

Kanab ambersnail

Oxyloma haydeni kanabensis

5-Year Review: Summary and Evaluation



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**U.S. Fish and Wildlife Service
Utah Field Office – Ecological Services
West Valley City, Utah 84119**

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TABLE OF CONTENTS

1. GENERAL INFORMATION	3
1.1 Purpose of 5-Year Reviews	3
1.2 Reviewers.....	3
1.3 Methodology Used to Complete the Review	3
1.4 Background.....	4
1.4.1 Federal Register Notice Citation Announcing Initiation of This Review.....	4
1.4.2 Listing History	4
1.4.3 Review History	4
1.4.4 Species' Recovery Priority Number at Start of 5-year Review	4
1.4.5 Recovery Plan	4
2. REVIEW ANALYSIS	5
2.1 Application of the 1996 Distinct Population Segment Policy	5
2.2 Recovery Criteria	5
2.2.1 Does the species have a final, approved recovery plan?.....	5
2.2.2 Adequacy of Recovery Plan.....	5
2.2.3 Downlisting Criteria and Progress Toward Achieving Them.....	5
2.3 Updated Information and Current Species Status	6
2.3.1 Biology and Habitat	6
2.3.1.1 New Information on the Species' Biology and Life History	6
2.3.1.2 Abundance, Population Trends, Demographic Features, or Demographic Trends	7
2.3.1.3 Genetics, Genetic Variation, or Trends in Genetic Variation	8
2.3.1.4 Taxonomic Classification or Changes in Nomenclature	9
2.3.1.5 Spatial Distribution, Trends in Spatial Distribution, or Historic Range	10
2.3.1.6 Habitat or Ecosystem Conditions.....	11
2.3.2 Five Factor Analysis	12
2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range...	12
2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes	14
2.3.2.3 Disease or predation.....	14
2.3.2.4 Inadequacy of existing regulatory mechanisms	16
2.3.2.5 Other natural or manmade factors affecting its continued existence	19
2.4 Synthesis	20
3. RESULTS	21
3.1 Recommended Classification.....	21
3.2 New Recovery Priority Number	21
4. RECOMMENDATIONS FOR FUTURE ACTIONS	22
5. REFERENCES	22

5-YEAR REVIEW
Kanab ambersnail (*Oxyloma haydeni kanabensis*)

1. GENERAL INFORMATION

1.1 Purpose of 5-Year Reviews

The U.S. Fish and Wildlife Service (FWS) is required by Section 4(c)(2) of the Endangered Species Act (ESA) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since the time it was listed or since the most recent 5-year review. Based on the outcome of the 5-year review, we recommend whether the species should: 1) be removed from the list of endangered and threatened species; 2) be changed in status from endangered to threatened; 3) be changed in status from threatened to endangered; or 4) remain unchanged in its current status. Our original decision to list a species as endangered or threatened is based on the five threat factors described in Section 4(a)(1) of the ESA. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and we review new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process that includes public review and comment.

1.2 Reviewers

Lead Regional Office: Mountain-Prairie Regional Office (Region 6)
Mike Thabault, Assistant Regional Director - Ecological Services, 303-236-4210
Bridget Fahey, Chief of Endangered Species, 303-236-4258
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Lead Field Office: Utah Ecological Services Field Office
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Cooperating Regional Office: Southwest Regional Office (Region 2)
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Susan Jacobsen, Chief of Endangered Species, 505-248-6641
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1.3 Methodology Used to Complete the Review

We initiated a 5-year review of Kanab ambersnail (*Oxyloma haydeni kanabensis*) on April 7, 2006 (71 FR 17900). Biologists from the Utah Ecological Services Field Office completed this review with assistance from biologists at the Arizona Game and Fish Department (AGFD) and our Arizona Field Office. It summarizes and evaluates information provided in the Kanab ambersnail Recovery Plan, current scientific research, and biological surveys. All pertinent literature and documents used for this review are on file at the Utah Field Office.

1.4 Background

1.4.1 Federal Register Notice Citation Announcing Initiation of This Review

71 FR 17900, April 7, 2006

1.4.2 Listing History

Original emergency listing: 56 FR 37671, August 8, 1991

Subsequent final listing rule: 57 FR 13657, April 17, 1992

Entity listed: subspecies: *Oxyloma haydeni kanabensis* Pilbsry (Kanab ambersnail)

Classification: Endangered. Critical habitat has not been designated.

1.4.3 Review History

This is the first 5-year review completed since the Federal listing of Kanab ambersnail in 1991. However, the species' status also was considered in the 1995 recovery plan (FWS 1995).

1.4.4 Species' Recovery Priority Number at Start of 5-year Review

At the start of this 5-year review, the recovery priority number for Kanab ambersnail was 6c (TABLE 1). This ranking indicated: 1) the Kanab ambersnail is listed at the subspecies level; 2) populations face a high degree of threat, in this case from loss and modification of wetland habitat; and 3) recovery potential is low; and 4) the species is in conflict with private land development projects.

DEGREE OF THREAT	RECOVERY POTENTIAL	TAXONOMY	PRIORITY	CONFLICT
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	6	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

TABLE 1. The above ranking system for determining Recovery Priority Numbers was established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

1.4.5 Recovery Plan

Name of plan: Kanab Ambersnail (*Oxyloma haydeni kanabensis*) Recovery Plan (hereafter the "Recovery Plan") (FWS 1995).

Date issued: October 12, 1995.

2. REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment Policy

This section of the 5-year review is not applicable to this species because the ESA precludes listing Distinct Population Segments (DPSs) of (plants/invertebrates). For more information, see our 1996 DPS policy (61 FR 4722, February 7, 1996).

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan?

Yes.

2.2.2 Adequacy of Recovery Plan

This review recommends a revision of the recovery plan (see Section 4 below). Revision is recommended because the recovery plan does not include delisting criteria (only downlisting criteria were developed) and because we now have new information regarding the species' habitat and biology. This new information was integrated into a 2002 interagency Interim Conservation Plan (Sorensen and Nelson 2002).

Despite the recovery plans shortcomings, we nevertheless review the species' status relative to the downlisting criteria so as to show progress, or lack thereof, toward recovery.

2.2.3 Downlisting Criteria and Progress Toward Achieving Them

Criterion 1: Locate and/or establish additional populations. Maintain 10 separate populations which have been demonstrated to have population numbers large enough to allow for the long-term viability of the population.

Status: This criterion is not met. There were two extant populations known at the time of listing (Vasey's Paradise, Arizona; and Three Lakes, Utah). Interagency teams conducted surveys of more than 350 springs, seeps, and wetlands across Arizona and southern Utah, but they did not find any additional populations of Kanab ambersnail (Stevens et al. 1997 and 2000). In 1998, AGFD translocated Vasey's Paradise Kanab ambersnails to Upper Elves Canyon in the Grand Canyon. Subsequent AGFD monitoring trips detected numerous snails and egg masses at Upper Elves Canyon (see section 2.3.1.5) (Sorenson and Nelson 2001, 2002; Sorenson 2005). Thus, we consider Upper Elves Canyon a viable population. Overall, there are 3 populations of the Kanab ambersnail rangewide: Vasey's Paradise, Three Lakes, and Upper Elves Canyon (FIGURE 1); however, this downlisting criterion requires the location or establishment of 10 populations.

Criterion 2: The establishment of formal land management designations and/or implementation of land management plans which provide long-term, undisturbed habitat for the Kanab ambersnail for the above 10 populations.

Status: This criterion is not met. Completion of this criterion is dependent upon the establishment of 10 separate Kanab ambersnail populations (see Criterion 1). No formal land management designations are in place for the protection of Kanab ambersnail.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New Information on the Species' Biology and Life History

There are two naturally occurring (Vasey's Paradise, Arizona and Three Lakes, Utah) and one introduced extant population of Kanab ambersnail (Upper Elves Canyon, Arizona). The private landowner of Three Lakes restricts public access to this population. The Upper Elves Canyon habitat is relatively small (when compared to the two natural population sites) and is logistically difficult to access (usually requiring a several day boat trip). For these reasons, most of our new information comes from studies conducted at the Vasey's Paradise population.

Kanab ambersnail growth, fecundity, and density may differ depending upon host plant use. Trends of increased growth and fecundity occur in snails reared on nonnative watercress (*Nasturtium spp.*) compared to those reared on native monkeyflower (*Mimulus spp.*) (Nelson 2001). However, host plant use does not appear to influence hatching success (Nelson 2001).

Kanab ambersnails live up to 15 months (Stevens et al. 1997). Peak reproduction occurs in mid-summer (Stevens et al. 1997; Nelson 2001). Kanab ambersnails grow at an average rate of 0.1 mm/day (0.004 in./day), and become reproductively mature at approximately 11.5 mm (0.45 in.) (Nelson 2001.) Cross-fertilized

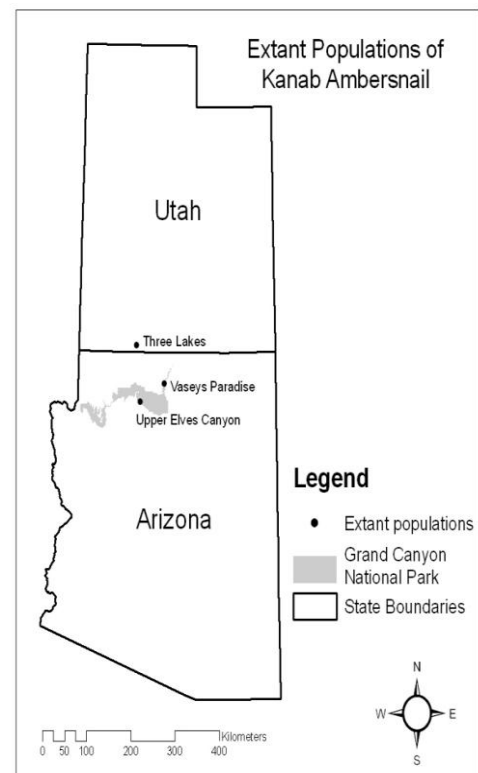


FIGURE 1. Map showing extant Kanab ambersnail populations.

(i.e., the introduction of sperm from one snail to the eggs of another snail) Kanab ambersnails produce an average of 1.25 gelatinous egg masses containing approximately 12 eggs per mass (Nelson 2001). Kanab ambersnails lay eggs on the undersides of host plant stems and leaves, or in moist soil (Nelson 2001). Eggs hatch in approximately 27 days (Nelson 2001).

Kanab ambersnails begin winter dormancy in October and emerge from dormancy in March (Stevens et al. 1997). During winter dormancy, the snails attach the aperture of their shells to a firm substrate such as host plant stems and leaves, rocks, sticks, or bark. Kanab ambersnail mortality rates are 25-80% during dormancy (Stevens et al. 1997; Interagency Kanab Ambersnail Monitoring Team (IKAMT) 1998).

In summary, recent studies have improved our understanding of Kanab ambersnail growth, fecundity, life cycle, and seasonal behavior. However, because microhabitat differences in temperature, water quality, and vegetation could result in slightly different snail behavior and physical characteristics, and because all of the information described above was collected via studies at Vasey's Paradise or using Vasey's Paradise snails, it is unknown if our biological knowledge is representative of the Three Lakes and Upper Elves Canyon populations.

2.3.1.2 Abundance, Population Trends, Demographic Features, or Demographic Trends

Estimates of Kanab ambersnail population size at Vasey's Paradise ranged from 18,476 individuals in March 1995, to 104,004 individuals in September 1995 (Sorensen and Kubly 1997). A more recent study estimated Vasey's Paradise Kanab ambersnail abundances of 35,000 in the fall of 1999, and 3,124 in the spring of 2002 (Gloss et al. 2005). Population counts at Vasey's Paradise are highly variable because of high temporal and spatial variability in population densities, sampling error, and variability in sampling effort. We are unable to determine population trends because of these issues.

The AGFD translocated 340 Kanab ambersnails from Vasey's Paradise to Upper Elves Canyon on several trips between 1998 and 2002. The population is now believed to be self-sustaining and no future translocations are planned. In 2005, AGFD estimated 792 Kanab ambersnail occupying approximately 50 m² (538 ft²) of Upper Elves Canyon habitat (Sorensen 2005). Similar to the Vasey's Paradise population, because of high variability, we are unable to determine population trends for the Upper Elves Canyon population.

In June 1990, we estimated that the Three Lakes population size was approximately 100,000 snails (FWS 1995). We do not know how this estimate was derived, or its accuracy. We do not have additional population data for the Three Lakes population because the private landowner has not allowed further work in the area. We are unable to determine population trends for Three Lakes without additional sampling.

In summary, we have relatively recent population estimates for both the Vasey's Paradise and Upper Elves Canyon populations. We do not have recent population estimates for the Three Lakes population. We also are unable to determine long-term population trends for these three populations because of high year-to-year biological and sampling variability, or because of a lack of adequate sampling events (in the case of the Three Lakes population).

2.3.1.3 Genetics, Genetic Variation, or Trends in Genetic Variation

The Recovery Plan (FWS 1995) determined that an understanding of Kanab ambersnail genetic variability, taxonomic uniqueness, and genetic similarity to other members of the genus was critical to recovery. There is substantial morphological and genetic variation among species of the genus *Oxyloma* (Franzen 1964). Researchers conducted three genetic and morphometric analyses on the Kanab ambersnail to better understand this variation (Miller et al. 2000; Stevens et al. 2000; and Culver et al. 2007). The research provides new information regarding Kanab ambersnail genetic variation; however, issues of the species' uniqueness remain unresolved. We provide a brief description of each of the three studies in the following paragraphs.

Miller et al. (2000) used Amplified Fragment Length Polymorphism (AFLP) markers to characterize genetic diversity of the Vasey's Paradise and Three Lakes Kanab ambersnail populations in addition to two, non-endangered, Niobrara ambersnail (*Oxyloma haydeni haydeni*) populations. The results of this analysis indicated that the Three Lakes Kanab ambersnail population was more closely related to one of the non-endangered Niobrara ambersnail populations than to the Vasey's Paradise Kanab ambersnail population. However, the genetic identity of all four populations differed significantly, with the Vasey's Paradise population being most distinct (Miller et al. 2000). The overall conclusion was that the Vasey's Paradise and Three Lakes populations separated more than 10,000 years ago during the Pleistocene Epoch, and thus could be separate subspecies (Miller et al. 2000).

Stevens et al. (2000) tested mitochondrial genetic variation in 63 ambersnail populations (genera: *Oxyloma*, *Catinella*, and *Succinea*). They sampled snails from the United States and Canada and determined

the relatedness of Kanab ambersnail populations to non-endangered ambersnail populations. Results from this study supported those of Miller et al. (2000), finding that the Vasey's Paradise Kanab ambersnail population was genetically distinct (Stevens et al. 2000). In addition, the Three Lakes population could be considered its own subspecies based on genetic differences (Stevens et al. 2000).

In a draft report, Culver et al. (2007), characterized mitochondrial diversity and AFLP marker diversity from 12 different southwestern *Oxyloma* populations. The characterized populations included 2 Kanab ambersnail (Vasey's Paradise and Three Lakes) and 10 non-endangered ambersnail populations. Analysis detected some gene flow among the studied *Oxyloma* populations. The authors speculate that the measured gene flow demonstrates that all of the populations studied are members of the same interbreeding species (Culver et al. 2007). Thus, in contradiction to previous studies, they concluded that Kanab ambersnails are genetically the same as all other *Oxyloma haydeni* and subsequently Kanab ambersnails do not deserve subspecies status. As of this writing, this report remains unpublished.

In summary, researchers conducted three genetic and morphometric analyses on the Kanab ambersnail (Miller et al. 2000; Stevens et al. 2000; Culver et al. 2007). The research provides new genetic information regarding the relatedness of Kanab ambersnail and other *Oxyloma* populations. However, there is currently no scientific consensus as to the taxonomic status of Kanab ambersnail, nor is there a convincing line of research that would justify the reclassification of Kanab ambersnail at this time.

2.3.1.4 Taxonomic Classification or Changes in Nomenclature

Kanab ambersnail is classified as a subspecies (Pilsbry 1948). It can be distinguished from other *Oxyloma* in the field by its slender and drawn out spire, and a short shell aperture (Pilsbry 1948; Spamer and Bogan 1993). However, classification of snails in the genus *Oxyloma* is not reliable based solely on shell morphology (Culver et al. 2007). Therefore, identifying members of this genus often requires not only examination of shell morphology, but also anatomical features such as genitalia, proportion and arrangement of organs, and pigmentation of tissue, as well as habitat assessment.

As previously discussed (section 2.3.1.3), the taxonomic classification of Kanab ambersnail received a great deal of scrutiny in recent years based on morphological and genetic variation in *Oxyloma* populations. Three views are evident in the literature, each with its own implications on the management of Kanab ambersnail relative to the ESA:

- 1) Kanab ambersnail is unique enough to be considered a distinct species (*Oxyloma kanabense*) (Clark 1991; Spamer and Bogan 1993).
- 2) Vasey's Paradise and Three Lakes Kanab ambersnail populations could be considered two separate subspecies (or species) distinct from each other, and distinct from other *Oxyloma* species (Miller et al. 2000; Stevens et al. 2000).
- 3) Kanab ambersnails should be considered indistinct from widespread *Oxyloma haydeni* populations throughout the Southwest (Culver et al. 2007).

Given this ongoing debate within the scientific community and a lack of conclusive data, at the present time, we will continue treating the Kanab ambersnail as a valid subspecies, *Oxyloma haydeni kanabensis* (Pilsbry 1948; FWS 1992). However, we will continue to evaluate this species' taxonomy as the literature continues to develop.

2.3.1.5 Spatial Distribution, Trends in Spatial Distribution, or Historic Range

Kanab ambersnails were first collected in 1909 in southern Utah (Ferriss 1910; Chamberlin and Jones 1929; Pilsbry 1948; and Clarke 1991). The type locality is known as "The Greens", a vegetated seep approximately 10 km (6 mi) north of Kanab in Kanab Creek Canyon (Ferriss 1910). Kanab ambersnails were not located during recent surveys of the area believed to be "the Greens," and thus we believe this population is extirpated (FWS 1995). However, we are not certain of the exact location of the type locality as geographical coordinates were not reported for the site (Meretsky et al. 2002).

Currently, Kanab ambersnail occur at three locations (FIGURE 1)—one in southern Utah (Three Lakes) and two in Grand Canyon National Park, Arizona (Vasey's Paradise and Upper Elves Canyon). The Three Lakes population is a series of small ponds on private land approximately 10 km (6 mi) northwest of Kanab, Utah (Clarke 1991; FWS 1995; Spamer and Bogan 1993). Occupied and potential habitat is approximately 2 hectares (215,278 ft²) (FWS 1995).

The Vasey's Paradise population was discovered in 1991. Vasey's Paradise is a riverside spring located approximately 53 km (33 mi) downstream of Lee's Ferry on the Colorado River, in Grand Canyon National Park, Arizona (Spamer and Bogan 1993). Occupied and potential habitat at Vasey's Paradise is between 850 and 900 m² (9,150 and 9,688 ft²) (IKAMT 1998).

In 1998, AGFD stocked three locations within the Grand Canyon with Kanab ambersnail (Keyhole Springs, Lower Deer Creek Spring, and Upper Elves Canyon). Of these, Kanab ambersnail persisted in the Upper Elves Canyon location (Sorenson 2005). Upper Elves Canyon is located approximately 134 km (83 mi) downstream of Vasey's Paradise on the Colorado River. Occupied and potential habitat is adjacent to a perennial seep and is 99.2 m² (1,068 ft²) in area (Sorenson 2005).

2.3.1.6 Habitat or Ecosystem Conditions

Members of the genus *Oxyloma* typically inhabit marshes and other wetlands watered by springs and seeps at the base of sandstone or limestone cliffs (Clarke 1991; Spamer and Bogan 1993). The known Kanab ambersnail populations occur within these general habitat conditions, but differ in the amounts and types of associated vegetation and water flow components.

The Three Lakes site contains a series of spring-fed ponds and wet meadows, at the base of sandstone cliffs within the Kanab Creek drainage (FWS 1995). At this site, Kanab ambersnail occupy wet meadow and marsh habitat that surrounds the Three Lakes ponds (FWS 1995). Cattail (*Typha domingensis*), marshes, and sedge (*Juncus spp.*) meadows dominate the Three Lakes habitat.

In contrast, the Vasey's Paradise site consists of a cool dolomitic spring that flows directly from Mississippian Redwall limestone (FWS 1995; Stevens et al. 1997). Spring water flows approximately 100 m (328 ft) down a steep gradient to the mainstem of the Colorado River. Spring water flows along several small rivulets bordered by patches of lush vegetation (Stevens et al. 1997). Large patches of mixed vegetation composed primarily of native crimson monkeyflower (*Mimulus cardinalis*), nonnative watercress (*Nasturtium officinale*), and native water sedge (*Carex aquatilis*) characterize Vasey's Paradise habitat (Stevens et al. 1997). Within this habitat, Kanab ambersnails often inhabit the dead and decaying monkeyflower litter and live watercress stems and leaves. The spring also contains large amounts of poison ivy (*Toxicodendron rydbergii*), which does not compromise Kanab ambersnail habitat, but does minimize human intrusion. Available habitat at Vasey's Paradise has increased approximately 40% since Glen Canyon Dam was installed in 1963 because controlled flows allowed the vegetation to grow lower and more extensively on the canyon wall (Stevens et al. 1997).

Upper Elves Canyon, the introduced population, is a spring fed habitat dominated by monkeyflower. Potential and occupied habitat at this location includes the spring seep, a large pool area, a patch of monkeyflower, and surrounding hanging gardens of maidenhair ferns (*Adiantum capillus-veneris*) and monkeyflower (Sorenson 2005).

2.3.2 Five Factor Analysis

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

In our listing decision (FWS 1992) and recovery plan (FWS 1995), we considered the present or threatened destruction, modification or curtailment of habitat or range to be a threat to Kanab ambersnail. Because this factor acts differently on each existing population, we will address each population separately.

Three Lakes

When we listed Kanab ambersnail, the Three Lakes private landowner had already graded and filled a marshy area adjacent to the ponds for future development purposes (Clarke 1991; FWS 1992). In addition, the landowner was planning to drain one of the three pond areas to facilitate the building of a retirement home or recreational vehicle park in the Three Lakes area, which would have resulted in further habitat destruction (FWS 1992). This activity has not occurred since the species was listed. Three Lakes also is located adjacent to a popular tourism corridor that connects several national parks (Bryce Canyon, Zion, and Grand Canyon), and thus is in a prime location for infrastructure development. The ESA's protections have reduced that threat of development to the Three Lakes population; however, absent the protection of the ESA development could extirpate the Three Lakes population.

Historically, Three Lakes was grazed. We did not consider the low levels of grazing at Three Lakes to be a threat when we listed Kanab ambersnail (FWS 1992). Access to the Three Lakes property was not provided until 2005 and then only for collection of samples for taxonomic and genetic analyses. Private landowners granted FWS biologists access to the Three Lakes site in 2011 (Capone, pers. obs., 2011). Currently, 2 horses graze a small fenced portion (less than 50 m² (538 ft²)) of Kanab ambersnail habitat for 6–9 months of the year (Capone, pers. obs., 2011). Grazing has occurred in this enclosed area for at least 12 years (Capone, pers. obs., 2011). We do not consider this low level of grazing a threat to the Three Lakes population because grazing activities are limited to a small enclosed area and we have no evidence to suggest that habitat characteristics are changing as a result.

Vasey's Paradise

In our listing rule, we did not find significant habitat loss threats specific to the Vasey's Paradise population (FWS 1992). In our recovery plan, we considered the effects of controlled flooding and visitation by river runners on Vasey's Paradise habitat (FWS 1995). We recognized controlled flooding of the Colorado River below Glen Canyon Dam as a

threat to Kanab ambersnail (FWS 1995). We found that recreational visitation was not likely a threat to Kanab ambersnail because river runners seldom visit habitat occupied by Kanab ambersnail (FWS 1995).

Habitat loss caused by controlled flooding of the Colorado River below Glen Canyon Dam continues to threaten the Vasey's Paradise population. When the hydrograph increases to levels greater than 567 cubic meters per second (cms) (20,000 cubic feet per second (cfs)), water inundates and scours away habitat and Kanab ambersnails at Vasey's Paradise (Stevens et al. 1997). In 1996, a 1,275-cms (45,000-cfs) experimental flow from Glen Canyon Dam inundated and scoured away approximately 14% of Kanab ambersnail habitat at Vasey's Paradise (FWS 2000). It is likely that several hundred snails were lost, and it took 2.5 years for the habitat to recover to pre-flood conditions (Stevens et al. 1997).

In 2004, prior to another high-flow test event, AGFD staff temporarily moved approximately 25-40% (29-47m²; 312-506 ft²) of Kanab ambersnail vegetated habitat that would have normally been lost due to scour effects from high flows. The AGFD staff successfully replaced the vegetated habitat afterwards with almost full recovery of the scoured snail habitat 6 months later. Therefore, we believe that releases from the dam can be done in a manner compatible with Kanab ambersnail persistence at this location, provided that the FWS and AGFD are coordinated with in advance, and the Bureau of Reclamation (BOR) implements mitigation measures. Mitigation measures should include temporary relocation of Kanab ambersnails and vegetated habitat that would be lost to scour effects from high flows.

Controlled flooding and high flows are an ongoing threat. The BOR released a draft environmental assessment in January 2011 entitled "Development and Implementation of a Protocol for High-flow Experimental Releases from Glen Canyon Dam, Arizona, 2011 – 2020." In this environmental assessment, the BOR proposed Glen Canyon Dam releases that will result in periodic high-flow events (similar magnitudes of previous test flow) over the course of the next 9 years (BOR 2011). Section 7(a)(2) of the ESA requires the BOR to consult with us to ensure that controlled flooding is not likely to jeopardize the continued existence of Kanab ambersnail. Absent the ESA's protection, controlled flooding could severely reduce the viability of the Vasey's Paradise population.

Other potential threats to this site include recreational visitation from river runners and grazing. Recreational visitation could crush snails and vegetation. As we stated in the recovery plan (FWS 1995), most river runners do not disturb occupied snail habitat because of the large amounts of poison ivy and, thus, we do not consider recreational visitation a threat to this population. Bighorn sheep (*Ovis canadensis*) grazing occurs in

Kanab ambersnail habitat at Vasey's Paradise (Sorensen 2005). Because the vegetation in the snail's habitat is in good condition, we do not consider bighorn sheep a threat to this population.

Upper Elves Canyon

Upper Elves Canyon was established recently and was not considered in the original listing or the recovery plan. Habitat loss is not considered a threat at Upper Elves Canyon. The site is very remote, and there is little human visitation or use. There is no livestock use at Upper Elves Canyon. Controlled flooding is not a threat to the Upper Elves Canyon population. Flows less than 2,832 cms (100,000 cfs) will not affect this population; therefore, controlled flooding is not a threat to this population as floods greater than 2,832 cms (100,000 cfs) are unlikely to occur (Sorensen 2005). We have no additional information that suggests habitat loss is a threat to the Upper Elves Canyon population.

In summary, habitat loss is a threat to two of the three populations of Kanab ambersnail (Three Lakes and Vasey's Paradise). Private lands development threatens the Three Lakes population. Controlled flooding is a threat to the Vasey's Paradise site.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes.

We considered overutilization in our threats analysis for the listing rule and the recovery plan and found that it did not threaten Kanab ambersnail (FWS 1992, 1995). Kanab ambersnails are not collected for commercial, recreational, or educational purposes. The only known collections are for genetic studies, and the level of collection for this purpose is minimal. Thus, we do not consider overutilization to be a threat to the Kanab ambersnail.

2.3.2.3 Disease or predation.

Disease

The listing rule (FWS 1992) and recovery plan (FWS 1995) found disease did not threaten the Kanab ambersnail. We are not aware of any disease that threatens Kanab ambersnail.

Predation

The listing rule (FWS 1992) and recovery plan (FWS 1995) found predation did not threaten the Kanab ambersnail, and there is no new information to indicate that predation threatens the Kanab ambersnail.

Terrestrial snails have numerous natural predators including insects, mammals, birds, and other snails (Godan 1983). Potential vertebrate predators at the three Kanab ambersnail populations include summer breeding Say's and black phoebe (*Sayornis sayi* and *S. niaricans*), canyon wren (*Catherpes mexicanus*), winter resident American dipper (*Cinclus mexicanus*), American robin (*Turdus migratorius*), and canyon mice (*Peromyscus crinitus*) (Clarke 1991; Stevens et al. 1997; FWS 1995). Predation rates by birds and mice are not available, but analysis of mice feces indicates that Kanab ambersnails are not regularly eaten by rodents (Meretsky and Wegner 1999). We do not have direct observational information or other data to suggest that predation on Kanab ambersnail is above what would be expected in a normally functioning ecosystem. Therefore, we consider predation a natural event to Kanab ambersnail populations and not a threat to the species.

Parasitism

The listing rule (FWS 1992) and recovery plan (FWS 1995) did not identify any threats to the Kanab ambersnail due to parasitism, and there is no new information that indicates parasitism threatens the Kanab ambersnail.

Kanab ambersnails serve as intermediate hosts to a number of parasitic trematode worms (Brown 1978), including the flatworm trematode (*Leucochloridium cyanocittae*) (Sorensen and Nelson 2002). This flatworm is found at Vasey's Paradise and Three Lakes (flatworm has not been documented in Upper Elves Canyon). This flatworm may be specific to Kanab ambersnails as it is not found parasitizing other snail species (Sorensen and Nelson 2002). Parasitism rates range between 1 and 10% among mature Kanab ambersnails at Vasey's Paradise (Stevens et al. 1997). We do not have information on the parasitism rates at Three Lakes or Upper Elves Canyon. Parasitism is not observed in snails <10 mm (0.4 in.) in length (Sorensen and Nelson 2002). This parasite does not kill host snails (Sorensen and Nelson 2002) and parasitized snails are capable of reproduction (Sorensen and Kubly 1997), although reproductive output may be reduced. Because of low parasitism rates and because parasitized snails can successfully reproduce, we do not consider parasitism a threat to Kanab ambersnail.

In summary, we do not have information to suggest predation or parasitism occurs at unnatural levels in any of the three Kanab ambersnail populations. Therefore, we do not consider predation or parasitism significant threats to Kanab ambersnail.

2.3.2.4 Inadequacy of existing regulatory mechanisms.

The major Federal mechanisms for protection of Kanab ambersnail and its habitat are through the ESA, the National Environmental Policy Act (NEPA), Section 404 of the Clean Water Act (CWA), and National Park Service (NPS) Organic Act (that specifies how their lands are managed for sensitive species). Below we analyze the current situation (i.e., the situation with ESA protections in place) and, in order to gauge the adequacy of regulatory mechanism, what would happen in the absence of ESA protections.

As previously described, two of the Kanab ambersnail populations (Vasey's Paradise and Upper Elves Canyon) are located on Federal NPS lands (Grand Canyon National Park). The third population (Three Lakes) is located on private land.

Endangered Species Act

The ESA is the primary Federal law providing protection for Kanab ambersnail since its listing in 1992. Section 7(a)(1) states that Federal agencies, in consultation with the FWS, shall utilize their authorities to carry out programs for the conservation of endangered species. Section 7(a)(2) requires Federal agencies to consult with us to ensure any project they fund, authorize, or carry out is not likely to jeopardize the continued existence of listed species or modify their critical habitat. We have consulted with the BOR under Section 7(a)(2) of the ESA to ensure that controlled flooding in the Grand Canyon is not likely to jeopardize the continued existence of Kanab ambersnail. Absent the ESA's protection, controlled flooding would have severely reduce the viability of the Vasey's Paradise population.

Section 9(a)(1) of the ESA prohibits the "taking" of any endangered species except as is provided for in Section 10 of the ESA. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. We define "harm" to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. We define "harass" as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Section 9 also makes illegal the international and interstate transport, import, export, and sale or offer for sale of endangered plants and animals except as provided for in Section 10 of the ESA.

Section 10 of the ESA allows for exceptions to activities and actions otherwise prohibited by Section 9. Section 10(a)(1)(A) permits acts otherwise prohibited by Section 9 for scientific purposes or to enhance the propagation or survival of the affected species. Section 10(a)(1)(B) permits taking otherwise prohibited by Section 9(a)(1) if that taking is incidental to, and not the purpose of carrying out an otherwise lawful activity. We issued a Section 10(a)(1)(A) permit to the AGFD permitting monitoring, research, and translocation of Kanab ambersnail in Arizona (i.e., Vasey's Paradise and Upper Elves Canyon). Section 10 (a)(1)(A) has allowed for the establishment of the Upper Elves Canyon population.

The ESA has provided adequate protection from impacts to the known locations. However, the status of the species still remains vulnerable because of the small number of known locations, the lack of success in establishing additional populations, and the threat of habitat degradation through controlled flooding (Vasey's Paradise) and private development (Three Lakes).

National Environmental Policy Act

The NEPA (42 U.S.C. 4371 et seq.) provides some protections for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires an agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where the analysis reveals significant environmental effects, the Federal agency must discuss mitigation that could offset those effects (40 CFR 1502.16). These mitigations usually provide some protections for listed species; however, the NEPA is a disclosure statute and does not require minimization of impacts.

The NEPA is likely to provide greater evaluation and protection for the Kanab ambersnail populations at Vasey's Paradise and Upper Elves Canyon because these populations occur on NPS lands—Three Lakes occurs on private land and subsequently would not receive NEPA protection unless a major Federal action occurred on or affected this land. However, even on NPS lands, NEPA does not require mitigation for impacts and acceptance of our NEPA recommendations is at the discretion of the action agency. In the absence of the ESA's protections, it is unclear what level of consideration and protection Federal agencies would provide the species through the NEPA process.

Clean Water Act

Kanab ambersnail occupied areas contain wetland habitats, and Section 404 of the CWA regulates fill in wetlands that meet certain jurisdictional requirements. Activities that result in fill of jurisdictional wetland habitat require a Section 404 permit. We can review permit

applications and provide recommendations to avoid and minimize impacts and implement conservation measures for fish and wildlife resources, including Kanab ambersnail. Incorporation of our recommendations into Section 404 permits is at the discretion of the U.S. Army Corps of Engineers; therefore, there are no assurances that conservation and impact minimization will occur without the ESA's protections. In addition, not all activities in wetlands involve fill and not all wetlands are "jurisdictional." Although the CWA provides a level of protection to Kanab ambersnail populations, absent the ESA's protection, it will not adequately protect Kanab ambersnail populations.

National Park Service Organic Act

The NPS Organic Act specifies that the NPS will "promote and regulate the use of the Federal areas known as national parks, monuments, and reservations ... which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The 2001 NPS Management Policies Section 4.4.1.1, Plant and Animal Population Management Principles, states that the NPS will maintain all native plant and animal species and their habitats inside parks. In addition, these policies state that "the (National Park) Service will work with other land managers to encourage the conservation of the populations and habitats of these species outside parks whenever possible" (NPS 2001). These policies, which implement Federal law, may afford protection to Kanab ambersnail populations located in Grand Canyon National Park (Vasey's Paradise and Upper Elves Canyon). The NPS policies provide a level of protection to the Vasey's Paradise and Upper Elves Canyon populations; however, in the absence of the ESA's protections, NPS policies may not provide adequate protection to these populations because the policies provide only recommendations for conservation.

State Mechanisms

The genus *Oxyloma* is listed in AGFD's Commission Order 42 (Crustaceans and Mollusks), as a closed-season species, prohibiting unauthorized collecting (AGFD 2008). The Commission Order regulates collection of Kanab ambersnails, which provides the species of some level of protection from intentional take, but does not provide habitat protection. Furthermore, a scientific collection permit is required to collect or manipulate populations within the State of Arizona. The State of Utah (Utah State Rule R657-3-22) prohibits the collection, importation, or possession of Kanab ambersnail. State regulations do not protect Kanab ambersnail from the threat of habitat loss, such as development on private land (e.g., Three Lakes population).

In summary, absent the ESA's protections, Kanab ambersnail would continue to receive some level of protection for the Vasey's Paradise and Upper Elves Canyon from both NEPA and NPS policies; however, these mechanisms do not provide an equivalent level of protection to the ESA. For example, NEPA does not require mitigation for species impacts. Because many potentially damaging activities in wetlands do not involve fill and not all wetlands are jurisdictional, the CWA does not adequately protect populations. State regulations, in both Arizona and Utah, protect Kanab ambersnail from unauthorized collection, but do not provide protection from land use activities (e.g., development).

Conclusion

Absent the ESA, regulatory mechanisms are not in place to sufficiently protect the Three Lakes population from the threat of private land development or the Vasey's Paradise population from controlled flooding.

2.3.2.5 Other natural or manmade factors affecting its continued existence.

Climate Change

We did not consider climate change in our threats analysis for either the listing rule or the recovery plan (FWS 1992, 1995).

According to the Intergovernmental Panel on Climate Change (IPCC) (2007, p. 1) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

Since the release of the IPCC report, new evidence that our planet is experiencing significant and irreversible changes has underscored reasons for concern (Smith et al. 2009 as cited by Glick et al. 2011). In the United States, we are seeing a multitude of changes consistent with a rapidly warming climate. Climate change impacts in the United States summarized by the U.S. Global Change Research Program in Global Change Impacts in the United States (Karl et al. 2009) include:

- United States average temperature has risen more than 2°F over the past 50 years and is projected to rise more in the future; how much more depends primarily on the amount of heat-trapping gases emitted globally and how sensitive the climate is to those emissions.
- Precipitation has increased an average of about 5% over the past 50 years. Projections of future precipitation generally indicate that northern areas will become wetter, and southern areas, particularly in the West, will become drier.

- The amount of rain falling in the heaviest downpours has increased approximately 20% on average in the past century, and this trend is very likely to continue, with the largest increases in the wettest places.
- Many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40-50 years.

During the past decade, the average temperature in Utah was higher than observed during any comparable period of the past century. Hot temperature extremes, heat waves, and heavy precipitation will increase in frequency, with the Southwest experiencing the greatest temperature increase in the continental United States (IPCC 2007). This temperature increase will likely be coupled with a 10–30% precipitation decrease in western North America (Milly et al. 2005) and an associated reduction in water resources (IPCC 2007).

Kanab ambersnails are restricted to vegetated shallow standing water or vegetated wet soil surfaces and unlike other terrestrial snails are not found in slightly drier habitats (Clarke 1991). The three existing Kanab ambersnail populations occupy relatively small spring-fed habitats. The Three Lakes, Vasey's Paradise, and Upper Elves Canyon populations occupy 2 hectares (215,278 ft²), 850 to 900 m² (9,150 and 9,688 ft²), and 50 m² (538 ft²) of habitat, respectively. Reductions in water availability, as are predicted for western North America (Milly et al. 2005; IPCC 2007; and Karl et al. 2009), will result in reductions of vegetated wet habitat at Three Lakes, Vasey's Paradise, and Upper Elves Canyon. Reduction of vegetated wet habitat will reduce resources available (shelter, breeding habitat, and food) for Kanab ambersnail. Reductions in resources will lead to decreases in already low population sizes. As stated above, all three Kanab ambersnail populations are entirely dependent upon spring flow for wetted habitat. Increases in flows along the Grand Canyon through BOR controlled flooding will not sustain Kanab ambersnail habitats during drought conditions. High flows will scour away existing habitat. For these reasons, we consider climate change a threat to Kanab ambersnail.

2.4 Synthesis

At the time of listing, we concluded that Kanab ambersnail was endangered due to existing and potential habitat degradation caused by private land development at Three Lakes (FWS 1992). The ESA's protections have prevented private land development; however, absent the ESA's protections, direct habitat destruction associated with development would likely have extirpated the Three Lakes population. Since we listed the species, the BOR initiated a controlled flooding program where high flows (released from Glen Canyon Dam) flood the Colorado River. These high flows scour away habitat in Vasey's Paradise and can kill individual snails. Section 7 consultation under the

authority of the ESA enables us to work with the BOR to minimize and mitigate the effects of controlled flooding on Kanab ambersnail. Absent the ESA's protection, controlled flooding could severely reduce the viability of the Vasey's Paradise population.

We did not consider climate change a threat when we listed Kanab ambersnail. Current climate change science predicts decreases in precipitation and water resources in areas occupied by Kanab ambersnail. Because Kanab ambersnail populations are restricted to small wet vegetated habitat areas, we consider climate change and associated reduction in water resources a threat to Kanab ambersnail. Existing regulatory mechanisms, absent the ESA's protections, would not protect Kanab ambersnail from the threats identified in this analysis. Subsequently, we find the inadequacy of existing regulatory mechanisms threatens Kanab ambersnail. In summary, private land development, controlled flooding in the Colorado River, climate change, inadequate existing regulatory mechanisms threaten Kanab ambersnail now and in the foreseeable future.

Since we listed Kanab ambersnail, researchers conducted several genetic studies on the taxonomy of *Oxyloma* populations, initially on populations in Utah and Arizona, and most recently from populations throughout Western North America (see section 2.3.1.3). The synthesis of genetic, anatomical, and morphological information resulted in conflicting views on the taxonomic status of the Kanab ambersnail (Miller et al. 2000; Stevens et al. 2000; Culver et al. 2007). The taxonomy of the Kanab ambersnail and other southwestern ambersnails will undoubtedly influence the future management of these species either by justifying greater protection for populations, or by downlisting or delisting currently protected Kanab ambersnail populations. Given this ongoing debate within the scientific community and a lack of conclusive data, at the present time, we will continue to treat the Kanab ambersnail as a valid subspecies, *Oxyloma haydeni kanabensis* (Pilsbry 1948; FWS 1992). However, we will continue to evaluate this species' taxonomy as the literature continues to develop.

3. RESULTS

3.1 Recommended Classification

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change needed

3.2 New Recovery Priority Number

No change is warranted from current recovery priority number of 6c.

Brief Rationale

Threats to the species and distribution changed little for this species, to the best of our knowledge, since it was first listed: 1) the Kanab ambersnail is listed at the subspecies level; 2) populations face a high degree of threat, in this case from loss and modification of habitat, inadequacy of existing regulatory mechanisms, and climate change; and 3) recovery potential is low with a possibility of human conflict.

4. RECOMMENDATIONS FOR FUTURE ACTIONS

Support Further Research

Additional analysis of shell morphology, anatomy, and molecular genetics are needed to resolve and refine the specific and subspecific taxonomy of the *Oxyloma* genus. Any further taxonomic analysis must consider *Oxyloma* at the subspecies level, as Kanab ambersnail is currently recognized as a valid subspecies.

Refine Taxonomy

Convene a team of snail, taxonomy, and genetics experts to conduct a Structured Decision Making exercise focused on reviewing or revising the current taxonomic status of the *Oxyloma* genus.

Conduct Regular Surveys and Monitor Known Populations

Continue monitoring Vasey's Paradise and Upper Elves Canyon populations to provide additional information on Kanab ambersnail abundance, distribution, and stability that is essential to the management of this species.

Reinitiate monitoring of the privately owned Three Lakes habitat and snail population.

Establish Conservation Easement

Attempts should be made to protect the privately owned Three Lakes population from future development through a conservation easement or similar mechanism.

Revision of Existing Recovery Plan

The existing recovery plan should be revised to include downlisting and delisting criteria that reflect the current understanding of Kanab ambersnail.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Kanab ambersnail (*Oxyloma haydeni kanabensis*)

Current Classification: Endangered

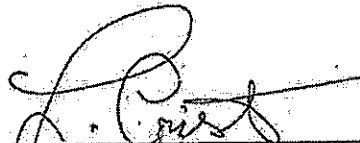
Recommendation resulting from the 5-Year Review

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change needed

Review Conducted By: Mark Capone, Fish and Wildlife Biologist, Utah Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve 
Field Supervisor, Utah Ecological Services Field Office

Date 8/18/11

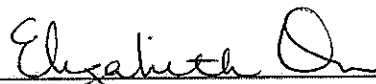
REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Fish and Wildlife Service

Approve 
Assistant Regional Director - Ecological Services

Date 8/25/11

Cooperating Regional Director, Fish and Wildlife Service

Concur 
for Assistant Regional Director - Southwest Region

Date 9/29/11