of fire from increasing human use of the Coopers Rock State Forest and Park (West Virginia Division of Forestry 2007). The effect of fire on *T. platysayoides* is unknown but potentially significant. Depending on the scope and intensity of the fire, snails occupying deep, cool, moist rock crevices at the time of fire likely stand a better chance of surviving than those foraging, laying eggs, or seeking cover in leaf litter. Fire could kill individual snails and significantly reduce foraging habitat in the area burned and possibly result in the loss of 1 or more years of reproduction. However, fires at certain times of the year when snails are inactive may not pose a significant threat and may help maintain the oak-hickory forest community (C. Stihler, pers. comm., 2007). Studies elsewhere have shown that land snail communities have survived fires when there was adequate habitat structure to provide for deep vertical movement and shielding from heat during wildfires (e.g., coarse rock substrate with deep fissures and access to underground moisture) (Kiss and Magnin 2003, Duncan 2007).

New threats to habitat have arisen since the time of listing. Collectively, road-building and logging pose ongoing threats (e.g., crushing of individuals and loss or degradation of habitat) within a substantial portion (50 percent) of the range of the species. Allegheny Wood Products (AWP) retained timber rights when the WVDNR purchased land for what became Snakehill Wildlife Management Area (WMA). In March and April 2007, AWP initiated a one-time harvest of trees on this WMA, which comprises roughly 30 percent of the known occupied snail site locations. On this WMA, known occupied and potential *T. platysayoides* habitat was buffered to avoid and minimize impacts to snails. Based upon a survey of rock structure, a 150-foot-wide "no touch" buffer was placed around occupied and optimal habitat; limited harvesting was allowed within an additional 50-foot buffer, extending from the outer edge of the no touch buffer. A 100-foot "no touch" buffer was placed around potential habitat, with limited harvesting within an additional 50-foot buffer. While these buffers likely avoided crushing *T. platsayoides* from road construction and timber harvest, their effectiveness in providing adequate shade and foraging habitat is unknown. At the present time, harvesting is occurring only on top of the gorge, away from the rim, where erosion is thought not to be a major issue. When harvesting in the gorge itself begins, the impacts of erosion from activities above potential habitat will need to be addressed. Although not an effect of the current harvest, soil erosion problems associated with old logging roads on this WMA became evident during the

heavy rains of summer 2007. Siltation from these old logging roads needs

to be addressed as they are threatening some areas of known occupied *T. platysayoides* habitat (C. Stihler, pers. comm., 2007).

Similarly, under the terms of a recent settlement agreement, AWP currently is resuming roadbuilding and harvesting trees on its private lands (roughly 4,600 acres) along approximately 8.5 miles of the Cheat gorge, roughly between the mouths of Muddy Run and Big Sandy Creek (Quarles et al. 2007). AWP has agreed to establish 6 "snail preserves," encompassing approximately 102 acres, which will be protected by management prescriptions, i.e., a ban on timber harvesting, road building, and access except for management purposes and scientific research. Although it is unclear whether the snail preserves will be protected by easements or deed restrictions, the agreement states that these management prescriptions are to remain in place permanently and be binding on any successors or assigns of AWP, unless the snail is delisted under the Endangered Species Act and the Fish and Wildlife Service determination decision makes clear that continued protection of all or particular preserves is not necessary for that determination. In addition, AWP has agreed to establish two "adjunct preserve areas," encompassing approximately 43 acres. The same management prescriptions as for preserves will apply to adjunct areas except AWP may terminate designation of adjunct areas if the snail is delisted. AWP also can change the delineation or designation of, and management prescriptions for, any preserve area based upon a determination of snail presence or absence using a survey protocol approved by the WVFO and WVDNR. In other words, the snail preserves and/or adjunct preserves could become smaller or fewer in number if surveys confirm the absence of *T. platysayoides* in these areas. Moreover, if surveys show the snail is not present, protection of the site does not benefit the snail.

Ongoing residential development at the rim of the gorge adjacent to the Snakehill Wildlife Management Area also poses a localized and minor threat to *T. platysayoides*. Habitat in this area is marginal. In addition, there are tracts of land in the gorge owned by other private landowners. At this time, the USFWS does not know how these land owners intend to manage their lands.

Forest insect infestations pose an increasing, potentially rangewide threat to the habitat of *T. platysayoides*. Gypsy moths and hemlock wooly adelgids attack trees and result in defoliation that could affect shading of snail habitat. Whereas the bulk of recorded gypsy moth defoliation occurred in the eastern panhandle of West Virginia in 2000-2002, some defoliation occurred in Preston and Monogalia counties (West Virginia Department of Agriculture 2005), and defoliation continues to spread eastward, peaking on a roughly 10-year population cycle, despite control efforts in place since 1983. Gypsy moths feed on more than 500 species of trees and shrubs, and repeated heavy defoliation by gypsy moths leads to death of trees, e.g., hardwood tree mortality after 2 successive years of defoliation can reach 80 percent. Thus, gypsy moths pose a pervasive threat to *T. platysayoides* habitat in the gorge, especially due to potential loss of shading.

Hemlock wooly adelgids likely pose less of a threat to *T. platysayoides* habitat than gypsy moths. It is possible that, within a decade, eastern hemlock will be reduced to

a minor component of forest in West Virginia. However, eastern hemlock occurs primarily in isolated patches on moist north and northeasterly aspects soils in the gorge (Kish 2007), and the position and orientation of *T. platysayoides* sites are important factors in assessing possible impacts to habitat. The loss of eastern hemlock trees on predominantly northerly slopes may not have as abrupt an impact as loss of other trees on hotter and drier slopes.

Deer herbivory in the gorge also may be a factor today in reducing oak regeneration in portions of the gorge, possibly leading to replacement by shade-tolerant maples (J. Vanderhorst, pers. comm., 2007). Whereas tree species composition may be less important than rock structure in *T. platysayoides* habitat (Dourson 2007), lack of understory vegetation may adversely affect snails. Hotopp (2005) reported that deer over-browsing was widespread at Snakehill Wildlife Management Area. On many forested slopes, herbaceous understory vegetation was reduced, possibly affecting cover and food supply of *T. platysayoides*; however, the extent to which over-browsing limits *T. platysayoides* is unknown.

There is some evidence that invasive plants may be increasing in the gorge, especially following recent disturbances from road-building and timber harvesting. Dourson (2007) reported the beginning of Tree-of-Heaven (*Ailanthus altissima*) encroachment, and C. Stihler (pers. comm., 2007) reported the incursion of garlic mustard in the gorge. The impact of invasive plants to snail food supply is presently considered to be localized and of unknown severity but increasing in magnitude.

In summary, while *T. platysayoides* is now known to be distributed at 99 scattered locations throughout its historic range, it continues to be threatened by recreational impacts at local sites and by threats to its habitat rangewide that pose an overall moderate or unknown degree of risk to the species. The efficacy of attempts to manage these threats is largely unknown.

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

This factor was not applicable at the time of listing and is not a threat today. The species is extremely difficult to find and there is no known market for collection of *T. platysayoides* for commercial or educational purposes. An extremely limited amount of collecting for scientific purposes is regulated by the WVDNR, and primarily consists of collecting dead shells.

2.3.2.3 Factor C. Disease or predation:

This factor was not identified as a threat at the time of listing. There are no known diseases of *T. platysayoides*. On several occasions, Dourson (2007) observed recently attacked but still alive and or fresh dead *T. platysayoides* among rock talus or as much as 10 feet from a rock feature (i.e., beyond the normal commuting distance of the species). The freshly bitten snails were not consumed, and Dourson speculated that *T. platysayoides* may exude distasteful mucus. Dourson named several potential predators of *T. platysayoides*; however, it is unknown to what extent predation limits snail population size. Potential predators include a variety of small mammals (e.g.,

short-tailed shrew, white-footed mouse, pine vole, eastern chipmunk), salamanders (e.g., red eft, green salamander, slimy salamander, mountain dusky salamander, seal salamander, and redback salamander), *Cychrine* beetles (Carabidae), and birds. Dourson (2007) noted that wild turkey and grouse, as well as a variety of song birds, regularly eat snails, and female birds that are laying eggs will consume snails and feed them to their young. Thus natural predation poses an unknown degree of threat to *T. platysayoides* rangewide. (Also see factor E below with regard to competition and cannibalism.)

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

At the time of listing, no specific regulatory mechanisms other than the Federal Endangered Species Act were adequate to protect the species from human pressures. This is still largely the case today. West Virginia does not have any State laws protecting endangered species, and there are no local or State land use regulations that would restrict activities within snail habitat, except for controlling erosion and soil movement into streams. West Virginia Code 19-1B-7(g) requires implementation of the West Virginia Division of Forestry's "Silvicultural Best Management Practices for Controlling Soil, Erosion, and Sedimentation from Logging Operations" (BMPs). The BMPs specify that streamside management zones be at least 100 feet wide on each side of perennial or intermittent streams and 25 feet wide on each side of ephemeral streams. Custom alternative practices can also be used to minimize soil erosion hazards as mandated by the Logging Sediment Control Act (West Virginia Division of Forestry 2005). Implementation of these practices provides a moderate degree of protection to *T. platysayoides* in a small portion of its range where it overlaps with riparian areas.

2.3.2.5 Factor E. Other natural or man-made factors affecting the continued existence of the species:

Declines in Allegheny woodrat (*Neotoma magister*) populations throughout the Appalachian Mountains during the past 20 to 30 years (Castleberry 2000) may potentially pose a low to moderate degree of threat to the food supply of *T. platysayoides* rangewide. Allegheny woodrats are still present at Cooper's Rock but there is some evidence of decline (C. Stihler, pers. comm., 2007). Dourson (2007) noted that the Allegheny woodrat supplies a provisional yet often reliable source of food to *T. platysayoides*. Woodrats carry into the talus and rock shelters a plethora of known and potential *T. platysayoides* food items, including fungi, freshly cut herbaceous vegetation, and deposits of their own excrement. Dourson (2007) observed *T. platysayoides* feeding on woodrat scat, especially during August when the snail remains deep in crevices. He speculated that woodrat scat may be a more reliable source of food than other sources at this time of year, but this is uncertain.

In addition, the effects of competition in the wild for resources among individuals of *T. platysayoides* and with other snail species are unknown. Grimm maintained a breeding colony of *T. platysayoides* in captivity for 4 years and found that a

population density of 3-4 individuals per square foot induced cannibalism (Moser 1985). In contrast, the WVDNR had a captive colony of *T. platysayoides* for several years, and even at high densities, there was no sign of cannibalism; however, the snails were provided chalk as a source of calcium and this may not have been done by Grimm (C. Stihler, pers. comm.. 2007). Dourson (2007) noted *T. platysayoides* grazing on the shells of other snails species as well as its own kind, presumably for the calcium carbonate content; however, it is unknown if, or to what degree, *T. playtsayoides* cannibalizes live snails in the wild. *T platsayoides* is often the most abundant snail at sites where it is found (Dourson 2007), suggesting that it may be more successful than other snails in the area competing for resources in calcium poor environments.

Another concern may be the unknown effect of toxins from treated lumber used for the boardwalk and railings near the overlook at Coopers Rock. This effect is extremely localized but present at the type locality.

2.4 Synthesis

Up to this point, this review has discussed the information (and its implications) that has become available since the time of listing of *T. platysayoides* as threatened in 1978. The Synthesis section brings this information together to draw an overall picture of the snail's biological status relative to the requirements of the Endangered Species Act (ESA). The fundamental question is whether *T. platysayoides* is in danger of extinction throughout all or a significant portion of its range (the ESA definition of endangered) or is likely to become endangered in the foreseeable future (the ESA definition of threatened). The information pertinent to addressing this question includes: (1) The population status of *T. platysayoides*, (2) implementation and success of recovery actions, and (3) threats to the long-term survival of this species.

The biological principles that allow us to evaluate the rangewide population status of the snail relative to its long-term conservation are representation, redundancy, and resiliency. At the time of listing, *T. platysayoides* was thought to be an extremely rare and declining taxon that occurred within a very small range. We now know that occupancy of available habitat is much more widespread than formerly thought, and that the geographic extent of the snail's range approximates the Cheat gorge. Although the sandstone/limestone oak-dominated ecosystem upon which the snail depends has not rebounded to pre-logging conditions, we have learned that *T. platysayoides* individuals have persisted at 99 locations in the largely contiguous second-growth forest that has come back since the widespread logging and fires that occurred at the turn of the 20th century. From this, we can infer that there is more representation (i.e., occupancy of representative habitats formerly occupied by the snail across its range) and redundancy (i.e., distribution of individuals in a pattern that offsets unforeseen losses across a portion of the snail's range) of the *T. platysayoides* than was known at the time of listing. However, the snail is still considered a rare, narrowly ranging species that is endemic to the Cheat gorge. We lack sufficient information to detect population trends because the species is extremely difficult to survey and site locations have not been grouped into populations. Until genetic information is analyzed, we will not know if populations are isolated or connected.

Although the recovery plan is in need of updating, about half of the actions in the plan have been or are being implemented. These include: protecting locations outside Coopers Rock which support *T. platysayoides*, determining and managing impacts of recreational activities in Coopers Rock State Park and Forest, conducting surveys at locations throughout the gorge, developing standardized presence/absence protocols and habitat delineation protocols, determining periods of snail activity and microhabitat use, and collecting data concerning threats from forest management practices, land use changes, and predation.

The status of *T. platysayoides* relative to the ESA is contingent not only on population viability and proactive conservation, but also on the demonstrated abatement of threats to the continued existence of the species. Rarity, potential isolation, and the new threat of habitat degradation are key factors continuing to support its classification as threatened today.

Whereas nearly two-thirds of the known snail sites occur on public land, human recreation impacts are increasing and a standardized monitoring program and long-term management plans or agreements that adequately secure the snail's habitat rangewide are lacking. Nearly half of the forest within the species' range has been or will be affected by logging activities within the next 5 years. The adequacy of current timber management prescriptions and habitat buffers for protecting the snail will not be known for some time into the future. Thus the species continues to face an overall moderate degree of threat within a large portion of its range from ongoing or imminent logging and human recreation impacts, and from forest defoliation. The species' forested ecosystem also faces a low or unknown but increasing degree of risk from deer herbivory, and invasive plants. Natural predation, cannibalism, and competition with other snail species are suspected threats, but the magnitude of their impact is largely unknown.

In sum, currently available information shows that the species is persisting throughout its historic range, with a relatively more widespread distribution than was known at the time of listing. However, this snail is not distributed widely enough to preclude serious losses from catastrophic events, and a substantial amount of habitat is either at risk from localized high-impact human recreation or declining in quality from ongoing timber management practices. Therefore, based on this 5-year review, there continues to be a likelihood of *T. platysayoides* becoming endangered within the foreseeable future throughout all or a significant portion of its range.

3.0 RESULTS

3.1 Recommended Classification: Threatened. No change is needed.

Rationale: Despite the discovery of numerous additional occurrences of *Tridopsis platysayoides*, little is known about population trends and viability, and threats to the snail and its habitat continue to pose a likelihood that the species could become endangered in the foreseeable future throughout all of its range.

3.2 **Recommended Recovery Priority Number:** Retain the current recovery priority number of 8c, indicating an overall moderate degree of threat, high recovery potential, and conflict with construction or other development projects.

Rationale: Threats to the species continue at levels that could result in long-term population declines if not abated; however, the tools and techniques to manage threats and increase the security of wild populations are known and feasible. As outlined in the five-factor analysis, logging continues to pose a conflict to the snail's recovery.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Based on the outcome of this 5-year review, we recommend:

- Revision of the recovery plan to account for populations, connectivity, genetic interchange, and new threats discovered since the plan was written, and to provide objective, measurable recovery criteria that address the relevant listing factors.
- Establishment of a long-term monitoring program, especially to discern the effectiveness of buffers for timber management practices.
- Completion of long-term management agreements with land managers.

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6.0 CONSULTED EXPERTS

During this review, information was requested from the following species, taxa, or ecosystem experts:

Craig Stihler, West Virginia Department of Natural Resources

Dan Dourson, Biological Consulting

Ken Hotopp, Appalachian Conservation Biology

Dr. Ron Caldwell, Cumberland Mountain Research Center

Dr. Tom Watters, Ohio State University

Dr. Tim Pierce, Carnegie Museum of Natural History

John MacGregor, U.S. Forest Service

Shane Jones, U.S. Forest Service

Jim Vanderhorst, West Virginia Department of Natural Resources

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW: FLAT-SPIRED THREE-TOOTHED LAND SNAIL

Current classification: Threatened

Recommendation Resulting from the 5-Year Review: No change in status

Listing/reclassification priority number: Not applicable

Review conducted by: Laura Hill, West Virginia Field Office

FIELD OFFICE APPROVAL:

Approved _____ Date 13 Sept 07

REGIONAL OFFICE APPROVAL:

Approved _____ Date 11.06.07

APPENDIX. FLAT-SPIRED THREE-TOOTHED LAND SNAIL THREATS ASSESSMENT					
Listing Factor	Stressor	Spatial Magnitude	Immediacy	Severity	Overall Threat Level
A. Destruction, modification, or curtailment of habitat or range	Recreational uses: trampling of individuals and foraging habitat	Localized (multiple locations within range)	Imminent or probable (Historic threats being managed but future threats continue)	Medium	Moderate
	Fire: burning individuals and understory vegetation and leaf litter (cover, foraging, and potential nesting habitat)	Potentially significant portion of range	Low probability; has not happened in 30 years since listing)	Unknown but potentially significant (unknown effect to individuals in deep crevices; depending on the geographic scope of the fire, could significantly reduce foraging habitat in the area burned and possibly result in loss of 1 or more years of reproduction)	Unknown
	Logging	Significant portion of range	Existing	With buffers, low risk of crushing; unknown effect on shade	Moderate

Listing Factor	Stressor	Spatial Magnitude	Immediacy	Severity	Overall Threat Level
A. Destruction, modification, or curtailment of habitat or range, cont'd.	Road building (to facilitate logging)	Localized	Existing	High risk of crushing and loss of habitat unless potential habitat is avoided; low to high risk of siltation downslope if erosion is not controlled on slopes.	Moderate
	Residential development	Localized (primarily at the rim of the gorge in lower quality habitat)	Existing	Low (impacts to suboptimal habitat)	Low
	Gypsy moth (defoliation)	Localized (but potential to spread rangewide)	Existing	Low but increasing	Low but increasing
	Hemlock wooly adelgid	Localized (primarily on north and northeast aspects)	Existing	Low (hemlocks are a small component of the forest in the Cheat gorge)	Low but increasing
	Deer browsing of understory vegetation	Localized (Snakehill WMA)	Existing	Unknown	Unknown
	Invasive plants	Localized	Existing	Unknown	Unknown but increasing

Listing Factor	Stressor	Spatial Magnitude	Immediacy	Severity	Overall Threat Level
B. Overutilization for commercial, recreational, scientific, or educational purposes	Scientific collecting	Extremely localized	Existing	Negligible	Extremely low
	Collecting for commercial or educational purposes	NA	NA	NA	NA
C. Disease or Predation	Natural predation by small mammals, amphibians, and birds	Rangewide	Existing	Unknown	Unknown
	Disease	NA	NA	NA	NA
D. Inadequacy of regulatory mechanisms	No state Endangered Species Act	Rangewide	Existing	Medium	High
	Enforcement of erosion control requirements	Localized (portion of range that overlaps with riparian areas)	Existing	Moderate to High	Moderate
E. Other natural or man-made factors	Competition, cannibalism	Potentially rangewide	Unknown	Low (known to occur in captivity but not in the wild)	Unknown
	Toxins from treated lumber used in boardwalk and railing at Cooper's Rock overlook	Extremely localized, but present at type locality	Existing	Low	Low

Listing Factor	Stressor	Spatial Magnitude	Immediacy	Severity	Overall Threat Level
E. Other natural or man-made factors, cont'd.	Decline of Allegheny woodrats (which supply provisional but reliable sources of food to *T. playtsayoides*)	Potentially rangewide for *T. platysayoides*; some evidence of woodrat decline at Coopers Rock but woodrats still present	Existing	Low to medium	Potentially high (if provisional food sources are relatively important compared to other food sources)

Key:

Spatial magnitude (the geographic scope of impact on the species and habitat that currently exists and can reasonably be expected within 10 years under current circumstances and the continuation of existing management situations): rangewide; significant portion of the range; localized; extremely localized.

Immediacy (the temporal nature of the threat): existing; imminent or probable; unknown.

Severity (the level of damage to the species that occurs or can be expected to occur when and where the species and/or its habitat is exposed to the threat): high; medium; low; negligible; unknown = 5

Overall Threat Level: high; moderate; low; unknown

FWS:R5:ES:MParkin:lf:10/30/07:
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