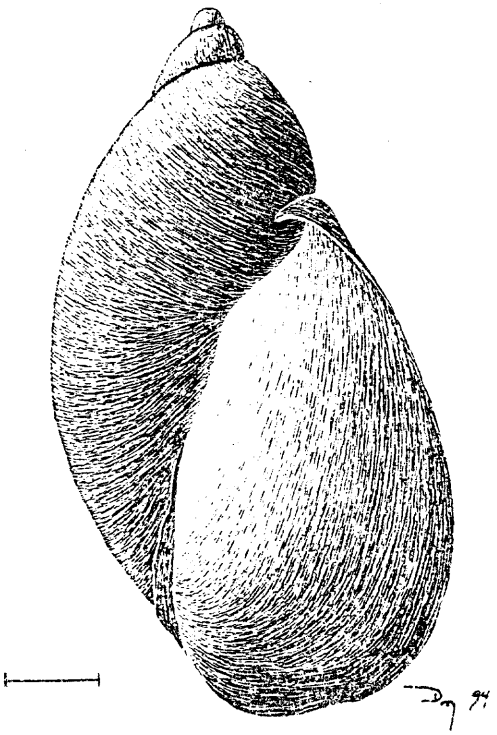
KANAB AMBERSNAIL

(*Oxyloma haydeni kanabensis*)



RECOVERY PLAN

U.S. Fish and Wildlife Service

Region 6/Region 2

1995

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KANAB AMBERSNAIL

OXYLOMA HAYDENI KANABENSIS

RECOVERY PLAN

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for

Region 2

U.S. Fish and Wildlife Service

Albuquerque, New Mexico

and

Region 6

U.S. Fish and Wildlife Service

Denver, Colorado

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DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and other interested parties. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views or the official positions or approvals of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

LITERATURE CITATIONS

Literature Citation should read as follows:

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Cover illustration by Douglas W. Moore.

EXECUTIVE SUMMARY

Current Status: The Kanab ambersnail is a rare endemic snail restricted to permanently wet areas within small wetlands of the Colorado Plateau. Three populations are known, two in southern Utah, the other within the Grand Canyon of Arizona. The two Utah populations are about 2.1 kilometers (1.3 miles) apart near the Utah-Arizona border in Kane County. The larger Utah population (which contains over 99 percent of the total number of individuals in Utah) occurs in Three Lakes Canyon about 10 kilometers (6 miles) northwest of the town of Kanab, Utah. This population inhabits wet meadow and marsh habitat (approximately 0.8 kilometers [0.5 miles] long) surrounding the "Three Lakes" ponds. The smaller Utah population is in a vegetated seep at the base of a sandstone cliff about 46 meters (150 feet) long and 15 centimeters (6 inches) wide near the main stem of Kanab Creek in Kanab Creek Canyon. The Arizona population occurs in a spring fed wetland at Vasey's Paradise generally above the 20,000 cubic feet per second water line of the Colorado River in Grand Canyon National Park. Vasey's Paradise is about 52 river kilometers (32 river miles) downstream from Lee's Ferry in Coconino County, and about 92 straight line kilometers (57 miles) southeast of the two Utah populations. Occupied habitat is about 840 square meters (1,005 square yards).

The Kanab ambersnail was discovered in 1909 at the "Greens" in the Kanab Creek drainage. The population at Three Lakes Canyon was estimated to contain 100,000 individuals in June 1990. During 1990 and 1991 this population experienced population and habitat lose due to wetland destruction and, to a limited extent, livestock trampling. The smaller Utah population (Kanab Creek Canyon) numbered over 300 individuals in the early 1980's. Its habitat has been dewatered within the past 10 years, and only three individuals were counted after an intensive search of its habitat in September 1990. No Kanab ambersnails have been observed since. This smaller Utah population may be extirpated.

The Arizona population at Vasey's Paradise was discovered in 1991. Preliminary population estimates indicate a population of about 16,000 individuals at this site. This population is thought to be relatively secure in relation to the Utah populations. Vasey's Paradise does, however, receive regular visitation from river runners because of its great natural beauty and the availability of fresh water at the site. This area also may be impacted by natural and human-caused variations in the flow of the Colorado River downstream from the Glen Canyon Dam.

Recovery Objective: The immediate objective of this recovery plan is to maintain viable populations of the Kanab ambersnail in the current range of the species. The long-term objective is to downlist and eventually delist.

Recovery Criteria:

Conservation Criteria: In order to prevent the species from becoming extinct, each Kanab ambersnail population and its habitat must be protected from loss of individuals and environmental degradation through sections 7 and 9 of the Endangered Species Act.

Downlisting Criteria: The Kanab ambersnail may be considered for downlisting to threatened when the above conservation criteria have been met and when the following criteria have been attained:

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. This criteria is provisional. It is probable that this criteria will be modified as additional information is acquired concerning the species distribution, abundance, and stability of its separate populations.

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.

Delisting Criteria: Delisting criteria will not be developed until there is sufficient information to do so.

Actions Needed:

1. Control activities that affect the habitat and populations of the Kanab ambersnail. These activities include the frequency, duration, magnitude, and timing of flood flows from Glen Canyon Dam and possible recreation in the area of Vasey's Paradise. Ensure that no unauthorized action harms all extant populations.

2. Acquire and restore the habitat of the Three Lakes population and acquire and/or protect other habitat suitable to the long-term viability of the Kanab ambersnail.

3. Inventory suitable habitat for Kanab ambersnail to determine existing population density and distribution of the species as well as potential recovery sites.

4. Determine the biological and ecological factors critical to the species conservation.

5. Locate or establish additional populations and establish ex situ breeding populations

6. Develop public awareness and appreciation for the conservation of the species.

Date of Recovery: unknown

Total Cost of Recovery: unknown

I. INTRODUCTION

The Kanab ambersnail, Oxyloma haydeni kanabensis Pilsbry, is a rare endemic snail restricted to permanently wet areas within small wetlands of the Colorado Plateau. The snail was emergency listed under an emergency rule published on August 8, 1991 (56 FR 37671). Emergency rules are effective for 240 days. To remain on the endangered species list, the normal listing process of publishing a proposed rule, requesting and considering public/agency comments, and publishing a final rule must be followed. The Kanab ambersnail was proposed for listing as an endangered species, with critical habitat for the species' larger Utah population (Figure 1), on November 15, 1991 (56 FR 50824). A final rule listing the Kanab ambersnail as an endangered species under the authority of the Endangered Species Act, as amended, was published on April 17, 1992 (57 FR 13661). Designation of critical habitat was not finalized in the rule because the U.S. Fish and Wildlife Service (Service) did not have the necessary economic information. Critical habitat for the larger Utah population remains proposed until the Service either publishes a final rule to designate it or publishes a notice to withdraw the proposed critical habitat. The recovery priority of this subspecies is 6C (a subspecies with a high degree of threat and low recovery potential with a possibility of conflict with human activities).

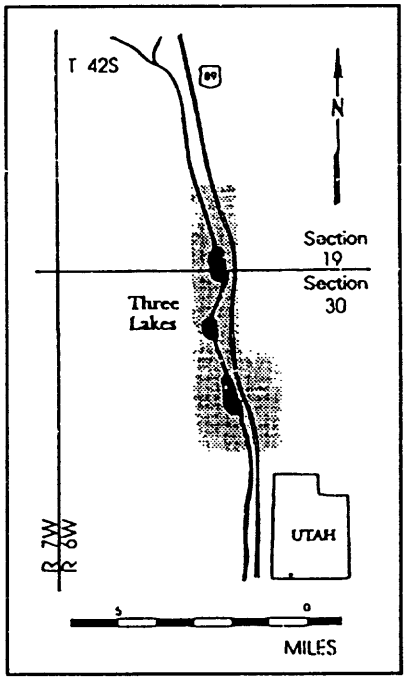

Figure 1. Proposed Critical Habitat for the Kanab Ambersnail (Oxyloma haydeni kanabensis). Utah, Kane County: Three Lakes Canyon, the "Three Lakes" ponds and adjacent wetlands and seeps in the E½ SE¼ SW¼ Sec. 19, E½ NE¼ NW¼ Sec. 30, E½ SE¼ NW¼ Sec. 30, and W½ SW¼ NE¼ Sec. 30, T.42S., R.6W., of the Salt Lake Meridian between U.S. Highway 89 and the sandstone cliffs west of the highway. Constituent elements include: Wetlands adjacent to water seeps in sandstone cliffs and surrounding the "Three Lakes" ponds and water seeps in sandstone cliffs.

This recovery plan was prepared in-house by the Service with technical input from biologists from the Bureau of Reclamation, National Park Service, and Arizona Game and Fish Department. The Kanab ambersnail draft recovery plan was sent to five species experts, with specific knowledge of the species and its ecosystem, for peer review. Two reviewers provided additional information concerning the species biology and distributional status. Their comments were incorporated into this final plan. The draft of this recovery plan was sent to the two private landowners of the species Utah habitat and to the National Park Service, the managers of the species public land habitat in Arizona, for their comment. One private landowner and the National Park Service commented on the proposed plan. Their comments were also incorporated into this final plan.

Private lands and individuals will be directly affected by the implementation of some recovery plan tasks. The Service will involve all interested and affected parties in the recovery plan implementation process through the development of a participation plan. As resources become available, all interested parties will be involved in the initiation of the various recovery plan tasks. This recovery plan, with its implementation schedule, will serve as the initial participation plan for this species.

A. DESCRIPTION

The Kanab ambersnail is a terrestrial snail in the family Succineidae. The empty shell is a light amber color. The live snail has a mottled grayish-amber to yellowish-amber colored shell. The shell is dextral (right handed spiral), thin-walled, with an elevated spire and a broad, patulous (expanded) aperture. Fully mature individuals are about 14 to 19 mm (0.5 to 0.75 inch) long, 7 to 9 mm (0.25 to 0.33 inch) in diameter, with 3.25 to 3.75 whorls in a drawn out spire. Its eyes are borne at the ends of long peduncles (stalks), while the tentacles are reduced to small protuberances at the base of the eye stalks (Pilsbry 1948, Clarke 1991).

Specimens of the Kanab ambersnail were first collected in 1909 by James Ferriss from: "The Greens", 10 kilometers (6 miles) above Kanab, Utah on Kanab Wash, on a wet ledge among moss and cypripediums" (Ferriss 1910, Pilsbry 1948). These specimens were originally placed in the species Succinea hawkinsi (Ferriss 1910, Chamberlin and Jones 1929). Henry Pilsbry (1948) transferred these specimens to the genus Oxyloma and erected the subspecies kanabensis in the species haydeni for them. Arthur Clarke (1991) notes that Pilsbry's decision to accord the Kanab ambersnail subspecific status was preliminary, and that, as Pilsbry himself noted, "its taxonomic status should be reevaluated." Clarke (1991) and Shei K. Wu (Colorado Museum of Natural History, Boulder, Colorado, pers. comm. 1992, 1995) suggest that the Kanab ambersnail may deserve full species status. Earle Spamer (Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, pers. comm. 1994) stated that current published mollusk checklists (Turgeon et al. 1988 and Groombridge 1993) treat the Kanab ambersnail at species level rather that as a subspecies, but until the criteria are derived and published by which the taxon can be shown to be a separate species it should continue to be called by its original name published by Pilsbry (1948): Oxyloma haydeni spp. kanabensis.

B. DISTRIBUTION

The existence of the Kanab ambersnail in Utah has been known since its discovery by Ferriss in 1909 (Ferriss, label information on type specimen, Philadelphia Academy of Sciences, 1909; Chamberlin and Jones 1929; Pilsbry 1948; and Clarke 1991). The Kanab ambersnail is currently known from three populations (Figure 2). The majority of the species total known population is located at Three Lakes about 10 kilometers (6 miles) NNW of Kanab in Kane County, Utah (Clarke 1991). This population inhabits wet meadow and marsh habitat (approximately 0.8 kilometers [0.5 miles] long) surrounding the "Three Lakes" ponds. Potential and occupied habitat is estimated by the Service at 2 hectares (5 acres).

A second, but much smaller, population is located in Kanab Creek Canyon about 10 kilometers (6 miles) north of Kanab, also in Kane County, Utah (Clarke 1991). This population occurs in a vegetated seep at the base of a sandstone cliff about 46 meters (150 feet) long and 15 centimeters (6 inches) wide near the main stem of Kanab Creek in Kanab Creek Canyon. This smaller population may be extirpated. No individuals have been collected or observed since 1990. The two Utah populations are about 2.1 kilometers (1.3 miles) apart near the Utah-Arizona border.

The third population is located at Vasey's Paradise along the Colorado River in the Grand Canyon in Coconino County, Arizona, about 52 river kilometers (32 river miles) downstream from Lee's Ferry and about 92 straight-line kilometers (57 miles) southeast of the two known Utah populations (Spamer and Bogan 1992, 1993b). This population was discovered recently by Spamer in 1991 (Spamer and Bogan 1992, 1993a, 1993b). Previous to 1991, the genus Oxyloma was unknown to the State of Arizona except in the fossil fauna (Bequaert and Miller 1973, Spamer and Bogan 1992, 1993a, 1993b). Potential and occupied habitat is estimated at about 840 square meters (1,005 square yards), (David Wegner, Glen Canyon Environmental Studies, Bureau of Reclamation, Flagstaff, Arizona, pers. comm. 1995). No other historical populations are known to have existed. Recent snail surveys within the Grand Canyon during 1994 and 1995 have failed to locate additional populations (Larry Stevens, Glen Canyon Environmental Studies, Flagstaff, Arizona, pers. comm. 1995).

C. POPULATION BIOLOGY

The Kanab ambersnail is a rare endemic snail restricted to permanently wet areas within small wetlands of the Colorado Plateau. Its population at Three Lakes Canyon was estimated to contain 100,000 individuals in June 1990. During 1990 and 1991 this population experienced habitat losses due to wetlands destruction and, to a limited extent, livestock trampling. In September 1994 a significant portion of its population was buried by silt deposited by runoff from a series of strong thunderstorms. The smaller Utah population (Kanab Creek Canyon) numbered over 300 individuals in the early 1980's. Its habitat has been dewatered within the past 10 years (Clarke 1991). Only three individuals were counted after an intensive search of the habitat in September 1990 and none have been observed since (U.S. Fish and Wildlife Service 1992). This population must be intensively surveyed before the Service can make a determination of extirpation. The size of the Arizona population has been estimated to be about 16,000 individuals (David Wegner, pers. comm. 1995).

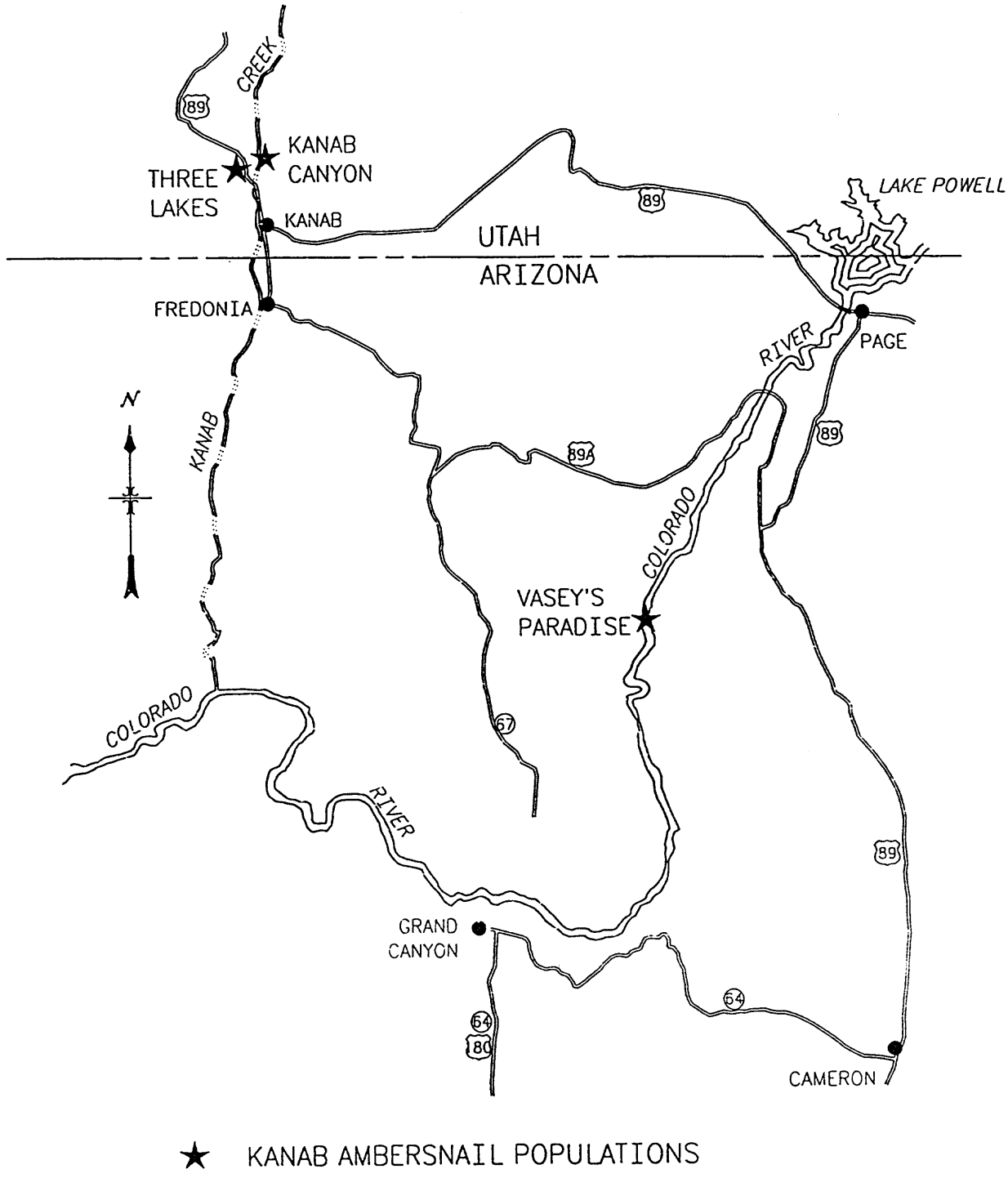

Figure 2. Distribution of the Kanab Ambersnail.

Great diversity in the size of individuals within the Utah populations early in the active growing season indicate that reproduction probably occurs throughout all warm, wet periods of the year and that the Kanab ambersnail overwinters as juveniles, sub-adults, and adults (Clarke 1991). Recent observations suggest that reproductive activity at Vasey's paradise is focused in summer months, with significant die-off of large individuals in late summer and autumn (Blinn et al. 1992). It is probable that the Kanab ambersnail has a life span of about 12 to 15 months (Clarke 1991).

D. HABITAT AND LIMITING FACTORS

The Kanab ambersnail lives in marshes watered by springs and seeps at the base of sandstone or limestone cliffs (Clarke 1991, Spamer and Bogan 1993a). It is restricted to a perennially wet soil surface or shallow standing water. The snails also are frequently seen just within the mouths of vole burrows. None have been found in drier areas, such as under logs or in other micro-habitats commonly frequented by other land snails (Clarke 1991).

The Utah populations are found in spring fed wetland habitats at the base of sandstone cliffs within the Kanab Creek drainage. The species habitat is characterized by the presence of cattail marshes dominated by Typha domingensis (Clarke 1991) and sedge meadows dominated by Juncus spp. (Peter Hovingh, private citizen, Salt Lake City, Utah, pers. comm. 1992; and Shei K. Wu, pers. comm. 1992). The Kanab ambersnail is most densely aggregated under fallen cattail stalks at the edges of cattail stands where they transition into wet sedge meadows. Cattails and dense sedge and grass meadows may provide crucial vegetative cover and food resources for the snails (Clarke 1991). Wetland grasses and sedges, if not overgrazed, also will provide suitable habitat for the species (Blaine Lunceford, Bureau of Land Management, pers. comm. 1991; Shei K. Wu, pers. comm. 1992; and Peter Hovingh, pers. comm. 1992). The American robin (Turdus migratorius) has been observed to feed on the Kanab ambersnail in Utah and may be the snail's principal natural predator (Clarke 1991). Robins are uncommon visitors along the Colorado River corridor in the Grand Canyon and thus are, not likely to be a significant predator to the Kanab ambersnail at Vasey's Paradise (Brown et al. 1984; Earle Spamer, pers. comm. 1995).

The Arizona population is found near a spring-fed wetland habitat within the gorge of the Grand Canyon above the 20,000 cubic feet per second water line stage on native cardinal monkey-flower (Mimulus cardinalis), and nonnative watercress (Rorippa nasturtium-aquaticum) (Spamer and Bogan 1993). The area is small, but unique to the Grand Canyon, supporting a localized community of vegetation and the only known population of the Kanab ambersnail in a wilderness setting. The vegetative community is composed of poison ivy (Toxicodendron rydbergii), redbud trees (Cercis occidentalis), coyote willow (Salix exigua), watercress, cardinal monkey-flower, and maidenhair fern (Adiantum capillus-veneris) (Stevens 1987, Spamer and Bogan 1993a). All individuals located during the May 1993 (Debra Bills, U.S. Fish and Wildlife Service, pers. comm. 1993) and subsequent surveys (David Wegner, pers. comm. 1995) were found on wet stems of dead and decaying monkey-flower and water-cress.

E. THREATS

Realized and potential threats to Kanab ambersnail stem primarily from loss and/or adverse modification of its wetland habitat. Some Kanab ambersnail individuals and associated habitat may be lost due to high flows and flood releases from Glen Canyon Dam. The Arizona population is vulnerable to uncontrolled floods and controlled high flows of the Colorado River between Glen Canyon Dam and Vasey's Paradise. The December 1994 final biological opinion on the operation of Glen Canyon Dam stated that the Service anticipates incidental take of the Kanab ambersnail due to high flow events. In addition, the species habitat receives recreational visitation from river runners because of the fresh drinking water available at the site. However, most river runners do not disturb occupied snail habitat (Robert Arnberger, National Park Service, Grand Canyon, Arizona, pers. comm. 1995). Flash flooding from the Vasey's Paradise spring-head or runoff from the canyon walls in the Grand Canyon in Arizona and in the Three Lakes Canyon drainage in Utah has caused and continues to have the potential to cause the loss of significant portions of the species known populations and has altered the species habitat through siltation and scouring.

The demographic stability of the various populations of Kanab ambersnail is not known. The smaller Utah population, located in Kanab Creek Canyon, may not be at population levels large enough to ensure the population's long-term survival, and is likely to go extinct in the near future if it has not already done so. Livestock grazing may be a threat to the survival of the species. The effect of natural factors, such as disease, parasitism, predation, and grazing of its habitat by native species, on the viability of the species population is not known (U.S. Fish and Wildlife Service 1992).

II RECOVERY

A. OBJECTIVE AND CRITERIA

The immediate objective of this recovery plan is to maintain viable populations of the Kanab ambersnail in the current range of the species. The long-term objective is to downlist and eventually delist the species. Downlisting will occur when additional populations of Kanab ambersnail exist to the degree that its inherent vulnerability will be decreased to the point that localized threats will not jeopardize the species. The recovery criteria are:

Conservation Criteria: In order to prevent the species from becoming extinct, each Kanab ambersnail population and its habitat must be protected from loss of individuals and habitat degradation through sections 7 and 9 of the Endangered Species Act.

Downlisting Criteria: The Kanab ambersnail may be considered for downlisting to threatened when the above conservation criteria have been met and when the following criteria have been attained:

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. This criteria is provisional, it is probable that it will be modified as additional information is acquired concerning the species distribution, abundance, and stability of its separate populations.

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.

It must be understood that the above objectives and criteria are subject to change as more information becomes available. Delisting criteria will not be developed until there is sufficient information to do so. The estimated date for completion of recovery is not determinable at this time.

B. STEPDOWN OUTLINE FOR RECOVERY TASKS ADDRESSING THREATS

1. Control human-caused activities that affect the Kanab ambersnail and its habitat.

1.1 Ensure human-caused activities do not adversely impact the Kanab ambersnail populations on Federal lands.

1.2 Assist willing landowners to manage occupied habitat of the Kanab ambersnail.

1.3 Monitor all populations of the Kanab ambersnail for current and potential threats.

1.4 Establish formal land management designations and/or implement land management plans for all Kanab ambersnail populations.

2. Acquire and protect all currently known occupied habitat of the Kanab ambersnail.

2.1 Acquire habitat on private lands.

2.2 Protect subsurface waters, and acquire and protect surface waters.

2.3 Establish a National Wildlife Refuge at Three Lakes.

3. Inventory all suitable habitat for the Kanab ambersnail.

3.1 Identify, delineate, and estimate size of existing populations.

3.2 Identify and survey potential habitat.

3.3 Develop detailed topographic and vegetation maps of the species habitat.

3.31 Develop habitat maps of Three Lakes Population.

3.32 Develop habitat maps of Vasey's Paradise Population.

3.33 Develop habitat maps of potential reintroduction sites.

4. Determine the biological and ecological factors which control the distribution and vitality of the Kanab ambersnail populations and the interaction of the significant biotic and abiotic elements of the Kanab ambersnail and its habitat.

4.1 Determine phenology, behavior, and life history.

4.2 Determine annual and long-term population variation and movement.

4.21 Establish a population study on the Three Lakes Canyon population.

4.22 Establish a population study on the Kanab Canyon population.

4.23 Establish a population study on the Vasey's Paradise population.

4.24 Determine viable population parameters.

4.3 Determine Kanab ambersnail density in relation to lower, middle, and upper Colorado River riparian zones at Vasey's paradise.

4.4 Determine the species synecological relationships.

4.5 Determine the species genetic relationships.

5. **Establish a captive breeding population.**

6. **Promote and encourage improved communication and information dissemination.**

   6.1 Develop and distribute printed educational material.

   6.2 Develop and distribute audio-visual documentary.

C. NARRATIVE FOR RECOVERY TASKS ADDRESSING THREATS

1. **Control human-caused activities that affect the Kanab ambersnail and its habitat.**

   Control of human activities that adversely affect the Kanab ambersnail through alteration and degradation of its habitat is central to its preservation. The species is vulnerable to alteration and degradation of its wetland habitat. All threatened and endangered animal species are protected from harm including habitat destruction and adverse modification of designated critical habitat under the provisions of the Endangered Species Act and implementing regulations.

   1.1 Ensure human-caused activities do not adversely impact the Kanab ambersnail population on Federal lands. A significant Kanab ambersnail population occurs at Vasey's Paradise on Federal land within Grand Canyon National Park under the jurisdiction of the National Park Service. The Bureau of Reclamation is responsible for the operation of Glen Canyon Dam on the Colorado River. The operation of that dam has the potential to directly affect the Vasey's Paradise population by causing intermittent flooding of the species habitat as a consequence of releasing high downstream flows, generally above 20,000 cfs.

   The final biological opinion for the operation of Glen Canyon Dam (U.S. Fish and Wildlife Service 1994) emphasized the need for a clear determination of the stage-discharge relationship at Vasey's Paradise. The Vasey's Paradise population should be surveyed before and after any flow greater than 25,000 cfs. Individuals are not likely to be impacted by daily flows especially during low water years, but could be impacted during uncontrolled floods or controlled flows in high water years above 25,000 cfs. The Bureau of Reclamation, with assistance from the Service and National Park Service, will ensure adequate monitoring of Kanab ambersnail populations and habitat before, during, and after Colorado River high flows.

   The National Park Service is responsible to ensure that resource values (including threatened and endangered species and their habitat) on lands under its jurisdiction are conserved for current and future generations. The National Park Service has the authority, under the agency's regulations and the Grand Canyon National Park enabling legislation, to regulate and control activities within the

Park and the specific obligation under the Endangered Species Act to do so for the conservation of the Kanab ambersnail. Potential recreational activities within the Park will require the necessary permits, etc. from the National Park Service before they can take place. The National Park Service must consult with the Service under section 7 of the Endangered Species Act for any activity which may adversely affect the Kanab ambersnail, including recreation.

At present, recreational use is occurring on the Kanab ambersnail habitat at Vasey's Paradise in the Park. Recreation use, however, is near the saturation limit for use of the Colorado River corridor through the Grand Canyon. Numbers of recreationists using this area are limited and are monitored and regulated by the National Park Service. Recreational use of the Colorado River is unlikely to increase significantly. However, use of Vasey's Paradise will continue due to the area's great natural beauty and the presence of large quantities of fresh drinkable water. Poison ivy, which is common to the site, however, serves as a barrier dissuading many recreationists from degrading the species' occupied habitat.

Occupied habitat areas at Vasey's Paradise within the gorge of the Grand Canyon with populations of Kanab ambersnail should be considered as a Kanab ambersnail conservation area. The use of Vasey's Paradise should be regulated to ensure the protection of the Kanab ambersnail and its habitat. This action is necessary to protect the viable Kanab ambersnail population at this spring fed wetland area. The National Park Service will be responsible for monitoring Kanab ambersnail habitat within Grand Canyon National Park to ensure that no unauthorized use of the species' habitat area is taking place.

Potential habitat exists on Federal lands on the Colorado Plateau and the possibility exists that one or more undiscovered populations may occur. If additional populations are discovered their habitat should receive high priority protection.

1.2 Assist willing landowners to manage occupied habitat of the Kanab ambersnail. A significant portion of the population and the proposed critical habitat of the Kanab ambersnail occurs on private lands in Kane County, Utah. The possibility exists that additional populations may occur on private, State, and Native American lands on the Colorado Plateau. The Service will assist willing private landowners in the conservation of the Kanab ambersnail on their lands. Those activities which are or will be detrimental will be identified, and land management measures and practices that will enhance populations and habitat will be recommended.

1.3 Monitor all populations of the Kanab ambersnail for current and potential threats. All populations on Federal land will be monitored on an ongoing basis. If private, State and Native American landowners concur and permit, all populations of the Kanab ambersnail will be monitored on an ongoing basis for any threat which may affect the species and/or its habitat. Prompt action will be taken to remedy any identified threat.

1.4 Establish formal land management designations and/or implement land management plans for all Kanab ambersnail populations. In order to consider downlisting the Kanab ambersnail, formal land management designations or land management plans must be established/implemented for at least 10 separate Kanab ambersnail populations to continue protection of its populations and its habitat after downlisting. Such designations on Federal and State lands may include: National Parks and Monuments, Areas of Critical Environmental Concern, formal Wilderness designation, research natural areas, and formal State designated protective areas. Specific Kanab ambersnail management guidelines must be incorporated into relevant land management documents. Land management designations or management plans on private lands may be addressed through perpetual conservation agreements with willing landowners.

2. Acquire and protect all currently known occupied habitat of the Kanab ambersnail.

The ecosystems supporting the Kanab ambersnail are extremely localized and subject to deleterious alteration. This extremely restricted distribution makes protection of all remaining habitat of the Kanab ambersnail necessary. The largest remaining habitat area for the species is located at Three Lakes Canyon, which is within the area currently proposed as critical habitat (U.S. Fish and Wildlife Service 1991). The Nature Conservancy (Johnson 1991; and Chris Montague, The Nature Conservancy, pers. comm. 1992) has identified Three Lakes as an important area for natural ecosystem conservation on the Colorado Plateau.

Desert wetland habitats are extremely fragile and intolerant to perturbation. The effects of disturbance are likely to last for many years and altered environments are quickly occupied by nonnative plants and animals. Disturbance also initiates influences that further degrade habitat, such as changes in drainage patterns, soil compaction, and water availability. These factors combine to require special management of the proposed critical habitat area.

2.1 Acquire habitat on private lands. Three Lakes is currently under private ownership. This parcel should be purchased to avoid conflicts with potential development which may cause modification of the proposed critical habitat and adversely affect the conservation of the Kanab ambersnail. The proposed critical habitat area occupied by the Kanab ambersnail and its constituent habitat elements includes approximately 10 acres. Private lands will only be acquired from willing sellers.

2.2 Protect subsurface waters, and acquire and protect surface waters. Certified rights to ground and surface waters necessary to maintain the Three Lakes wetland ecosystem need to be acquired to ensure the continued viability of the Kanab ambersnail population and its proposed critical habitat. Acquisition will only take place if the owners are willing sellers.

2.3 Establish National Wildlife Refuge at Three Lakes. If Three Lakes is acquired, inclusion of this proposed critical habitat area within the National Wildlife Refuge system would enable the positive proactive management necessary to ensure the long-term survival of this Kanab ambersnail population and its ecosystem.

3. Inventory all suitable habitat for the Kanab ambersnail.

Through an inventory of all suitable habitat, additional populations may be located and essential habitat identified.

3.1 Identify, delineate, and estimate size of existing populations. Inventories will define the areas occupied by Kanab ambersnail populations. An initial total population size estimate will be made for each population. This information will provide a biological baseline necessary for determining population trends and indications of any obscure factors affecting its population. These surveys will include age class distribution, documentation of losses, and population trends. Impacts of recreation and livestock trampling, predation, disease, parasitism, etc. on each Kanab ambersnail populations will be identified. A detailed species study and monitoring plan will be developed jointly by the Service, State wildlife management agencies, and Federal land managing agencies. The field implementation of the study and monitoring plan will be the responsibility of the affected land managing agencies with technical assistance from the Service.

Survey of the Kanab Canyon population will be the Service's first priority. If the population is extant the Service will advise and work with the private landowner to protect and enhance this population. If that population has been extirpated the Service will consider the habitat site as the highest priority for the reintroduction of a viable Kanab ambersnail population. The private landowners have requested that the Service reestablish this population.

3.2 Identify and survey potential habitat. Potential habitat in spring and seep fed wetlands near the current range of the Kanab ambersnail will be surveyed for suitable habitat. It is possible that additional Kanab ambersnail populations exist and may be found. Unoccupied potential habitat may have harbored populations of the species in the past and should be considered as reintroduction sites, if necessary. Additional discovered or introduced populations of the Kanab ambersnail will increase its abundance and could contribute to maintaining the species overall viability in the event of a catastrophic loss of one or more of the existing populations.

3.3 Develop detailed topographic and vegetation maps of the species habitat. Detailed maps of the species habitat will facilitate precise management and study of the Kanab ambersnail. This task will be accomplished using high resolution aerial and ground photography,

space and ground based geographic positioning systems, and traditional survey techniques.

3.31 Develop habitat maps of Three Lakes Population. Mapping the Three Lakes population will be the responsibility of the Service.

3.32 Develop habitat maps of Vasey's Paradise Population. Mapping the Vasey's Paradise population will be the responsibility of the National Park Service and the Bureau of Reclamation.

3.33 Develop habitat maps of potential reintroduction sites. Once potential reintroduction sites are identified, they will be mapped as discussed in Task 3.31 and 3.32.

4. Determine the biological and ecological factors which control the distribution and vitality of Kanab ambersnail populations and the interaction of the significant biotic and abiotic elements of the Kanab ambersnail and its habitat.

Recovery of the Kanab ambersnail will depend upon knowledge of the ways habitat perturbations affect the species. Understanding the relationship between its ecological requirements is prerequisite to its recovery. In depth research of the biology and ecology of the Kanab ambersnail will assist in the determination of the factors controlling the distribution and vitality of Kanab ambersnail populations and provide direction in the management of its population and habitat.

4.1 Determine phenology, behavior, and life history. The Kanab ambersnail is poorly known to science. Current assumptions concerning its life history are extrapolations from similar species within the family Succineidae. Phenological, behavioral, and life history information is critical in determining the site specific management needs of each of its populations.

4.2 Determine annual and long-term population variation and movement. Population studies will document demographic stability of Kanab ambersnail populations. If, as a consequence of these studies, other factors, natural or human-caused, are identified as having potential detrimental effects on the species population, those factors will be addressed and this recovery plan will be revised to accommodate them. Little is known concerning natural threats such as disease, parasitism, and predation by native species on the Kanab ambersnail. No known diseases have been reported in this species. Moderate to heavy domestic livestock grazing may have an impact to the Kanab ambersnail by reducing the vegetative cover necessary to protect the species from excessive predation and direct mortality from trampling. The American robin has been observed as a regular predator on the Three Lakes population in Utah (Clarke 1991). It is not known if the

populations of Kanab ambersnail are at population levels that will assure long-term demographic and genetic viability.

4.21 Establish a population study on the Three Lakes Canyon population. Population monitoring sites will be established strategically within the Three Lakes Canyon population. The total variation of habitat types and degree of habitat use will be represented in the monitoring sites.

4.22 Establish a population study on the Kanab Canyon population. A population study will be established in the Kanab Canyon population of the Kanab ambersnail. There is a possibility that this small population, if still extant, may not be at demographically stable levels to ensure long-term survival.

4.23 Establish a population study on the Vasey's Paradise population. Population monitoring sites will be established strategically within the Vasey's Paradise population. The total variation of habitat types and degree of habitat use will be represented in the monitoring sites.

4.24 Determine viable population parameters. Population studies will be established to determine population numbers, age-class distribution of the populations, spacial distributions of each of the populations, and the periodic variation of both numbers and spacial distributions of each of the populations.

4.3 Determine Kanab ambersnail density in relation to lower, middle, and upper Colorado River riparian zones at Vasey's paradise. This information is critical for the effective management and protection of the Kanab ambersnail in relation to variations in the regulated flow of the Colorado River below Glen Canyon Dam.

4.4 Determine the species synecological relationships. Knowledge is needed concerning the species ecological interaction with its environment. Studies will include Kanab ambersnail dietary studies, predator interactions, and other biotic and abiotic factors affecting the viability of the species populations.

4.5 Determine the species genetic relationships. A determination of the genetic variability for O. h. kanabensis populations in Arizona and Utah and O. h. haydeni populations in western North America is needed to determine uniqueness of the population and infra-specific relationships of the species. This information is critical in evaluating the species various populations for potential reintroductions into unoccupied suitable habitats. Cytological and biochemical investigations with traditional anatomical and morphological investigations may demonstrate the need for a nomenclatural re-evaluation of the O. haydeni complex.

5. **Establish a captive breeding population.**

The feasibility of establishing ex situ populations of the Kanab ambersnail should be investigated, including the development of reintroduction protocol. These populations could be located at academic research facilities or zoological gardens. Individuals from both extant populations should be involved, with care given to maintain the probable genetic variation of the two populations. If the extirpation of one of the existing Kanab ambersnail populations appears imminent, or if catastrophe causes an extirpation, then reintroduction into suitable habitat should be expedited.

6. **Promote and encourage improved communication and information dissemination.**

Communications between citizens, the scientific community, and government; the sharing of information; and the education of the public about the goals, methods, and benefits of the recovery program are essential for achieving the objectives of this recovery plan.

6.1 Develop and distribute printed educational material. Develop pamphlets depicting the biology and ecology of the Kanab ambersnail and recovery efforts in its behalf.

6.2 Develop and distribute audio-visual documentary. Develop an audio-visual documentary program depicting the wetland environments of the Colorado River and Plateau with emphasis on special status species including the Kanab ambersnail. This program would be directed towards local residents of the region and to tourists and recreationists visiting National Parks and other public lands on the Colorado Plateau. This program would also be available to schools and other public and private groups.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and costs for the recovery program. It is a guide for meeting the objectives elaborated under the Recovery section of this plan. This schedule indicates task priorities, task numbers, task description, duration of tasks ("ongoing" denotes a task that once begun should continue on an annual basis), the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should allow the Kanab ambersnail to be downlisted to threatened.

Priorities in column one of the following implementation schedule are assigned as follows:

1. Priority 1--An Action that must be taken to prevent extinction of, or to prevent the species from declining irreversibly in the foreseeable future.

2. 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.

3. Priority 3--All other actions necessary to meet the recovery objective.

Key to Acronyms used in Implementation schedule

BLM -	Bureau of Land Management
BR -	Bureau of Reclamation
FWS -	Fish and Wildlife Service
	ES - Ecological Services
	LE - Law Enforcement
	RW - Refuges and Wildlife
NPS -	National Park Service
AZ -	Arizona Game and Fish Department
UT -	Utah Division Wildlife Resources
NN -	Navaho Nation
TNC -	The Nature Conservancy

Kanab ambersnail (*Oxyloma haydeni kanabensis*) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible party			Cost			Comments
				FWS		Other				
				Region	Program		FY-01	FY-02	FY-03	
1	1.1	Ensure human-caused activities do not impact Kanab ambersnail on Federal lands	ongoing	2,6	ES, LE, RW	BLM, BR, NPS				Part of ongoing agency program
1	1.2	Assist willing land owners to manage occupied habitat of the Kanab ambersnail	ongoing	2,6	ES, LE	AZ, UT, NN, TNC				Funding for landowners to accomplish specific activities cannot be determined until the activities are identified
1	1.3	Monitor populations of the Kanab ambersnail for current and potential threats	ongoing	2,6	ES, LE, RW	BLM, BR, NPS, AZ, UT	5,000	5,000	5,000	
1	4.1	Determine phenology, behavior, and life history	5 year	2,6	ES	BR, NPS, AZ, UT	15,000	15,000	15,000	
1	4.3	Determine Kanab ambersnail density in relation to lower, middle, and upper Colorado River riparian zones at Vasey's Paradise	2 year	2	ES	BR, NPS, AZ	5,000	5,000		
1	4.4	Determine the species synecological relationships	3 year	2,6	ES	BR, NPS, AZ, UT	15,000	15,000	15,000	
1	4.5	Determine the species genetic relationships	2 year	2,6	ES	AZ, UT	15,000	15,000		
1	5	Establish a captive breeding population	ongoing	2,6	ES	AZ, UT	10,000	10,000	5,000	
2	1.4	Establish formal land management designations and/or implement land management plans for all Kanab ambersnail populations	1 year	2,6	ES, RW	NPS, BLM, AZ, UT, NN				To be determined
2	2.1	Acquire habitat on private lands	3 years	6	ES, RW	TNC	5,000	5,000	150,000	
2	2.2	Protect subsurface waters and acquire and protect surface waters	ongoing	6	RW	TNC	5,000	1,000	1,000	
2	2.3	Establish a National Wildlife Refuge at Three Lakes	ongoing	6	RW		10,000	10,000	20,000	
2	3.1	Identify, delineate, and estimate size of existing populations	3 years	2,6	ES	BR, NPS, AZ, UT	5,000	5,000	5,000	

2	3.2	Identify and survey potential habitat	3 years	2.6	ES	BLM, NPS, AZ, UT, NN	20,000	20,000	20,000	
2	3.31	Develop habitat maps of Three Lakes	2 years	6	ES	UT	5,000	5,000		
2	3.32	Develop habitat maps of Vasey's Paradise	2 years	2	ES	BR, NPS, AZ	25,000	10,000		
2	3.33	Develop habitat maps of potential reintroduction sites	2 years	2,6	ES	BLM, NPS, AZ, UT, NN		5,000	5,000	If identified
2	4.21	Establish a population study at Three Lakes	10 years	6	ES, RW	UT	5,000	5,000	5,000	
2	4.22	Establish a population study at Kanab Canyon	10 years	6	ES	UT	2,000	2,000	2,000	If population still extant
2	4.23	Establish a population study at Vasey's Paradise	10 years	2	ES	BR, NPS, AZ	7,000	7,000	7,000	
2	4.24	Determine viable population parameters	10 years	2,6	ES, RW	BR, NPS, AZ, UT	10,000	10,000	10,000	
3	6.1	Develop and distribute printed educational material	ongoing	2,6	ES, RW	BLM, BR, NPS, AZ, UT, NN	5,000	5,000	1,000	
3	6.2	Develop and distribute audio visual documentary	ongoing	2,6	ES, RW	BLM, BR, NPS, AZ, UT, NN	10,000	10,000	1,000	

This recovery plan was made available to the public for comment as required by the 1988 amendments to the Endangered Species Act of 1973. The public comment period was announced in the Federal Register (59 FR 49710) on September 29, 1994, and closed on November 28, 1994.

During the public comment period, comment were received from 14 individuals. The comments provided in these letters have been considered and incorporated as appropriate. Comments addressing recovery tasks that are the responsibility of an agency other than the Fish and Wildlife Service have been sent to that agency as required by the 1988 amendments to the Endangered Species Act.