

CHITTENANGO OVATE AMBER SNAIL
(Novisuccinea chittenangoensis)

RECOVERY PLAN
First Revision

Original Approval: March 24, 1983

TECHNICAL/AGENCY DRAFT

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for

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Literature citations for this document should read as follows:

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<http://nyfo.fws.gov/es/recoveryplans.htm>

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EXECUTIVE SUMMARY

Chittenango Ovate Amber Snail Revised Recovery Plan, Technical/Agency Draft

Current Status: The Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) was listed as threatened in July 1978, and the initial recovery plan for the species was completed in March 1983. *Novisuccinea chittenangoensis* is known from only one site, located in the Chittenango Falls State Park in Madison County, New York. The species was listed due to its rarity and population decline; since listing, habitat protection and captive propagation have been implemented, but the species' status remains exceedingly precarious. The primary threats to the snail in its existing habitat are considered to be the small population size and limited distribution of the species and the negative interaction with an introduced snail, *Succinea* sp. B. Additionally, habitat changes and inadvertent human disturbance present potential threats to *Novisuccinea chittenangoensis*.

Habitat Requirements: The Chittenango ovate amber snail is a terrestrial species that requires the cool, mild-temperature, moist conditions provided by the waterfalls and mist in its environment. Its habitat lies within a ravine at the base of a 167-foot waterfall, and the ledges where it is found comprise an early successional sere that is periodically rejuvenated to a bare substrate by floodwaters. *Novisuccinea chittenangoensis* appears to be an obligate calciphile and seems to prefer green vegetation such as the various mosses, liverworts, and other low herbaceous vegetation found within the spray zone adjacent to the Falls. Clean water may be necessary to maintain essential habitat; however, any effects of water quality on this snail are most likely indirect. Much is still unknown about the species' particular biological and physical needs.

Recovery Strategy: The primary initial strategy for recovery of the Chittenango ovate amber snail is to stabilize the extant population at Chittenango Falls. Two necessary conditions for stabilization are maintaining the baseline population size of the natural colony and maintaining multiple captive populations of *Novisuccinea chittenangoensis*. Achievement of the first condition will entail habitat management planning and research into the species' biological requirements and possible means of controlling the competing *Succinea* sp. B. Other elements of the strategy for working toward a self-sustaining population in the wild include continued surveys of other potentially suitable habitat in order to reach a definitive conclusion about whether any other populations of *Novisuccinea chittenangoensis* exist and a determination as to whether *Novisuccinea chittenangoensis* genetically distinct from *Succinea* sp. B. In addition to securing the *in situ* conditions necessary to stabilize the natural population, captive propagation should be reinitiated in accordance with a newly established propagation protocol to safeguard against extinction of this species.

If and when stabilization of the extant *Novisuccinea chittenangoensis* population at Chittenango Falls has been achieved, progress toward full recovery of the species can commence. This will include establishing additional *Novisuccinea chittenangoensis* subpopulations (defined as groups of snails separated by temperature and humidity barriers) at the Falls. These subpopulations, along with captive populations, will ensure that highly localized environmental events do not result in extinction.

Recovery Goal: To establish long-term sustainability of the species in the wild.

Recovery Objectives: Given its precarious biological status, the immediate objective of this revised recovery plan is to **stabilize** *Novisuccinea chittenangoensis* in the wild and in captivity. The long-term recovery objective is to delist species.

Recovery Criteria: In order to consider the *Novisuccinea chittenangoensis* **stabilized**, the following criteria must be met.

1. The population at Chittenango Falls is shown to be stable or improving for five generations, i.e., 10 years. To accomplish this, a baseline population size and distribution must be determined following three years of monitoring efforts.
2. At least two healthy captive colonies of *Novisuccinea chittenangoensis* are successfully established in order to: (1) provide a source for augmenting the population at Chittenango Falls or introductions to new sites, (2) buffer against extinction in the wild, and (3) provide a source of *Novisuccinea chittenangoensis* for various scientific experiments.
3. The genetic distinctiveness of *Novisuccinea chittenangoensis* from other snails occupying the site is demonstrated.
4. With respect to the five listing factors, threats to the species are abated as follows:
 - a. Protection of the snail's Chittenango Falls habitat by the NYSOPRHP is perpetuated.
 - b. Effective measures to reduce competition between *Novisuccinea chittenangoensis* and *Succinea* sp. B are in place.
 - c. A sufficient understanding of the threat of hybridization is gained to respond accordingly.
5. Monitoring of threats and effects of management practices indicate that recovery actions are contributing to the improved status of the species.

If and when the population is shown to be stable or increasing for at least five generations (10 years), recovery of *Novisuccinea chittenangoensis* can then focus upon meeting conditions for delisting.

Delisting will be considered when the following criteria (in addition to criteria 1-3) are met.

6. Three additional *Novisuccinea chittenangoensis* subpopulations are established or verified at Chittenango Falls. Each of the four subpopulations must have a minimum of 100 snails, with a minimum total population of 1000 snails. All subpopulations must be shown to be stable (or improving) for five generations (10 years).
7. Threats to the snail are abated as follows:
 - a. All sites with *Novisuccinea chittenangoensis* are permanently protected through acquisition, conservation, easement, or another form of agreement.
 - b. Written management/monitoring plans are in place for each site.
 - c. A sufficient understanding of habitat and biological requirements is gained to conduct management efforts.
 - d. *Novisuccinea chittenangoensis* is ensured continued protection under the New York State Endangered Species Act after ESA protections are removed.
 - e. Competition between *Novisuccinea chittenangoensis* and *Succinea* sp. B or other

potential competitors is controlled with minimal management intervention.

- f. Searches for any other potential extant populations have been completed, and the extant population at Chittenango Falls has been successfully augmented.
8. Monitoring of threats and effects of management practices indicate that recovery actions have led to a secure status for the species.

The stabilization and delisting criteria will be reassessed as additional information on *Novisuccinea chittenangoensis* becomes available. Meeting the criteria for recovery will rely upon implementation of the following recovery actions.

Actions Needed:

- 1. Conduct genetics research.
- 2. Continue to protect the *Novisuccinea chittenangoensis* population and its habitat at Chittenango Falls.
- 3. Expand data on the biological and environmental requirements of *Novisuccinea chittenangoensis*.
- 4. Research techniques for removal of *Succinea* sp. B from the *Novisuccinea chittenangoensis*' habitat at the Falls.
- 5. As feasible, increase the population size and broaden the distribution of the Chittenango ovate amber snail.
- 6. Review and track recovery progress.

Estimated Costs for Stabilization (in thousands):

	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Need 5*</u>	<u>Need 6</u>	<u>Total</u>
FY1	8.0	5.5	16.5	--	--	--	30.0
FY2	9.0	3.0	15	7.5	5	--	39.5
FY3	2.0	4.5	15	10.0	15	--	46.5
FY4-10	6.0	16.0	--	15.0	48	--	85.0
<u>FY11-20</u>	<u>--</u>	<u>1.5</u>	<u>--</u>	<u>--</u>	<u>53</u>	<u>--</u>	<u>54.5</u>
Total	25	30.5	46.5	32.5	121	--	255.5

* additional costs to be determined

Estimated Time Frame:

Stabilization may be achieved by the year 2014, if recovery actions are implemented on schedule. If stabilization occurs and all other necessary activities are accomplished, delisting may be possible in 20 years.

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PART I. BACKGROUND

The Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) is a terrestrial species that comprises one extant population at Chittenango Falls in central New York. The taxon was first discovered at Chittenango Falls in August 1905 by a field party from the Academy of Natural Sciences of Philadelphia (Figure 1). In 1908, H.A. Pilsbry reported the discovery, describing the snail as a subspecies of the widely distributed *Succinea ovalis* Say, 1817, which he placed in the Section *Novisuccinea* (Pilsbry 1948). Hoagland and Davis (1987) subsequently elevated *Novisuccinea* to the genus level.



Figure 1. Type specimens from Philadelphia Academy of Natural Sciences.

Novisuccinea chittenangoensis was originally proposed as a Federal endangered species in April 1976 (41 FR 17742-17747) owing to an apparent decline in the species' population coupled with its extremely limited range. Ultimately, however, the species was listed as threatened, in July 1978 (43 FR 28932-28935), because of the presumed existence of a second colony in Tennessee and North Carolina. Since listing, it has been determined that the Tennessee/North Carolina snails are not *Novisuccinea chittenangoensis*, and the Chittenango Falls colony remains the only known population of this species (Figure 2). In 1977, the New York State Department of Environmental Conservation (NYSDEC) amended the State list of endangered species to include *Novisuccinea chittenangoensis* as an endangered species in New York.

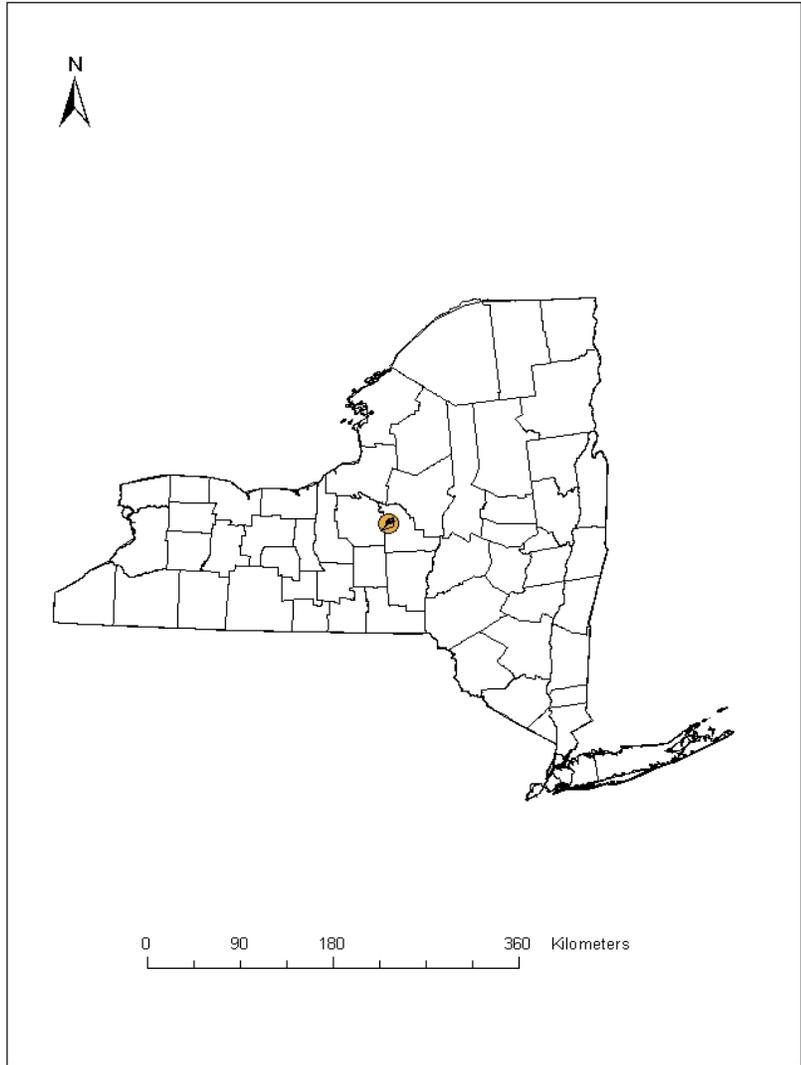


Figure 2. Location of Chittenango Falls State Park, Madison County, New York.

Based on the single population and existing threats, *Novisuccinea chittenangoensis* may be more accurately classified as an endangered rather than threatened species; however, *Novisuccinea chittenangoensis* will retain its Federal listing as threatened until a full status review is conducted in accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (ESA). Reclassification of the *Novisuccinea chittenangoensis* to endangered would not result in additional protection, as the Chittenango Falls population and its habitat are currently protected. In addition, management efforts are ongoing and would not likely increase due to a reclassification. Consequently, although *Novisuccinea chittenangoensis* does remain highly vulnerable to extinction due to ongoing threats (see Reasons for Decline and Continuing Threats, p.15), retaining the snail's status as threatened will continue to allow for the timely undertaking of recovery activities without decreasing its protection and without diverting resources to listing activities until such time as a status review may require that reclassification be initiated.

The initial recovery plan for the *Novisuccinea chittenangoensis* was completed in March 1983 (Riexinger *et al.* 1983). Although some progress toward recovery has been made since its listing, the species remains extremely vulnerable to environmental and stochastic events; of particular concern is another snail, *Succinea* sp. B, that was possibly introduced from Europe and has an undefined negative interaction with the *Novisuccinea chittenangoensis*. This revised recovery plan focuses upon these issues and recommends strategies for addressing them. The plan includes a revised recovery objective and a change in priority of required actions. Because there is still relatively little known about this species, the recovery program for *Novisuccinea chittenangoensis* is intended to adapt to new information and issues as they arise.

The recovery priority number for the *Novisuccinea chittenangoensis* is 5. This ranking was determined in accordance with the recovery priority criteria in 48 FR 41985, and is based on a high degree of threat, low recovery potential, and taxonomic standing as a species.

DESCRIPTION

Pilsbry (1908) provides a detailed description of the species as *Succinea ovalis chittenangoensis*, which is further refined by Hoagland and Davis (1987) as *Novisuccinea chittenangoensis*.

The shell of *Novisuccinea chittenangoensis* is ovate, slender, acute, and of moderate thickness (Figure 3). The shell suture is deep. The spire is gently convex, laterally compressed, with $3\frac{1}{4}$ whorls. The spire is long, slightly less than half the shell length, and the aperture is very oblique. The shell color is subtranslucent, calcareous pale yellow to white. The surface is somewhat glossy and marked with growth wrinkles and lines. The size varies somewhat, but adult specimens of the type lot averaged 20.9 millimeters in shell length. Various adult specimens measured during the summer of 1981 and 1982 ranged from 19.0 to 24.0 mm (Aloi and Ringler 1982). Hatchlings measure 1 to 2 mm in shell length (Molloy and Norton 1993, and Molloy 1995), and yearlings average around 10 mm (Aloi 1985). Measurements of all *Novisuccinea chittenangoensis* in 2002 (Arrigoni 2002) ranged from 7.0 to 23.0 mm.

The base color of the living animal is very pale subtranslucent yellow. The mantle, kidney, and hepatopancreas are visible through the shell but are often slightly obscured by the thickness of the shell. The dorsal surface of the mantle is pale yellow, tinted with olive, often marked with black streaks and blotches. Over the hepatopancreas is a golden yellow tessellation that is marked with grey or black spots and streaks. A dark marking on the posterior surface of the foot is distinctive (Thomee 1986). However, the mark is not present on the hatchlings making them impossible to identify in the field. The mark is obvious when the snail reaches approximately 6-9mm in length.

A non-native snail from Europe, *Succinea* sp. B (Figure 4), is also found at Chittenango Falls State Park and looks quite similar to the *Novisuccinea chittenangoensis*. Positive identification of *Novisuccinea chittenangoensis* is based on a combination of morphometric, anatomical, and genetic markers (Hoagland and Davis 1987). At Chittenango Falls State Park external features alone can be used to differentiate *Novisuccinea chittenangoensis* from other species for individuals with a shell length of 9 mm or greater. The characteristics used to identify *Novisuccinea chittenangoensis* at the Falls are a deep clearly defined suture on the whorls of the shell and a small dark spot on the dorsal surface of the foot. The DNA of snails with these characteristics at other locations would have to be analyzed in order to determine if they are *Novisuccinea chittenangoensis*. Positive identification is often not possible for empty shells.



Figure 3. Photograph of *Novisuccinea chittenangoensis* (J. Arrigoni).



Figure 4. Photograph of *Succinea* sp. B (USFWS).

Other succineid snails (*Oxyloma* spp.) have also be found at Chittenango Falls (Hoagland and Davis 1987). Solem (1976) stated that *Oxyloma* spp. can be easily separated from *Succinea* spp. at the Falls by shell morphology and internal anatomy. Electrophoretic studies by Hoagland and Davis (1987) verified *Oxyloma* as a distinct genus from both *Novisuccinea* and *Succinea*.

TAXONOMY

Mollusca: Gastropoda: Pulmonata: Succineidae: *Novisuccinea chittenangoensis*.

The Chittenango ovate amber snail was originally described as a subspecies or form of the more widespread ovate amber snail *S. (= N.) ovalis*, and is referred to in many publications as *S. ovalis chittenangoensis* (Pilsbry 1908, Solem 1976). Whereas Solem (1976) considered the species as a form of *N. ovalis*, citing similarities in genitalia and radula between the two and attributing shell differences to, possibly, a marked genetic mutation (perhaps with dominance accounting for lack of intergradation between *Novisuccinea chittenangoensis* and *N. ovalis*), Hubricht (1972) and Grimm (1981) considered it a distinct species due to external morphological differences. By 1981, *N. ovalis* could not be found at the Falls. However, during sampling for Hoagland's electrophoretic analyses, *N. ovalis* was found at two locations within approximately 16 kilometers of Chittenango Falls (Hoagland and Davis 1987).

Individuals assigned to *Novisuccinea chittenangoensis* appeared to be divided into two color morphs, a "gray morph" that was relatively common and widespread at the Falls, and a "red morph" that was restricted to the ledges at the base of the Falls. A preliminary analysis by Hoagland (1984) stated unequivocally that the red and the gray morphs were two distinct species, possibly in separate genera. Solem examined specimens of the gray morph and assigned it to *S. putris*, an introduced pest snail from Europe (Solem pers. comm.). Hoagland and Davis (1987) subsequently completed a thorough analysis, based on electrophoresis, shell morphology, and internal anatomy, of the succineids at Chittenango Falls. They divided *Succinea* into two genera, keeping the Old World *Succinea* in the genus and elevating the New World *Succinea*, of the Section *Novisuccinea* including *ovalis* and *chittenangoensis*, to the genus level. They also determined that the Old World *S. putris* is probably a species complex and that the gray morph, although closely related to *S. putris* sensu lato, is a distinct species, which they designated

Succinea sp. B (see Appendix A). Based upon these factors, the species designation *Novisuccinea chittenangoensis* is considered valid. Both species have been observed with red and gray morphs, bringing into question whether the earlier separation truly represented taxonomic distinctiveness. Currently, *Novisuccinea chittenangoensis*, *Succinea* sp. B, and *Oxyloma* spp. are considered to be the only succineid species present at Chittenango Falls.

SPECIES BIOLOGY

Until recently, relatively little was known about the biology of the Chittenango ovate amber snail, and it should be emphasized that, due to uncertainty of species identification in earlier work, additional work is crucial to understanding this species and ensuring its survival. Contract studies by investigators at the State University of New York at Syracuse, College of Environmental Science and Forestry (ESF), since 1981 have contributed to the base of knowledge about the biology and life history of the *Novisuccinea chittenangoensis*. Aloi (1985) analyzed the population dynamics of the succineid snails at Chittenango Falls (see Appendix B). Thomee (1986) investigated their behavioral ecology (see Appendix C), and Molloy and Norton (1993) developed techniques for captive propagation. Molloy (1995) reported on the captive population of *Novisuccinea chittenangoensis* and associated field studies related to factors influencing the distribution of *Succinea* sp. B. (see Appendix D). Confusion on snail identification may have affected the results of Thomee's and Aloi's work, but by the time Molloy's study was initiated the identification problems had been resolved.

Novisuccinea chittenangoensis survives in, and presumably prefers, cool, partially sunlit areas of lush herbaceous growth within the spray zone of the Falls. The snails mate from May through July, ovipositing from June through July. They are hermaphroditic, however it is unclear if selfing is possible. The eggs, numbering 8 to 14 (Molloy and Norton 1993), are approximately 2 mm in diameter, spherical, transparent, and very distinctive within a cluster. Generally, *Novisuccinea chittenangoensis* eggs are not found to have a heavy gelatinous layer surrounding the entire cluster, which is associated with egg masses of *Succinea* sp. B. *Novisuccinea chittenangoensis* egg clusters are deposited at the base of plants, under matted vegetation, or in loose wet soil. The young snails hatch in two to three weeks, measuring barely 2 mm. It is still unclear when the snails mature, although Grimm (1981) believes they reach maturity in five to eight months, or the spring following hatching. At the end of their first full year of growth, snails observed by Aloi and Ringler (1982) averaged around 10 mm. By the end of the following year, the adult

snails were observed to reach a length of approximately 21 mm, then die, completing a life span of about two and one-half years. This life span is similar to those in captive populations (unpublished data, Rosamond Gifford Zoo).

A study of the movements of individual snails (Aloi and Ringler 1982), cited in the original recovery plan (Riexinger *et al.* 1983), was conducted on the gray morph in the watercress beds (*Nasturtium officinale*) below Chittenango Falls. Those animals have subsequently been identified as *Succinea* sp. B (Hoagland and Davis 1987) rather than *Novisuccinea chittenangoensis*.

Novisuccinea chittenangoensis apparently feed on microflora, and must obtain high levels of calcium carbonate from their environment for proper shell formation. Thomee (1986) observed that they were generally found on green vegetation, whereas *Succinea* sp. B was more frequently found on dead vegetation.

Competition from the introduced snail may be having a significant impact. Hubricht (1985) reported that *S. putris* (*Succinea* sp. B of Hoagland and Davis) is a "very common species within its range. I found no other Succineidae with it. It appears to crowd out all other species." In that the captive colony of *Novisuccinea chittenangoensis* at Rosamond Gifford Zoo did quite well in the first three generations in the absence of *Succinea* sp. B, additional studies on the interspecific relationship of these two taxa are needed. It does not appear that the other sympatric snail species (e.g., *Oxyloma* spp.) occurring at the Falls are having a significant impact on *Novisuccinea chittenangoensis*, as they are thought to be native species; *Oxyloma retusa* Lea was described by Pilsbry in 1905 within Madison County (Hoagland and Davis 1987). Nevertheless, further efforts are needed to determine the habitat use of these snails.

Predators may include carabid, staphylinid and lampyrid beetles, and sciomyzid larvae, many of which specialize in feeding upon snails. Other potential predators may include the Northern Two-lined (*Eurycea bislineata*), Northern Dusky (*Desmognathus fuscus*), and Allegheny Mountain Dusky (*Desmognathus ochrophaeus*) salamanders, which are common in the talus and on the ledges, and various small mammals or passerine birds such as robins and pigeons, which are often seen in or near the habitat. Although predation does not appear to be a limiting factor at this time, its potential impact on a low or stressed population is unclear. Thomee (1986) reported that the relative frequency of the two color morphs

of the *Novisuccinea chittenangoensis* changes seasonally, suggesting the possibility of a color-discriminant predator.

HABITAT

Occupied Habitat

The habitat of *Novisuccinea chittenangoensis* lies within the ravine at the base of the 167-foot-tall waterfall formed by Chittenango Creek as it flows north from Cazenovia Lake toward Oneida Lake. This north-south oriented ravine forms a deep gorge that is shaded or partially shaded throughout most of the growing season, resulting in a microclimate that stays relatively cool during the summer, and, because of the creek flow and ice formations, is relatively warm in the winter compared to the surrounding area. Spring thaws and periodic major rainfall events tend to remove vegetation from significant portions of the primary *Novisuccinea chittenangoensis* habitat.

Pilsbry (1948) reported that *Novisuccinea chittenangoensis* was found "on a sloping weedy talus near the foot of the falls." The only sloping weedy talus is on the east side of the Falls. This area is adjacent to and between the vegetated ledge at the base of the falls where *Novisuccinea chittenangoensis* now occurs and the spring-fed watercress beds previously reported to be *Novisuccinea chittenangoensis* habitat. The *Novisuccinea chittenangoensis* has not been verified on the west side of the Falls.

Work by Grimm, Riexinger, and Aloi and Thomee, conducted before the 1987 report authored by Hoagland and Davis, did not differentiate between *Novisuccinea chittenangoensis* and *Succinea sp. B* (*S. putris* sensu lato), and their observations that *Novisuccinea chittenangoensis* occurred on both sides of the Falls and in the spring-fed patch of watercress may have been in error. Thomee (1986) mapped the habitat occupied by *Novisuccinea chittenangoensis*. The snails occupied an area of 53.7 m² at the base of the Falls, with most snails found in an area of 11.4 m².

Habitat Parameters

Five parameters appear to have significance in habitat considerations: humidity, substrate, temperature, vegetation, and water quality.

Humidity: *Novisuccinea chittenangoensis* appears to require sustained, very high humidity. Active snails were found only when relative humidity approached 100 percent (Thomee 1986). During dry periods, Thomee found the snails to be relatively inactive. Portions of the habitat and substrate are consistently at near maximum humidity or saturation in the spray zone of the Falls. However, during 2002, the majority of *Novisuccinea chittenangoensis* were found >5 meters from the edge of the ledge nearest the Falls.

Substrate: *Novisuccinea chittenangoensis* appears to be an obligatory calciphile, requiring a substrate either derived from limestone dolomite or rich in calcium carbonate from other sources. The dynamic nature of its habitat does not allow for the development of soil.

Temperature: The species has a narrow thermal niche, requiring cool, mild-temperature, relatively constant conditions, which are apparently provided by the waterfalls and mist. Active *Novisuccinea chittenangoensis* are generally found at temperatures from 12E to 20E C (Thomee 1986). During warmer periods, the snails retreat to cool areas provided by the moist rock and moss, or aestivate in the vegetation. During cold winter temperatures, it is believed that the snails at the Falls retreat into the rocks, cracks, or fissures and remain inactive. Various temperature readings were gathered during the summer of 1980-82. In the spray zone, the rock surface temperatures averaged 16EC, the moss averaged 14EC, and the combined temperatures of the substrate, water, and vegetation averaged 16EC. Seasonal and daily temperature variation has not been quantified.

Vegetation: Most of the spray zone adjacent to the Falls is covered with patches of various mosses, liverworts, and other low herbaceous vegetation including *Eupatorium purpureum*, *Angelica atropurpurea*, and *Aster* spp. (Thomee 1986). In addition, watercress (*Nasturtium officinale*) increased after the 1993 flood event. *Novisuccinea chittenangoensis* were found on vegetation up to 92 cm above the ground and at maximum sunlight intensities of about 1/3 lux of the sympatric *Succinea* sp. B. Vegetation is quite sparse on the west side of the Falls, and the only snails that have been observed there are *Succinea* sp. B. In drier talus adjacent to the mossy areas are various plant species, such as skunk cabbage (*Symplocarpus foetidus*) and angelica, upon which *Succinea* sp. B has also been found. During periods of heavy water flow, dew, or rain, when the vegetation is saturated, the snails have been observed actively crawling on the vegetation. During drier times, the snails attach themselves to the underside of leaves with a mucous epiphragm. In the patch of watercress, the vegetation is dense and lush. Although the watercress is dominant, other species include angelica, jewelweed (*Impatiens capensis* and *I. palida*), forget-me-nots

(*Myosotis scorpioides*), various mints, and poison ivy (*Rhus toxicodendron*), which again support *Succinea* sp. B, not *Novisuccinea chittenangoensis*. The ledges where the *Novisuccinea chittenangoensis* is found clearly comprise an early successional sere, periodically rejuvenated to a bare rock substrate by flood waters.

Water Quality: It may be fair to presume that clean water is necessary to maintain essential habitat and a healthy population of *Novisuccinea chittenangoensis*, just as it is to the survival of many other invertebrates; however, since *Novisuccinea chittenangoensis* is a terrestrial snail, the effects of water quality are expected to be somewhat indirect. For instance, while oxygenation of the water from tumbling over the Falls may decrease the effect of organic pollutants such as sewage (which historically was - discharged into Chittenango Creek from Cazenovia), the actual effect on this snail is unclear. Furthermore, recent reconsideration of the possible effects of stream pollutants or water-borne contaminants on the *Novisuccinea chittenangoensis* suggests that there is little likelihood that these factors have played a measurable role in its decline, especially given the success of the related *Succinea* sp. B, which is thriving at the Falls and throughout the rest of the Chittenango Creek drainage (Molloy 1995). In the 1983 *Novisuccinea chittenangoensis* recovery plan, monitoring and maintenance of water quality in Chittenango Creek were considered to be actions of major importance; based on more recent insights, the series of tasks outlined in the original recovery plan that address water quality concerns have been deleted from this revised plan.

RANGE

The only verified extant colony of *Novisuccinea chittenangoensis* is the type-population at Chittenango Falls, in Chittenango Falls State Park, 3.6 miles north of Cazenovia, between the towns of Cazenovia and Chittenango, in Madison County, New York. At various times in the past, the species has been thought to have a broader range.

During the summer of 1982, "sub-fossil" shells of what appeared to be *Novisuccinea chittenangoensis* were found in the banks on the west side of Chittenango Creek near the Falls. Grimm (1981) postulated that Pleistocene deposits of *N. ovalis pleistocenica* (Baker 1927) are instead *Novisuccinea chittenangoensis*, and that this species was widely distributed during the Pleistocene epoch.

Shell specimens have been recorded from Yarmouth, Sangamon, and Peorian deposits (Baker 1927) in the States of Arkansas, Illinois, Iowa, Michigan, Missouri, and Nebraska, and in the Province of Ontario. Alan Solem (pers. comm.), however, questioned assigning fossil succineid shell deposits to any species group. Although Hubricht (1985) mapped the location of extant populations of *Novisuccinea chittenangoensis* to include New York, West Virginia, Virginia, Tennessee, and North Carolina, with fossil records from Iowa, Illinois, Missouri, and Arkansas, Hoagland and Davis (1987) concluded that there is only one verified extant population of *Novisuccinea chittenangoensis* and that it is impossible to verify fossil records as being *Novisuccinea chittenangoensis* based on shell characteristics alone.

Many field searches have been conducted for additional extant *Novisuccinea chittenangoensis* colonies. Originally, six colonies in North Carolina, Tennessee, Virginia, West Virginia, and Quebec were identified as supporting succineid snail populations; these were investigated further in the early 1980s as potential *Novisuccinea chittenangoensis* colonies, and there was disagreement as to whether *Novisuccinea chittenangoensis* occurred at these other sites. A number of other locations were field-checked by Grimm in 1981 without finding any additional *Novisuccinea chittenangoensis* populations. In October 1981, fourteen waterfalls in central and western New York were visited by representatives of the NYSDEC and Region 5 of the U.S. Fish and Wildlife Service (USFWS) to assess their potential as habitat for *Novisuccinea chittenangoensis*. Only two sites yielded succineid shells, none of which were *Novisuccinea chittenangoensis*. Pursuant to the 1983 recovery plan, various waterfalls and other potential *Novisuccinea chittenangoensis* habitat were checked in North Carolina, West Virginia, New York, Minnesota, and Iowa, and succineid snails have been collected and sent to Hoagland and Davis (ANSP), Solem (Field Museum of Natural History), Franzen (Illinois Wesleyan University), and Hubricht for identification. There has been some disagreement of species identification among these malacologists, but *Novisuccinea chittenangoensis* has not been confirmed at any of the sites and the species is considered to be endemic to Chittenango Falls.

The current revision of the original recovery plan has precipitated further efforts to identify additional extant *Novisuccinea chittenangoensis* colonies. To date, although many potentially suitable colony sites have been searched, no colony has been conclusively identified as *Novisuccinea chittenangoensis* outside of the Chittenango Falls area. Recent efforts to identify additional colony sites by examining shell collections at the National Museum of Canada and the U.S. National Museum and by investigating reports from cooperating malacologists have proved unsuccessful, and based on findings by

Hoagland and Davis (1987), there appears to be little likelihood of discovering new sites. However, new techniques for identifying genetic relationships should be employed to further test whether *Novisuccinea chittenangoensis* at Chittenango Falls is distinct from specimens at previously reported locations.

POPULATION STATUS

Accurate population trends are not available for this species. In addition to the infrequent surveys and confusion between *Novisuccinea chittenangoensis*, *Succinea* sp. B, and *N. ovalis*, conditions at Chittenango Falls have precluded extensive surveys of the entire spray zone. Climbing the higher, extremely fragile rock ledges may damage these areas and any snails inhabiting them.

Prior to 1982, no quantitative estimates were made of the size or status of the *Novisuccinea chittenangoensis* population at Chittenango Falls. The species was supposedly "in great abundance" when a field party collected it in 1905 but was not surveyed again until 1954 when Hubricht (Solem 1976) found it in "equal abundance" with *N. ovalis*. Grimm found *N. ovalis* more abundant than *Novisuccinea chittenangoensis* during field surveys in 1964, 1965, and 1973. In 1972, Grimm estimated the total *Novisuccinea chittenangoensis* population to number less than 200, but Solem estimated it at about 500 in 1974. Three investigators spent two hours searching the habitat in 1973 and located only 13 specimens; a trip later that summer yielded none. Surveys by the NYSDEC Endangered Species Unit have generally uncovered only a few shells or living animals during annual trips since 1976, although an intensive search in July of 1981, with Grimm's assistance, yielded 18 live individuals.

Past surveys are suspect, as Grimm and Hubricht no longer believe that *N. ovalis* even occurs in the *Novisuccinea chittenangoensis* habitat at Chittenango Falls. They surmise, rather, that earlier specimens of *N. ovalis* reported were instead immature *Novisuccinea chittenangoensis*. However, a review of photographic records showed shells of *N. ovalis* that were collected at the Falls when the type specimens of *Novisuccinea chittenangoensis* were collected. Apparently, *N. ovalis* occurred at or near the Falls historically but it is no longer encountered there or is only located in adjacent habitats. Therefore, the problem of relative comparisons between the two species' abundance is troublesome and confusing (See the Taxonomy section of this plan).

During the summer of 1982, Aloï and Ringler conducted a mark-recapture study in the patch of watercress where the snails appeared most densely. Using two methods (Jolly and Schnabel) and two models, they estimated a population of about 300 snails with a density of four snails per square meter of watercress habitat. These snails have subsequently been identified as *Succinea* sp. B, not *Novisuccinea chittenangoensis*. A collection of 83 snails made in 1983 for use in electrophoretic studies resulted in the removal of 24 *Novisuccinea chittenangoensis* from the population (Hoagland 1984); unfortunately, their identity was not verified at the time of collection, on top of which *Novisuccinea chittenangoensis* was thought to be more abundant than it actually was. The population of *Succinea* sp. B expanded rapidly to an estimate of more than 3,000 snails in 1984 (Aloï 1985), whereas counts of *Novisuccinea chittenangoensis* in 1984 indicated the presence of approximately 100 adults (Thomee 1986). Counts of live *Novisuccinea chittenangoensis* from 1995-2001 have yielded an average of five adults per survey with a high of 12 adults in 2001 (A. Breisch pers. comm.), and post-reproductive shell counts made at the end of the activity season since 1987 have generally identified 4 to 20 adult (*Novisuccinea chittenangoensis*) (A. Breisch pers. comm.). Subsequent studies have shown that *Succinea* sp. B outnumbers *Novisuccinea chittenangoensis* by as much as 30 to 1 in the primary habitat areas (A. Breisch pers. comm.).

In 2002, the NYSDEC, ESF, and the USFWS increased the survey effort and conducted a mark-release-recapture study at the Falls. Sixteen surveys were conducted during this study between July and October 2002. The final population estimate using the Schumacher-Eschmeyer method was 183 individuals (95% C.I.: 145-222 individuals) (Arrigoni 2002). Arrigoni also estimated population size based on capture frequencies with a final estimate of 206 individuals. Due to differences in survey intensity and questionable species identification in years past, the validity and comparability of survey data available do *not* provide a sound basis for any accurate status statement. The mark-release-recapture study has continued in the summer of 2003 and is planned for 2004 as well. The three years of data collection should provide a reliable baseline population estimate at the Falls and provide a protocol for future monitoring of the population status.

In addition to the wild population at Chittenango Falls State Park, efforts to establish captive populations began in 1990. A single captive *Novisuccinea chittenangoensis* colony was being maintained at the Rosamond Gifford Zoo, in Syracuse, New York; however, the last remaining snails died in November of 2002.

REASONS FOR DECLINE AND CONTINUING THREATS

The primary reasons *Novisuccinea chittenangoensis* was Federally listed as a threatened species were its extremely limited range and apparent population decline. Since this species is so poorly studied, actual causes of its decline can only be inferred. The 1978 listing rule included trampling of habitat, water pollution, predation by European snails, and the lack of existing regulatory mechanisms as threats to the species. Currently, the most significant threats to the *Novisuccinea chittenangoensis* appear to be the species' extremely small population size and limited distribution as well as the impacts of the introduced snail, *Succinea* sp. B. Human disturbance also continues to threaten the *Novisuccinea chittenangoensis*, although this has been greatly minimized by fencing at the Falls. Other factors may also pose a threat to the species, but further investigations are needed.

The present or threatened destruction, modification, or curtailment of its habitat or range

While modification or destruction of *Novisuccinea chittenangoensis* habitat due to development is not an issue at Chittenango Falls State Park, habitat has been modified due to human disturbance. The 1978 final rule listing the *Novisuccinea chittenangoensis* as threatened estimated that sixty percent of the habitat at Chittenango Falls was trampled by humans. Since 1928, Chittenango Falls has been part of Chittenango Falls State Park, one of a series of State Parks in the Central New York Region of the New York State Office of Parks, Recreation, and Historic Preservation (NYSOPRHP). Approximately 57,000 visitors come to the Park each year to engage in a variety of outdoor recreational activities (D. Wheelock pers. comm.). Fishing and hiking have brought a large number of visitors down to the Falls area, where potential conflicts may arise. Trampling of the snails and their habitat was identified early on as a major potential threat. This threat was exacerbated in the early 1980s by flooding, which destroyed a bridge that would have tended to route visitors away from the snail population. Problems with littering in the snail's habitat, e.g., beverage containers and fishing paraphernalia found at various levels of the rock face and around the pool at the base of the Falls, have decreased since the erection in 1984 and 1985 of the fence along the ravine trail and the reconstruction of the bridges. Dislodging rocks, talus, or vegetation can cause serious harm to the snails and their eggs and can seriously harm their habitat. Flood events also have the potential to dislodge rocks along the Falls; this is further discussed in "Other natural or manmade factors affecting its continued existence."

The USFWS also reported that pollution in the spray from Chittenango Creek may have caused the population decline. Water quality is not considered to be a significant threat to the *Novisuccinea chittenangoensis*. Changes in water quality may impact the vegetation along the Falls, but no information is available regarding this relationship. Water quality should be monitored along with any changes in the vegetation and the *Novisuccinea chittenangoensis* population status to ensure that it does not surface as a threat. During the summer of 2003, water samples were collected to begin to monitor water quality.

Overutilization for commercial, recreational, scientific, or educational purposes

Collection of *Novisuccinea chittenangoensis* has not been documented as a threat to the species.

Disease or predation

The listing rule included predation by the introduced European snails, *Discus rotundatus* and *Oxychilus* spp. as serious threats to *Novisuccinea chittenangoensis*. Little is currently known about this relationship. Predation by small mammals, birds, and salamanders is also a potential threat at a low level. There are no reports of disease threatening *Novisuccinea chittenangoensis*.

The inadequacy of existing regulatory mechanisms

This is not currently considered to be a direct threat to the species. At the time of the proposed rule, there were no adequate regulatory mechanisms in place to protect the *Novisuccinea chittenangoensis*. During the final listing process (1977), the NYSDEC amended the State list of endangered species to include *Novisuccinea chittenangoensis* as an endangered species in New York. New York State (ECL 11-0535) prohibits the “taking, importation, transportation, possession or sale of any endangered or threatened species.... or other parts thereof, or the sale or possession with intent to sell any article.... of any endangered or threatened species except under license or permit.” The definition of take includes pursuing, shooting, hunting, killing, capturing, trapping, snaring, disturbing, harrying, or worrying (ECL 11-01-03). In addition through a court decision (Amato and Rosenthal 2001) it was recognized that in New York, adverse modification of habitat may jeopardize the continued existence of listed species. This modification was considered a take under New York State law and was therefore prohibited by ECL 11-0535. However, if after the USFWS delisted the *Novisuccinea chittenangoensis* the State was to delist it as well, the protection would again be minimal to nonexistent without an adequate management plan in place.

Projects that might adversely affect the general area surrounding Chittenango Falls may be reviewed by either the NYSDEC or the USFWS. The NYSDEC reviews non-Federal projects that may significantly impact the environment through the State Environmental Quality Review Act (SEQR). The SEQR is similar to the National Environmental Policy Act of 1969, which provides a mechanism for public comment on projects that involve Federal agencies. New York State law also requires a permit for the following activities that could impact Chittenango Creek: constructing or using an outlet or discharge pipe (referred to as a "point source") that discharges wastewater into the surface waters or ground waters of the state, constructing or operating a disposal system such as a sewage treatment plant, or discharge of storm water.

Other natural or manmade factors affecting its continued existence

Species with limited range and narrow ecological niches tend to be more vulnerable and stressed by change than are wider-ranging species. This is evident with the endemic *Novisuccinea chittenangoensis*, a Pleistocene relict that has been able to survive in a small island of paraglacial habitat, which mimics the cool, moist conditions existing when the species may have been more common and widespread. Periodic floods caused by spring thaws (e.g., 1980, 1993, and 1995) have resulted in much of the vegetation being washed away from the primary habitat ledge where most *Novisuccinea chittenangoensis* have been found in recent years. Since the species may be intolerant of large fluctuations in light, temperature, and humidity, and this is the only area where the species occurs, impacts to the habitat can certainly be a threat. However, spring thaws generally occur before the snails are active, reducing the potential impact to the species by flood events.

In addition to washing away vegetation, flood events also have the potential to dislodge rocks along the Falls. The ledges may break off, destroying the primary habitat and potentially the snails themselves.

A particularly perplexing problem that was first recognized at the Falls in 1985 is the presence of an introduced snail, *Succinea* sp. B, that may be competing with *Novisuccinea chittenangoensis* for food, or breeding or wintering habitat. *Succinea* sp. B has saturated *Novisuccinea chittenangoensis*' habitat at Chittenango Falls, and further information is needed about the possible effects of this, e.g., whether *Succinea* sp. B is suppressing the ability of the *Novisuccinea chittenangoensis* colony to sustain itself

at viable levels. Furthermore, *Succinea* sp. B has become widespread throughout the Chittenango Creek drainage basin both up and downstream (Molloy 1995), including habitat that might otherwise be suitable for *Novisuccinea chittenangoensis*. In addition to the concerns about competition, there are questions about whether the *Novisuccinea chittenangoensis* and *Succinea* sp. B have the potential for hybridization, although no evidence of this was found by Hoagland and Davis (1987). Genetics studies are necessary to determine their taxonomic relationship and whether any hybridization may be occurring. Pending results of those studies, the assumption is that hybridization is not occurring based on the fact that while *Succinea* sp. B far outnumbers *Novisuccinea chittenangoensis*, there still appears to be clear morphological distinction between the two groups in the wild. Initial concerns regarding *Novisuccinea chittenangoensis*' genetics surfaced when the individuals raised in captivity began to change morphologically. These changes, which became noticeable after five generations in captivity, included the shell becoming more rough and opaque and the sutures became less distinct; in addition, the spires were less pronounced and were angled to the side, giving the snails a rounder shape (Figures 5a, 5b). These changes could be due to environmental conditions in a captive setting, diet, genetics, or a combination of these influences.



Figures 5a and 5b. Photographs of captive *Novisuccinea chittenangoensis* at the Rosamond Gifford Zoo (USFWS, NYSDEC).

CONSERVATION MEASURES

The only known habitat of the *Novisuccinea chittenangoensis* is fully protected as a State Park, and there is a cooperative program among the NYSDEC, NYSOPRHP, and the USFWS to protect the snail and its habitat. Post-listing surveys have occurred at the Park almost every year since 1977. These surveys have generally consisted of timed searches within the known habitat area. The second (higher) ledge area has been surveyed a few times, but no *Novisuccinea chittenangoensis* have been found there to date. The current survey protocol consists of 15-minute surveys of 1-meter plots along the primary ledge (Appendix E). As previously described, a mark-release-recapture study was initiated in 2002 to better estimate the population size.

During the course of the recovery process, the imperative need to establish a captive colony of *Novisuccinea chittenangoensis* was confirmed. The objectives of establishing one or more captive colonies are to offset imminent threats of extinction at the Chittenango Falls site and to serve as a source of founders for enhancing the existing population and creating additional subpopulations at the Falls.

The first captive *Novisuccinea chittenangoensis* colony was established in 1990 at ESF at Syracuse (Molloy and Norton 1993, Molloy 1995), starting with six founders from Chittenango Falls. In 1995, F₃ offspring reared at ESF were transported to the Wildlife Conservation Park/Bronx Zoo and the Burnet Park Zoo in Syracuse. Both the Wildlife Conservation Park/Bronx Zoo and Burnet Park Zoo (R. Clawitter pers. comm.) produced a new generation of *Novisuccinea chittenangoensis*. Unfortunately, the population at Burnet Park Zoo was lost to unknown causes in 1996. While reproduction was achieved at the Wildlife Conservation Park/Bronx Zoo, survival of young was very limited. In 1998, the seven remaining *Novisuccinea chittenangoensis* from the Wildlife Conservation Park/Bronx Zoo were transferred to the Rosamond Gifford Zoo (the renamed Burnett Park Zoo). Successful reproduction occurred in 1998 and 1999 with hundreds of eggs produced, although survival of juveniles was low (N. Porter pers. comm). Minimal reproduction occurred in 2000, and five and seven *Novisuccinea chittenangoensis* were given to the Seneca Park Zoo (Rochester, NY) and Buffalo Zoo, respectively. All snails at Seneca Park and Buffalo died within the first year (Murphy pers. comm., Wyatt pers. comm.). In 2001, egg masses proved to be infertile at Rosamond Gifford Zoo; two adults remained through the fall of 2002, and those died in November 2002.

Further experiments are necessary to determine the ideal conditions for maintaining a healthy captive population of *Novisuccinea chittenangoensis*. In addition to problems with recruitment, growth and shell morphology of the remaining captive adults is different from those in the wild, and the relationship of this difference to either diet or genetic factors is uncertain.

RECOVERY STRATEGY

The current strategy for recovery of the *Novisuccinea chittenangoensis* is to stabilize (as defined in the Recovery Criteria section of this plan) the extant population at Chittenango Falls by perpetuating the population at a baseline size and by maintaining multiple captive populations of the species. Several actions have been identified as necessary for population stabilization. Given the pervasive threat presented by the introduced competitor *Succinea* sp. B and the previous failure of captive breeding efforts, this is considered to be an ambitious but achievable aim. Paired with these *in situ* and *ex situ* efforts to conserve the extant population, research is needed to better understand the *Novisuccinea chittenangoensis*' biological requirements and optimal conditions for captive breeding and rearing, and to find a means to control *Succinea* sp. B.

Given the grave uncertainty about the *in situ* survival prospects of this snail, captive propagation is viewed as essential for the species' stabilization. Captive propagation should be reinitiated in accordance with a sound propagation protocol in order to ensure success in breeding and rearing *Novisuccinea chittenangoensis*. Surveying other potentially suitable habitat also remains a recovery priority for this species. The primary purpose of conducting surveys will be to determine whether any other populations of *Novisuccinea chittenangoensis* exist. In concert with these recovery actions, it must be determined whether *Novisuccinea chittenangoensis* is genetically distinct from *Succinea* sp. B. The current working assumption is that hybridization is not occurring, but this needs to be verified in order to verify the level of threat presented by the introduced snail and to refine *in situ* management techniques for stabilizing the extant *Novisuccinea chittenangoensis* population.

If the current *Novisuccinea chittenangoensis* population at Chittenango Falls can be stabilized or increased, progress toward the second phase of the recovery strategy, which includes advancing toward

delisting by establishing additional *Novisuccinea chittenangoensis* subpopulations at the Falls, will become possible. Subpopulations are being defined as snail colonies separated by physical, temperature, and humidity barriers. It is likely that other suitable habitat at the Falls may not be in use due to the presence of *Succinea* sp. B and the presence of barriers between potentially suitable areas. In tandem with long-term maintenance of captive populations, establishment of subpopulations at Chittenango Falls will provide adequate assurance that highly localized catastrophic events will not cause the extinction of the species. This strategy is based on assumption that the discovery of additional populations of *Novisuccinea chittenangoensis* outside the Chittenango Falls habitat is highly unlikely and on the premise that preservation of the species within its current known range, i.e., Chittenango Falls, buffered by a captive propagation program will suffice to ensure its long-term viability in the wild.

PART II: RECOVERY

RECOVERY GOAL

The overall recovery goal under the Endangered Species Act is to establish the long-term viability of the Chittenango ovate amber snail population(s) sufficiently to allow delisting the species.

RECOVERY OBJECTIVES

Given its precarious biological status, the immediate objective of this revised recovery plan is to stabilize *Novisuccinea chittenangoensis* in the wild by ensuring that it is not excessively outcompeted by *Succinea* sp. B, and in captivity by establishing a successful propagation program. The ultimate objective is to delist the species by establishing additional *Novisuccinea chittenangoensis* colonies within its current known range at Chittenango Falls.

RECOVERY CRITERIA

In order to consider the *Novisuccinea chittenangoensis* as **stabilized** the following criteria need to be met:

1. The population at Chittenango Falls is shown to be stable or improving for five generations, i.e., 10 years (Actions 2.1.2, 2.1.3). To accomplish this, a baseline population size and distribution must be determined following three years (2002-2004) of monitoring efforts (Action 2.1.1).
2. At least two healthy captive colonies of *Novisuccinea chittenangoensis* are successfully established in order to: (1) provide a source for augmenting the population at Chittenango Falls or introductions to new sites, (2) buffer against extinction in the wild, and (3) provide a source of *Novisuccinea chittenangoensis* for various scientific experiments (Action 5.2.2).

A healthy captive population is defined as having sufficient genetic diversity and being large enough to meet population goals, which will be specified in a new protocol based in part up the

results of genetics research as well as results of research into the optimal conditions for rearing and breeding *Novisuccinea chittenangoensis* (Actions 5.2.1, 5.2.3).

3. The genetic distinctiveness of *Novisuccinea chittenangoensis* from other snails occupying the site is demonstrated (Action 1.1).
4. With respect to the five listing factors, threats to the species are abated as follows:
 - a. Protection of the snail's Chittenango Falls habitat by the NYSOPRHP is perpetuated (Actions 2.2, 2.3, 2.4).
 - b. Effective measures to reduce competition between *Novisuccinea chittenangoensis* and *Succinea* sp. B are in place (Actions 3.1, 4).
 - c. A sufficient understanding of the threat of hybridization is gained to respond accordingly (Action 1.1).
5. Monitoring of threats and effects of management practices indicate that recovery actions are contributing to the improved status of the species (Action 6).

If and when the population is shown to be stable or increasing for at least five generations (10 years), recovery of *Novisuccinea chittenangoensis* can then focus upon meeting conditions for delisting. **Delisting** will be considered when the following criteria (in addition to criteria 1-3) are met.

6. Three additional *Novisuccinea chittenangoensis* subpopulations are established or verified at Chittenango Falls (Action 5.4). Each of the four subpopulations must have a minimum of 100 snails, with a minimum total population of 1000 snails. All subpopulations must be shown to be stable (or improving) for five generations (10 years) (Actions 2.1.2, 2.1.3).
7. Threats to the snail are abated as follows:

- a. All sites with *Novisuccinea chittenangoensis* are permanently protected through acquisition, conservation, easement, or another form of agreement (Action 2.2.4).
 - b. Written management/monitoring plans are in place for each site (Actions 2.2.4, 6.4).
 - c. A sufficient understanding of habitat and biological requirements is gained to conduct management efforts (Actions 3.2, 3.3).
 - d. *Novisuccinea chittenangoensis* is ensured continued protection under the New York State Endangered Species Act after ESA protections are removed.
 - e. Competition between *Novisuccinea chittenangoensis* and *Succinea* sp. B or other potential competitors is controlled with minimal management intervention (Action 4).
 - f. Searches for any other potential extant populations have been completed, and the extant population at Chittenango Falls has been successfully augmented (Actions 1.2, 5.1, 5.3).
8. Monitoring of threats and effects of management practices indicate that recovery actions have led to a secure status for the species (Action 7).

The stabilization and delisting criteria will be reassessed as additional information on *Novisuccinea chittenangoensis* becomes available. Meeting the criteria for recovery will rely upon implementation of the following recovery actions (see also Table 1).

Table 1. Recovery Action Outline

Note: See Appendix F for a list of recovery tasks from the original 1983 recovery plan.

1. Conduct genetics research to:
 - 1.1 Re-evaluate the taxonomic relationship between the *Novisuccinea chittenangoensis* and other snails, such as *Succinea* sp. B.
 - 1.2 Identify markers for *Novisuccinea chittenangoensis* to assist with future identification of snails at other sites.
2. Continue to protect the Chittenango ovate amber snail population and its habitat at Chittenango Falls.
 - 2.1 Determine the size and status of the population at Chittenango Falls.
 - 2.1.1 Establish a monitoring protocol to determine the baseline population at Chittenango Falls.
 - 2.1.2 Establish a long-term monitoring protocol for subsequent surveys at Chittenango Falls.
 - 2.1.3 Conduct surveys based on the monitoring protocols in occupied habitats.
 - 2.2 Continue to preserve the habitat of this species at Chittenango Falls.
 - 2.2.1 Ensure consideration of habitat protection in any activities of Park personnel.
 - 2.2.2 Inhibit or prevent, when possible, human-induced alterations that may adversely affect the snail's habitat at Chittenango Falls.
 - 2.2.3 Continue to restrict access to the population and habitat at Chittenango Falls.
 - 2.2.4 Develop a *Novisuccinea chittenangoensis* management/protection agreement for Chittenango Falls.
 - 2.3 Establish an information and education system conducive to achieving other recovery actions.
 - 2.3.1 Provide information to both permanent and seasonal NYSOPRHP staff, on an annual basis, as to the presence and uniqueness of the species, and to the importance of the protection of its habitat.
 - 2.3.2 Provide information to Park patrons and the local community as to the presence and uniqueness of the species, and to the regulations for its protection.
 - 2.3.2.1 Improve and maintain the permanent display panel located near the main parking area, keeping it accessible to all patrons, and develop any other necessary signage.
 - 2.3.2.2 Upon request, provide additional information in the form of brochures or reports on the species.
 - 2.4 Enforce all laws protecting the species and its habitat.
 - 2.4.1 Monitor public use and enforce rules to keep visitors off the Falls.
 - 2.4.2 Enforce water quality regulations along Chittenango Creek upstream of Chittenango Falls.
 - 2.4.3 Coordinate collecting or other scientific permits that could result in possible take of the species.
3. Expand data on the biological and environmental requirements of *Novisuccinea chittenangoensis*.
 - 3.1 Determine if *Succinea* sp. B is having a negative impact on *Novisuccinea chittenangoensis*.
 - 3.2 Further define optima of physical and biotic characters in *Novisuccinea chittenangoensis* habitat.

- 3.3 Investigate the effects of environmental contaminants on the *Novisuccinea chittenangoensis* and its habitat.
4. Research techniques for removal of *Succinea* sp. B from the *Novisuccinea chittenangoensis*' habitat at the Falls.
5. As feasible, increase the population size and broaden the distribution of the *Novisuccinea chittenangoensis*.
 - 5.1 Expand data on species' Post-Pleistocene range.
 - 5.1.1 Check succineid collections at various institutions to determine whether any additional colonies exist.
 - 5.1.2 Survey similar appropriate habitats within the eastern U.S. and Canada to locate additional colonies of *Novisuccinea chittenangoensis*, if any, and to identify suitable habitats for establishing new colonies.
 - 5.2 Establish and refine the *Novisuccinea chittenangoensis* captive propagation program.
 - 5.2.1 Develop an initial captive breeding protocol.
 - 5.2.2 Establish and maintain the captive-breeding program.
 - 5.2.3 Conduct research experiments to refine rearing protocols.
 - 5.3 Research the potential for augmenting the **extant** Chittenango Falls population with captive offspring.
 - 5.4 As appropriate, establish additional *Novisuccinea chittenangoensis* populations within the species' Post-Pleistocene range.
 - 5.4.1 Develop a protocol for evaluating potential release sites.
 - 5.4.2 Survey appropriate habitats within Chittenango Falls to identify potentially suitable sites for establishing new subpopulations.
 - 5.4.3 Determine the methods for establishing additional subpopulations at Chittenango Falls.
 - 5.4.4 Establish additional *Novisuccinea chittenangoensis* subpopulations.
6. Review and track recovery progress.
 - 6.1 Create a data repository for captive population reports, wild population survey reports, scientific research, etc.
 - 6.2 Conduct recovery team meetings as needed.
 - 6.3 Revise recovery plan as appropriate.
 - 6.4 Develop and implement a monitoring strategy.
 - 6.4.1 Monitor the implementation/completion of actions.
 - 6.4.2 Monitor the effects of any management actions conducted for the *Novisuccinea chittenangoensis*.
 - 6.4.3 Monitor current or potential threats to the species.
 - 6.4.4 Monitor the biological status of the *Novisuccinea chittenangoensis*.

RECOVERY ACTIONS

1. **Conduct genetics research to identify markers to:**
 - 1.1 **Re-evaluate the taxonomic relationship between the *Novisuccinea chittenangoensis* and other snails, such as *Succinea* sp. B.** This research will assist us with determining whether hybridization has occurred, or is occurring, between *Novisuccinea chittenangoensis* and *Succinea* sp. B. This information is critical for determining if the *Novisuccinea chittenangoensis* remains a distinct evolutionary entity. Moreover, technologies have improved dramatically since earlier assessments of the taxonomy of the *Novisuccinea chittenangoensis*. These new technologies (direct DNA sequencing) provide a hitherto fore unavailable opportunity to resolve questions about the evolutionary distinctiveness of the *Novisuccinea chittenangoensis* and its potential for interbreeding with other sympatric snails. Part of this action is to develop genetic sampling techniques that do not require sacrificing the snails.
 - 1.2 **Assist with future identification of snails at other sites.** This action covers the genetics labwork associated with Action 5.1.2 (to determine if there are other extant *Novisuccinea chittenangoensis* sites beside Chittenango Falls).
2. **Continue to protect the Chittenango ovate amber snail population and its habitat at Chittenango Falls.**
 - 2.1 **Determine the size and status of the *Novisuccinea chittenangoensis* population at Chittenango Falls.**
 - 2.1.1 **Establish a monitoring protocol to determine the baseline population at Chittenango Falls.** Three years of intensive mark-recapture-release surveys are necessary to determine the baseline population size and distribution of the *Novisuccinea chittenangoensis*. The protocol will identify the appropriate marking techniques, frequency of monitoring, and any other information necessary to adequately explain the expected methods for a chosen surveyor to use. A draft protocol is attached (Appendix E).
 - 2.1.2 **Establish a long-term monitoring protocol for subsequent surveys at Chittenango Falls.** Data from the initial 3-year monitoring program will help determine the necessary frequency and intensity of subsequent surveys. The goal of long-term monitoring is to assess any change in the species' status, abundance and reproductive success, and/or the level of threats. The protocol should address the number and types (live counts, shell counts) of surveys needed within and among years. The protocol should also include efforts be made to minimize activity in the species' habitat.
 - 2.1.3 **Conduct surveys based on the monitoring protocols in occupied habitats.** It is essential that Chittenango Falls is monitored according to the established monitoring plans by qualified surveyors.

2.2 Continue to preserve the habitat of this species at Chittenango Falls.

2.2.1 Ensure consideration of habitat protection in any activities of Park personnel. It is imperative that habitat integrity be considered during any Park activities that may affect the species. This could include routine maintenance work or responses to unusual safety hazards. In 1981, a geologist from the NYSOPRHP determined that a fracture exists in the rock beneath the overlook on the west side of the Falls. For human safety reasons, he suggested that about 100 cubic yards of rock be removed by blasting. Regional Park officials, working with the State recovery team, completed the removal in 1983 without adversely affecting the snail's habitat. This type of cooperation should be continued, and since any NYSOPRHP actions affecting, either directly or indirectly, the Falls or *Novisuccinea chittenangoensis* habitat are subject to review under the State Environmental Quality Review Act, this action should be easily attained. Efforts should be made to include recovery plan objectives and actions into any regional planning efforts and documents.

2.2.2 Inhibit or prevent, when possible, human-induced alterations that may adversely affect the snail's habitat at Chittenango Falls. Human-induced alterations may include erosion, rock falls, and exotic species introductions. While erosional processes are natural, most problems at the Falls can be linked to human causes (*e.g.*, road construction, hiking). If a problem can be anticipated or is detected early, certain amelioratory actions may avert or minimize the impact of those processes on the snail population and habitat. These actions may also be necessary for the protection of human safety at the Park (*e.g.*, stabilizing rock ledges). Another action that may minimize human-induced impacts is the removal of undesirable invasive vegetation that becomes established in the habitat. Unusual weather events or habitat changes should be reported to the recovery team.

2.2.3 Continue to restrict access to the population and habitat at Chittenango Falls. Erecting endangered species critical areas signs and fencing along the trails into and out of the ravine and the reconstruction of the two footbridges has greatly decreased the number of park visitors who unknowingly wandered through the habitat in the past. Annual maintenance of signs and fencing should continue.

In general, a continued low-key approach to limiting access to the habitat is recommended; obtrusive, unaesthetic barriers are not the favored means to keep people from entering the snail's habitat. However, some steps are necessary to limit access to the Falls. A combined program of limited accessibility, public education, and law enforcement is recommended. This program is consistent with current Park management policy, which calls for limitation of access to the Falls for the purpose of patron safety. It is recognized that these efforts will not keep all patrons off the Falls -- some will try to gain access regardless of rules or obstacles -- but decreasing the frequency of intrusion into the snail's habitat will improve conditions significantly.

2.2.4 Develop a *Novisuccinea chittenangoensis* management/protection agreement for Chittenango Falls. The existing relationship between the NYSOPRHP, NYSDEC, and USFWS is extremely cooperative. Staff at Chittenango Falls have accommodated

research and monitoring requests and have assisted with various protection measures at the Falls. However, as staff turnover will affect all three agencies, it is essential to formally document the management and protection efforts necessary for the future conservation of the *Novisuccinea chittenangoensis*.

2.3 *Establish an information and education system conducive to achieving other recovery actions.* The endangered species issue is generally well supported by the public, and when informed and allowed to help, the public will cooperate more readily with necessary, albeit inconvenient, limitations. Considerable concern has been expressed that publicizing the occurrence of this species could result in additional collecting or harassment. Recognizing this, a thoughtfully designed educational approach, with the appropriate amount of detail (or lack thereof), is far superior to suppressing or denying information to the public. When combined with a program to limit access and ensure law enforcement, this approach is expected to serve both the species and the public.

2.3.1 *Provide information to both permanent and seasonal NYSOPRHP staff, on an annual basis, as to the presence and uniqueness of the species, and to the importance of the protection of its habitat.* Regional and Park staff may change over time, making regular contact at these levels important. The NYSOPRHP staff that should be targeted for this effort include Chittenango Falls Park staff, regional office administration, engineers, and landscape architects. Appropriate information and guidance should be provided to all of the above-mentioned parties on an annual basis to ensure that any work plans at Chittenango Falls will not impact the *Novisuccinea chittenangoensis* or its habitat. For example, one form of guidance/protocol should address appropriate responses by NYSOPRHP to any potential habitat modifications (e.g., broken ledges due to flood events). Another should assist the staff with appropriate responses to questions from the public and/or media contacts.

2.3.2 *Provide information to park patrons and the local community as to the presence and uniqueness of the species, and to the regulations for its protection.* Providing information about the presence of the species will probably not increase deleterious activities (e.g., collecting) *if presented properly*. Furthermore, if given a good reason to refrain from harmful activities, visitors may be more likely to oblige. Media interest has been relatively high for this threatened species in the past, and efforts should be made to take positive advantage of this situation. Because of the uniqueness of this localized endemic, the media and the public have been supportive of all recovery actions taken to date. If future recovery activities affect the local communities, more support can be anticipated if people have been made aware of the situation and need for action.

2.3.2.1 *Improve and maintain the permanent display panel near the main parking area, keeping it accessible to all patrons, and develop any other necessary signage.* The existing educational display presents information about the uniqueness of the environment and ecology within the lower ravine below the Falls and notifies park patrons of the sensitivity of the habitats. The *Novisuccinea chittenangoensis* is identified as one of the

unique resident species, and basic information is presented on its status and biology without identifying exact habitat locations. Other rare or unique species are also presented. In this manner, the presence of the snail is presented in context and not over-emphasized, and public cooperation in protecting the sensitive habitats is appropriately encouraged. Additional signs could be created which provide more information on rare and listed species and their importance for maintaining the biodiversity at the Falls.

2.3.2.2 *Upon request, provide additional information in the form of brochures or reports on species.* Interested parties may desire more information on the species, and more detailed information should be made available.

2.4 *Enforce all laws protecting the species and its habitat.*

2.4.1 *Monitor public use and enforce rules to keep visitors off the Falls.* Park personnel routinely monitor patron activities as staffing allows. The Park staff has been very effective in restricting patron access to the Falls.

2.4.2 *Enforce water quality regulations along Chittenango Creek upstream of Chittenango Falls.* Continued efforts must be made to ensure that water quality regulations are strictly enforced.

2.4.3 *Coordinate collecting or other scientific permits that could result in possible take of the species.* NYSDEC scientific collectors licenses are recommended for collecting of any fish and wildlife. Further, special permits are required from both the NYSDEC and from the USFWS to collect or affect endangered or threatened species. Any permit applications received for activities that may affect the snail or its habitat must be closely scrutinized and the effects on the *Novisuccinea chittenangoensis* of any approved activities minimized.

3. *Expand data on the biological and environmental requirements of *Novisuccinea chittenangoensis*.* Relatively little is known about the exact biological requirements of this species, and if full recovery and protection is expected, more must be learned. Studies may further reveal new techniques or actions for recovery. Studies completed since 1983 have identified preliminary humidity, thermal, and light requirements of the *Novisuccinea chittenangoensis*. Unfortunately they included both the *Novisuccinea chittenangoensis* and *Succinea* Sp. B in their analyses. In addition, these looked at point data, and continuous monitoring of temperature and humidity throughout the year has been initiated.

With the establishment of a new captive colony, it will be possible to conduct laboratory studies to further measure the biotic and physical factors that define this species' habitat, predator-prey relationships, and interspecific competition. One note of particular interest is that when five founders were removed from the Falls and placed in captivity, they were able to produce 130+ descendants by the F₂ generation. The question of continued survival is not a result of low reproductive potential, but apparently involves some other factor at the Falls such as predation, competition, disease, or habitat suitability.

3.1 Determine if *Succinea sp. B* is having a negative impact on *Novisuccinea chittenangoensis*. Using individuals from the captive colony, it should be determined if there are interspecific relationships between these two species (such as competition, aggression, predator-prey interactions) that would limit reproductive success of the *Novisuccinea chittenangoensis*. Potential relationships may also be studied in the wild. For example, an enclosure study might determine survival of egg masses with and without the presence of *Succinea sp. B*.

3.2 Further define optima of physical and biotic characters in *Novisuccinea chittenangoensis* habitat. The effects of food, temperature, humidity, substrate, light, and other factors on the growth and development of the *Novisuccinea chittenangoensis* should be determined. This may be accomplished through experiments with a captive colony. Environmental factors may also be measured within, and outside of, *Novisuccinea chittenangoensis* habitat at Chittenango Falls.

Knowledge of the vegetative composition and structure is important in order to maintain and protect essential habitat. Vegetative composition at this site has changed significantly since 1983 due to scouring of the habitat by flood waters followed by revegetation of the bare substrate and due to elimination of the trampling affect of park visitors who are now restricted from the site. It is unknown whether these changes in vegetative composition has affected the *Novisuccinea chittenangoensis*. Depending on the outcome of this research and monitoring, the need for vegetative manipulation to improve conditions at Chittenango Falls should be determined.

In addition, an understanding of what limits *Novisuccinea chittenangoensis* habitat is essential for making decisions on what other areas at Chittenango Falls may be suitable for the snails. This will become important for determining which sites should be surveyed as potential occupied habitat and which Chittenango Falls' areas may be considered as future introduction areas (see Action 5.4).

3.3 Investigate the effects of environmental contaminants on the *Novisuccinea chittenangoensis* and its habitat. It should be determined, through laboratory and field studies, whether any contaminants are affecting the snail or its habitat.

4. Research techniques for removal of *Succinea sp. B* from the *Novisuccinea chittenangoensis*' habitat at the Falls. *Succinea sp. B* appears to be an aggressive colonizer that is currently widespread within the Chittenango Creek drainage basin. Because of its broad habitat tolerance, it is unlikely that it can be removed from the *Novisuccinea chittenangoensis* habitat, and kept out, without applying environmentally unacceptable techniques. However, since the *Novisuccinea chittenangoensis* is endemic to this site, and *Succinea sp. B* may impact other rare succineids at other locations in the future, any potential method for removing, eliminating or controlling *Succinea sp. B* should be investigated. If feasible methods for removal are discovered, an additional task will be added to actually conduct the removals.

5. As feasible, increase the population size and broaden the distribution of the Chittenango ovate amber snail. Continued protection and efforts to preserve the Chittenango Falls population may halt further declines in this species, but enhancement activities will be necessary to promote or accelerate recovery.

- 5.1 *Expand data on the species' Post-Pleistocene range.*** This species' status and vulnerability is largely a result of its extremely limited range and the presence of *Succinea*. sp B. The identification of additional potential colonies, or suitable sites for introduction, would increase delisting or recovery potential.
- 5.1.1 *Check succineid collections at various institutions to determine whether any additional colonies exist.*** Investigation of existing collections of succineid snails might reveal other potential colonies. Identification of other closely related species of *Novisuccinea* might indicate the presence of habitats that could be evaluated for introduction attempts. In addition, the presence of *S.* sp B at a site would preclude that drainage from consideration.
- 5.1.2 *Survey similar appropriate habitats within the eastern U.S. and Canada to locate additional colonies of *Novisuccinea chittenangoensis*, if any, or to identify suitable sites for establishing new colonies.*** Surveys of suitable waterfalls and other similar habitats may reveal undiscovered colonies of this species as well as additional habitats that may be suitable for the release of captive-reared snails. The current intention is to focus on releasing *Novisuccinea chittenangoensis* to other areas at Chittenango Falls (see action 5.4.2).
- 5.2 *Establish and refine the *Novisuccinea chittenangoensis* captive propagation program.*** There are no existing captive populations at this time. However, recreating and maintaining captive populations are an essential part of the recovery strategy for the *Novisuccinea chittenangoensis*. Maintaining the captive colony of this species will involve dividing the colony between two or more institutions to minimize chances of catastrophic loss of the entire captive population.
- 5.2.1 *Develop an initial captive breeding protocol.*** A protocol must be developed to determine when and how many founders will be collected to begin a new captive population. The protocol will also address all of the actual rearing methods. A starting point for this protocol should be the methods used in the last attempt to maintain a captive colony of *Novisuccinea chittenangoensis*. If known, appropriate changes should be made to the previous rearing methods and areas of necessary research should be identified. This protocol should also address the addition of new snails to the captive population over time, and when and how many *Novisuccinea chittenangoensis* should be transferred to other facilities. It will be necessary to identify the levels of diversity that need to be maintained over a specified time frame. The protocol will also specify methods for releasing captive animals to the wild.
- 5.2.2 *Establish and maintain the captive breeding program.*** Based on the information gathered from Action 5.2.1, reinstate the captive breeding programs at the appropriate zoo facilities.
- 5.2.3 *Conduct research experiments to refine rearing protocols.*** Further research is necessary to determine the optimal conditions for maintaining healthy populations. Conducting an inbreeding study to determine what impact

inbreeding actually has on the *Novisuccinea chittenangoensis* should also be considered.

5.3 Research the potential for augmenting the extant Chittenango Falls population with captive offspring. Once healthy, sustained captive populations of *Novisuccinea chittenangoensis* are successfully established, release of snails back to the extant Chittenango Falls site can be considered. Further research is necessary to determine when (which stage), how many, and how *Novisuccinea chittenangoensis* should be released.

5.4 As appropriate, establish additional *Novisuccinea chittenangoensis* populations within the species' Post-Pleistocene range. As more is learned about the ability of these animals to survive and reproduce within new habitats, a protocol for operational releases or management and monitoring of new populations should be developed in order to gauge progress toward meeting the recovery objective of ensuring self-sustaining populations of the *Novisuccinea chittenangoensis* in the wild.

5.4.1 Develop a protocol for evaluating potential release sites. Based on information learned from the habitat monitoring at the extant site at Chittenango Falls, it should be possible to narrow the search image for other potentially suitable areas for *Novisuccinea chittenangoensis*. One factor considered to be essential is that any location either needs to be free of *Succinea sp.* B or long-term management plans for their control will be necessary.

5.4.2 Survey appropriate habitats within Chittenango Falls to identify potentially suitable sites for establishing new subpopulations. After defining potentially suitable *Novisuccinea chittenangoensis* habitat (Action 3.2), begin conducting surveys and monitoring to find these sites that meet this criteria. At this time, Chittenango Falls appears to be the only potentially suitable site for establishment of new populations (or subpopulations). However, once more is learned about the potential historic range of the species (Action 5.1), the need to survey other appropriate habitats to identify potentially suitable release sites may be reconsidered.

5.4.3 Determine the methods for establishing additional subpopulations at Chittenango Falls. It needs to be determined whether captive individuals or individuals from the extant population should be used to establish any additional subpopulations at Chittenango Falls. Information from Action 5.3 can be used to determine appropriate reintroduction/translocation techniques.

5.4.4 Establish additional *Novisuccinea chittenangoensis* subpopulations. After locating suitable sites (5.4.2) and determining the appropriate methods (5.4.3), the process of establishing the additional subpopulations should be initiated. Should any additional sites be established away from Chittenango Falls, they will also need management plans (Action 2.2.4).

6. **Review and track recovery progress.**

6.1 **Create a data repository for captive population reports, wild population survey reports, scientific research, etc.** A single collection point for information on the *Novisuccinea chittenangoensis* will streamline recovery efforts.

6.2 **Conduct recovery team meetings as needed.** Conference calls or meetings should be held to discuss new information, make decisions on field or captive techniques, and exchange information in general.

6.3 **Revise recovery plan as appropriate.** At minimum, the recovery plan should be reviewed every five years to ensure that it reflects the current needs of the species. If necessary, the plan should be revised to incorporate research findings and any other changes in the status of the species or threats.

6.4 **Develop and implement a monitoring strategy.**

6.4.1 **Monitor the implementation/completion of actions.** It is necessary to track progress towards completing the various actions deemed necessary for the recovery of the *Novisuccinea chittenangoensis*.

6.4.2 **Monitor the effects of any management actions conducted for the *Novisuccinea chittenangoensis*.** In order to determine the effectiveness of the various prescribed management actions, it is essential to monitor the response of the species to various management practices. This would entail monitoring the population before, during, and after the management efforts are undertaken.

6.4.3 **Monitor current or potential threats to the species.** In addition to monitoring the *Novisuccinea chittenangoensis*' response to various management actions, it is essential to monitor the known and potential threats to the species. While monitoring the *Novisuccinea chittenangoensis* population size and distribution, supplemental information on the threats to the species will further increase our understanding of these relationships. Monitoring will also help to identify new threat sources or threats that were previously overlooked (such as predation).

6.4.4 **Monitor the biological status of the *Novisuccinea chittenangoensis*.** After taking into account the various effects of management actions, implementation of other actions, and the status of the various threats to the species, the biological status of the *Novisuccinea chittenangoensis* must be monitored. It is essential for the monitoring strategy to lead to a determination as to whether there are stable, increasing, or decreasing populations of *Novisuccinea chittenangoensis* in the wild and in captivity.

PART III: IMPLEMENTATION

The following Implementation Schedule outlines actions and estimated costs for the Chittenango ovate amber snail recovery program over the next three years. It is a guide for meeting the recovery objectives discussed in Part II of this plan. This schedule indicates action priorities, action numbers, action descriptions, duration of actions, and estimated costs. In addition, parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the schedule. The listing of a party in the Implementation Schedule neither requires nor implies a requirement for the identified party to implement the action(s) or secure funding for implementing the action(s). However, parties willing to participate may benefit by being able to show in their own budgets that their funding request is for a recovery action identified in an approved recovery plan and is therefore considered a necessary action for the overall coordinated effort to recover the Chittenango ovate amber snail. Also, section 7(a)(1) of the Endangered Species Act of 1973 (ESA), as amended, directs all federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of threatened and endangered species. The schedule will be updated as recovery actions are accomplished.

Key to Implementation Schedule Priorities (column 1)

- Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
- Priority 3: All other actions necessary to provide for full recovery of the species.

Key to Responsible Agencies (column 5)

- USFWS = U.S. Fish and Wildlife Service
R5 = Region Five, U.S. Fish and Wildlife Service
NYSDEC = New York State Department of Environmental Conservation
OPRHP = New York State Office of Parks, Recreation and Historic Preservation
Zoos = Zoological institutions such as the Wildlife Conservation Park/Bronx Zoo and Burnet Park Zoo (Rosamond Gifford Zoo)
Acad. Inst. = Academic institutions
OSA = Natural resource agencies from states or provinces other than New York
Cons = The Nature Conservancy and/or other conservation organizations
USGS = U.S. Geological Survey

IMPLEMENTATION SCHEDULE
Chittenango Ovate Amber Snail Revised Recovery Plan

Technical/Agency Draft, December 2003

Priority	Action Description	Action Number	Duration	Responsible Agency		Est. Costs (\$1000)			Comments
				USFWS	Other	FY1	FY2	FY3	
1	Re-evaluate the taxonomic relationship between the <i>Novisuccinea chittenangoensis</i> and other snails, such as <i>Succinea</i> sp. B.	1.1	2 years	R5	Acad. Inst. USGS	8	7		Cost includes the development of genetic markers.
1	Assist with future identification of snails at other sites.	1.2	5	R5	Acad Inst. USGS	--	1-2	1-2	+ 1-2K for FY4-6. Dependent on number of samples collected under Action 5.1.2.
1	Establish a monitoring protocol to determine the baseline population at Chittenango Falls.	2.1.1	3 years	R5	NYSDEC OPRHP	2.5	--	--	Action funded FY02, FY03 and underway; due to be completed FY04.
	Establish a long-term monitoring protocol for subsequent surveys at Chittenango Falls.	2.1.2	One year	R5	NYSDEC, Acad. Inst	--	--	--	Information gathered from Action 2.1.1 will assist with this action.
1	Conduct surveys based on the monitoring protocols in occupied habitats.	2.1.3	As determined necessary	R5	NYSDEC OPRHP	3	3	3	+ \$3k/yr for FY4-8 Volunteers and Section 6 funds are used for this action. This may change once the survey protocol is finalized, as monitoring needs may vary among years.
1	Ensure consideration of habitat protection in any activities of Park personnel.	2.2.1	Ongoing- Yearly	R5	NYSDEC OPRHP	-	-	-	Standard operating costs.

1	Continue to restrict access to the population and habitat at Chittenango Falls.	2.2.3	Ongoing-Yearly	R5	OPRHP	--	--	--	Standard staff costs.
1	Develop a <i>Novisuccinea chittenangoensis</i> management/protection agreement between the NYSDEC, NYSOPRHP, and the USFWS for Chittenango Falls.	2.2.4	1-2 years	R5	NYSDEC OPRHP	--	--	--	Standard staff costs.
1	Educate NYSOPRHP staff as to the presence and uniqueness of the species, and to the regulations for its protection.	2.3.2	Yearly	R5	NYSDEC OPRHP	--	--	--	Standard staff costs.
1	Determine if <i>Succinea</i> sp. B is having a negative impact on <i>Novisuccinea chittenangoensis</i> .	3.1	3 years	R5	NYSDEC Zoos Acad. Inst.	15	15	15	Study design in first year +15K/yr for two-year study.
1	Further define optima of physical and biotic characters in <i>Novisuccinea chittenangoensis</i> habitat.	3.2	1-2 years	R5	NYSDEC Zoos Acad. Inst.	1.5	--	--	Equipment costs for first year.
1	Research techniques for removal of <i>Succinea</i> sp. B from the <i>Novisuccinea chittenangoensis</i> ' habitat at the Falls.	4	2 years research; annual implementation	R5	NYSDEC OPRHP	--	7.5	10	+5K/yr for FY4, 5, and 6; initial costs high because of intensive monitoring needs; tied closely to Actions 2.1.1 and 3.1.
1	Develop an initial captive breeding protocol.	5.2.1	Ongoing	R5	NYSDEC Zoos Acad. Inst.	--	--	--	Standard staff costs.
1	Establish and maintain the captive breeding program.	5.2.2	20 years	R5	NYSDEC Zoos	--	5	5	+5K for FY4-20. These costs will be refined when the means for establishing a captive breeding population are determined.

1	Conduct research experiments to refine rearing protocols.	5.2.3	After captive population is reinitiated	R5	NYSDEC Zoos Acad. Inst.	--	--	1	+1K for FY 4-5. Costs in addition to those associated with 5.2.2.
1	Research the potential for augmenting the Chittenango Falls population with captive offspring.	5.3	To be determined	R5	Zoos	--	--	2	+2K for FY 4-6.
2	Inhibit or prevent, when possible, human-induced alterations that may adversely affect the snail's habitat at Chittenango Falls.	2.2.2	As needed	R5	NYSDEC OPRHP	--	--	--	Costs contingent on need to offset unpredictable natural hazards, e.g., removing loose boulders above <i>Novisuccinea chittenangoensis</i> habitat.
2	Improve and maintain the permanent display panel erected near the main parking area, keeping it accessibly to all patrons and develop any other necessary signage.	2.3.1.1	Ongoing	R5	NYSDEC OPRHP	--	1.5	--	Replacement of the sign, a new smaller sign along the trail. + \$500 every three years for sign maintenance.
2	Monitor public use and enforce rules to keep visitors off the Falls.	2.4.1	Ongoing- Yearly		OPRHP	--	--	--	Enforcement part of standard park operating costs.
2	Enforce water quality regulations along Chittenango Creek upstream of Chittenango Falls.	2.4.2	Ongoing		NYSDEC	--	--	--	Enforcement part of state/federal standard costs.
2	Coordinate collecting or other scientific permits that could result in possible take of the species.	2.4.3	Ongoing	R5	NYSDEC	--	--	--	No chargeable expenses.
2	Investigate the effects of environmental contaminants on the <i>Novisuccinea chittenangoensis</i> and its habitat.	3.3	Field:1 year lab: 1 year	R5	NYSDEC Acad. Inst. Zoos	--	--	--	Field work part of standard operating costs; lab work costs at 2-3K, pending establishment of larger captive populations.

2	Develop a protocol for evaluating potential release sites.	5.4.1	1 year	R5	NYSDEC Acad. Inst. Zoos	--	--	--	Standard staff costs.
2	Survey appropriate habitats within Chittenango Falls to identify potentially suitable sites for establishing new subpopulations.	5.4.2	1-2 years	R5	NYSDEC OPRHP Acad. Inst.	--	--	--	Coordinated with Action 5.4.3; this action will not begin until Action 2.4.1 is completed.
2	Determine the methods for establishing additional subpopulations at Chittenango Falls.	5.4.3	~2 years	R5	NYSDEC OPRHP Acad. Inst.	--	--	--	This action could be accomplished through an M.S. research project (est. 15K/year). Partially completed under Action 5.3.
2	Establish additional <i>Novisuccinea chittenangoensis</i> subpopulations.	5.4.4	As appropriate	R5	NYSDEC OPRHP	--	--	--	Standard staff costs. Monitoring costs are included under Action 2.1.3.
3	Upon request, provide additional information in the form of brochures or reports on the species.	2.3.1.2	As necessary	R5	NYSDEC OPRHP	--	--	--	Fact sheets available; costs include park brochure that highlights, among other things, <i>Novisuccinea chittenangoensis</i> protection.
3	Check succineid collections at various institutions to determine whether any additional colonies exist.	5.1.1	1 year	R5	NYSDEC	--	--	--	
3	Survey similar appropriate habitats within the eastern U.S. and Canada to locate additional colonies of <i>Novisuccinea chittenangoensis</i> , if any, and to identify suitable habitats for potentially establishing new colonies.	5.1.2	5 years	R5	NYSDEC OPRHP Acad. Inst. OSA Cons	--	7	5	Comprehensive survey. +1K FY 4,5,6.

3	Create a data repository for captive population reports, wild population survey reports, scientific research, etc.	6.1	Ongoing	R5	NYSDEC	--	--	--	Standard staff costs.
3	Conduct recovery team meetings, as needed.	6.2	Periodic	R5	Recovery Team	--	--	--	Standard staff costs.
3	Revise plan as appropriate.	6.3	Review every 5 years	R5	Recovery Team	--	--	--	Standard staff costs.
3	Monitor the implementation/completion of actions.	6.4.1	Yearly	R5	Recovery Team	--	--	--	Standard staff costs.
3	Monitor the effects of any management actions conducted for the <i>Novisuccinea chittenangoensis</i> .	6.4.2	As appropriate	R5	NYSDEC OPRHP Acad. Inst. Zoos	--	--	--	Standard staff costs.
3	Monitor current or potential threats to the species.	6.4.3	As appropriate	R5	NYSDEC OPRHP Acad. Inst. Zoos	--	--	--	Standard staff costs.
3	Monitor the biological status of the <i>Novisuccinea chittenangoensis</i> .	6.4.4	As appropriate	R5	NYSDEC OPRHP Zoos	--	--	--	Standard staff costs.

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APPENDIX A. The Succineid Snail Fauna of Chittenango Falls, New York: Taxonomic Status with Comparisons to Other Relevant Taxa. Proceedings of The Academy of Natural Sciences of Philadelphia 139:465-526, 1987.

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ABSTRACT.--In order to determine the relationships between *Succinea ovalis* Say, *S. ovalis chittenangoensis* Pilsbry of Chittenango Falls, New York, and specimens of uncertain affinity from Minnesota, electrophoretic studies of allozymes were conducted. *Oxyloma retusa* Lea and *O. decampi gouldi* Pilsbry of Chittenango Falls were included in the analysis for comparison. Via electrophoresis and shell morphometrics, we found yet another taxon at Chittenango Falls, *Succinea* sp., with shell shape similar to *Succinea putris* (Linnaeus) of Europe. Subsequent collection yielded two unknown species discovered by noting differences in mortality rate in the laboratory, considerable anatomical differences, and later, electrophoretic data. Anatomical studies were done on the above *Succinea*, including *S. putris* of Holland, and a population of *Succinea* from Philadelphia that also has a shell shape similar to *S. putris*. Because we could not find living topotypical *S. ovalis* from Philadelphia, we dissected topotypical material collected in 1923 to confirm the anatomy of *S. ovalis*. *Succinea chittenangoensis* is indistinguishable electrophoretically from *S. ovalis*, but has anatomical and shell-morphological differences worthy of species status. The Minnesota specimens belong to two closely-related taxa, probably subspecies, that in turn are specifically distinct from but in the same species group as *S. ovalis* and *S. chittenangoensis*. These taxa are relegated to the genus *Novisuccinea* Pilsbry. The two *Oxyloma* taxa group as a genus distinct from *Succinea*, as expected. Based on electrophoresis, the *Succinea* spp. of Chittenango Falls and Philadelphia are members of *Succinea* s.s., more closely related to *Oxyloma* than to *Novisuccinea*. Within *Succinea* s.s., one population from New York was referable to *S. pennsylvanica* Pilsbry; the other, along with the population from Philadelphia, grouped with the *S. putris* species complex. We conclude that *N. chittenangoensis* is a valid species and a member of the *N. ovalis* species complex along with the species from Minnesota. *S. putris* in Europe is probably a species complex, i.e. a superspecies, with some members found in North America. [allozymes, anatomy, endangered species, introduced species, Minnesota, New York, Pennsylvania, Succineidae, *Succinea ovalis chittenangoensis*, *Succinea putris*, systematics]

APPENDIX B. Aloi, M.A. 1985. Population dynamics of a pulmonate snail adjacent to a central New York stream. Unpublished MS thesis. State University of New York, College of Environmental Science and Forestry. 116 pp.

Abstract

Population dynamics and life history characteristics were determined for two species of pulmonate snail (Gastropoda; Succineidae) found near the base of Chittenango Falls, Madison Co., N.Y. The species studied were Succinea ovalis chittenangoensis (Pilsbry), regarded as endangered by the NYS Department of Environmental Conservation and a “gray morph” population whose species identity appears to be Succinea putris (L.). Mark-recapture data for the gray morph population were collected during the summers of 1982, 1983, and 1984. Mark-recapture data for Succinea chittenangoensis were collected during 1982 and 1983, but remained unchanged between 1983 and 1984. Density of the snails ranged from 1.4 - 11.5 snails/m² during 1984. The population size and density of both species populations found on the face of the falls did not change significantly between the sampling years. Several models of population estimation were applied to the data collected during 1984. These were the Schnabel, the Jolly-Seber, the Bailey triple-catch, and a modified Removal model. All gave similar results when the various assumptions were met. The Jolly-Seber method was robust in estimating death rates, whereas the Bailey triple-catch method was not. A life table of the gray morph population was constructed utilizing the data collected. Gray morph individuals had a life span of approximately one year, and their fecundity was approximately 160 eggs/snail. Reproduction occurred later in the season than reported for many succineids. The potential for adverse interaction between S. chittenangoensis and the gray morph should be further examined in the event that the gray morph is confirmed as a European introduction.

APPENDIX C. Thomee, E.T. 1986. Behavioral ecology of the endangered Chittenango ovate amber snail *Succinea chittenangoensis* and a sympatric introduced succineid. Unpublished MS thesis. State University of New York, College of Environmental Science and Forestry. 227 pp.

Abstract

A two-year, descriptive field study of *Succinea chittenangoensis* (Novisuccinea chittenangoensis), an endangered stylommatophoran gastropod, was conducted in 1983-1984 to determine its life history, behavioral ecology, and requirements for survival. Distribution was limited to a few vertical square meters of saturated, weedy, limestone shelves beside the base of a shaded, 49-meter, north-facing waterfall in Madison County, New York. A European isomorph, *Succinea putris* (never before verified as having migrated to the continental U.S.) was discovered surrounding and sharing the habitat, considered a threat, and studied as well.

Lifespan of *Novisuccinea chittenangoensis* was 2 to 2.5 years, based on shell characters and range of sizes seen. It appeared in May, copulated in June, deposited eggs in July, suffered an abrupt dieoff, became cryptic in August, and overwintered under thick ice overhangs. The highest density of *Novisuccinea chittenangoensis* was always near seeps; multiple regression analyses predicted highest densities in plots with blue *Aster*, *Bidens* sp., exposed wet soil, low light and no Graminae spp. Individual (modal) *Novisuccinea chittenangoensis* were most often seen on green, dry *Eupatorium purpureum*, *Angelica purpurea* and blue *Aster*. Modal microhabitat variable values for individuals were: temperature 16 C, relative humidity 100%, 1615 to 7535 lux, and windspeed 0. Field activity correlated positively with wet green vegetation, relative humidity >85%, temperature >16 C, light 1615 to 2691 lx, morning hours, and no wind.

S. putris lifespan was 1 to 1.5 years. It reproduced earlier, and for a longer period than *Novisuccinea chittenangoensis*: a seasonal average of 9 masses of 37 eggs or 326 eggs/snail in biweekly peaks (low estimate, determined by culturing). *S. putris* density was lower near seeps, it favored dead vegetation, and its habitat had less stability of temperature and moisture, and more hours of full light, than *Novisuccinea chittenangoensis* habitat. Otherwise, habitats overlapped physically, botanically and microclimatically.

The historical length and nature of the association between the two species remains unresolved; future management decisions would be enhanced by clarification. Further investigation of *Novisuccinea chittenangoensis* requirements is needed prior to attempts to relocate snails, as this study was limited in physical and seasonal scope. Tracking of the *Novisuccinea chittenangoensis* population is important, if it can be done in a non-invasive manner. Factors most

adversely affecting survival of the *Novisuccinea chittenangoensis* population are potential competition with *S. putris*, and physical disturbance by man.

APPENDIX D. MOLLOY, ANDREW. W. Studies on the endangered Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) and related species of the Chittenango Creek watershed. Typed and bound thesis, 150 pages, 26 tables, 42 figures, 1995.

The Chittenango Ovate Amber Snail (*Novisuccinea chittenangoensis*; COAS) is a terrestrial snail known to exist only on ledges adjacent to Chittenango Falls in Madison County, NY. The population has declined to an estimated 25-50 adults. Field and laboratory studies were conducted on COAS and a coexisting succineid snail, *Succinea* sp. B, which may be a competitor. A captive colony of COAS produced an F₂ generation, adults of which are now reproductively active. A survey of area waterfalls to examine sites for introduction of COAS revealed few suitable sites. A point system to reate waterfalls was developed and applied. *Succinea* sp. B is widespread throughout the Chittenango watershed, from source to outlet. Experiments suggest that *Succinea* sp. B can use the water column and shorelines to spread downstream, complicating control efforts at Chittenango Falls. *Succinea* sp. B was found in higher densities on vegetation and wood substrates over rock and soil/mud.

APPENDIX E. Draft Protocol: Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) mark-release-recapture survey.

Materials:

one collecting jar for each survey block
containers for sorting snail
paint pens for marking snails
timer
date sheets

Habitat areas of the Chittenango ovate amber snail (COAS) at Chittenango Falls will be searched using a time and area constrained search.

First time habitat is surveyed, begin by marking ledge with permanent marks delimiting search blocks. Each block will include 1 meters of ledge frontage and will extend back to bottom of vertical cliff and up 1 meter from the ledge. For record keeping blocks will be numbered from "1" to "x" beginning at the block closest to the falls. Each block will be surveyed for 15 minutes. Record start and stop time and name of surveyor who did each block. If a sufficient number of surveyors are present, survey of all blocks will be done at same time and survey will be completed within 15 minutes. It may be necessary for surveyor(s) to do multiple blocks in order to survey all blocks each survey interval. Searching should be done with minimum disturbance to the vegetation on the ledge and without surveyor standing or kneeling on the ledge (never stand or kneel on the vegetation on the primary ledge) except as absolutely necessary and only after surveyor has thoroughly searched and removed snails from ledge area where surveyor will stand or kneel. All living and dead plant surfaces and substrate should be searched carefully. All succineid snails and empty shells found will be put in container numbered to correspond to block. On completion of the search, each live snail will be carefully examined to determine species identification and checked for previously applied marks. Empty shells will be kept to be cleaned, sorted and counted in the laboratory. Live *N. chittenangoensis* will be placed in one container, *Succinea* sp. B will be placed in another container, and unknowns (which could include immatures of all species) in a third container. Number of snails in each group will be recorded. Snails identified as *Succinea* sp. B will not be put back in the habitat. They will be removed from the area and destroyed or used for other laboratory observations. Unknown snails will be marked with one black dot on underside of whorls above the foot and returned to block where they were collected. *N. chittenangoensis* will be marked with a colored marker in a similar manner. All COAS found on a given day will be marked with the same color. A different color will be used for each resurvey (COAS caught multiple times will be marked with multiple colors). On subsequent searches the color of the dot(s) on any snail found that has been previously marked should be noted. Survey should be repeated every 7 days throughout the snail's activity period.

APPENDIX F. Outline of Recovery Tasks from 1983 Recovery Plan

PRIORITY 1 TASKS:

- Task I.A.1 Assess COAS population.
- Task I.A.2 Monitor COAS population.
- Task I.B.1 Determine occupied habitat.
- Task I.B.2 Prevent habitat destruction.
- Task I.C.1 Determine non-point source pollution.
- Task I.C.2 Monitor water quality.
- Task I.D.1 Limit access to Chittenango Falls.
- Task I.D.2 Evaluate access plan.
- Task I.G Expand biological data.

PRIORITY 2 TASKS:

- Task I.C.3 Monitor sewage effluent.
- Task I.C.4.a Sample invertebrates.
- Task I.C.4.b Monitor contaminant levels.
- Task I.C.4.c Determine salinity effects.
- Task I.E.1.a Erect information/education display.
- Task I.E.1.b Provide information.
- Task I.E.2 Provide news releases.
- Task I.F Law enforcement.
- Task I.H.1 Expand range data.
- Task I.H.2 Survey habitats.
- Task I.H.3 Determine status of colonies.
- Task II.B Enhance habitat.

PRIORITY 3 TASK:

- Task I.A Enhance population.