

Iowa Pleistocene Snail
(*Discus macclintocki*)



about four times natural size

Illustration by U.S. Fish and Wildlife Service

http://www.fws.gov/midwest/endangered/Shell/ips_fet.html

5-Year Review:
Summary and Evaluation
2013

U.S. Fish and Wildlife Service
Midwest Region
Rock Island, Illinois Ecological Services Field Office

5-YEAR REVIEW
Iowa Pleistocene snail (*Discus macclintocki*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office

Carlita Payne, Recovery Coordinator, Midwest Region (612-713-5339)

Lead Field Office

Mike Coffey, Rock Island, Illinois Ecological Services Field Office (309-757-5800)

Cooperating Field Office

Lisa Maas, Driftless Area National Wildlife Refuge, Iowa (563-873-3423)

1.2. Methodology used to complete the review

The U.S. Fish and Wildlife Service (Service) solicited information from the public through a Federal Register notice (75 FR 55820) requesting new information on the Iowa Pleistocene snail (*Discus macclintocki*) that may have a bearing on its classification as endangered. No comments were received during the public comment period or since the open review period.

The review of new information and this evaluation was completed by Mike Coffey, biologist at the Rock Island, Illinois Ecological Services Field Office. The new information was from scientific journal articles; unpublished field observations by Service, State, and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. The Service also sought peer review from experts familiar with the species, its habitat, and geology of the algific talus slopes in the Midwest Driftless Area (Appendix A).

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review

Federal Register, Volume 75, Number 177, Tuesday September 14, 2010, pages 55820 to 55823.

1.3.2 Listing history

Original Listing: Final Determination that Seven Eastern U.S. Land Snails are Endangered or Threatened Species; July 3, 1978; 43 FR 28930. Date Listed: August 2, 1978

Entity listed: Iowa Pleistocene snail; species

Species Classification: Endangered

1.3.3 Associated rulemakings

Not applicable.

1.3.4 Review history

The Iowa Pleistocene snail was included in a cursory five-year review of all species listed in 1978 (December 8, 1983; 48 FR 55100), a cursory review of all species listed before January 1, 1991 (November 6, 1991; 56 FR 56882), and the Iowa Pleistocene snail 5-Year Review and Evaluation dated August 2009. These 5-year reviews resulted in no change to the listing classification of endangered.

1.3.5 Species' Recovery Priority Number at start of review

Recovery Priority number 8: Degree of threat considered low at the species level with low to moderate recovery potential.

1.3.6 Recovery Plan

Name of plan: National Recovery Plan for Iowa Pleistocene snail (*Discus macclintocki*).

Date issued: March 22, 1984

Dates of previous revisions: Not applicable

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?

No. The species is an invertebrate that is listed in its entire range; therefore, the DPS policy is not applicable to this listing.

2.2 Recovery Criteria

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

Yes. The species recovery plan was approved in 1984 and it contains measurable criteria to reclassify the Iowa Pleistocene snail from endangered to threatened and to delist the species. The recovery criteria contain terms that are not defined in the recovery plan. See below for more details on the terms that need clarification.

It is recommended that you read through the synthesis first (Section 2.4), because it will provide the background information on the unique algific talus slopes ecosystem in the Midwest Driftless Area that is mentioned many times in the 5-year review.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

No. There are aspects or assumptions for the recovery objectives and criteria that are in need of clarification. The terms “colony”, “viable population”, and “stringently protected” or “permanently protected” used in the recovery plan remain undefined.

Colony

The ecological term “colony” in the recovery plan is used both to represent the population on an algific talus slope and for some slopes it refers to the multiple locations (or “colonies”) where the Iowa Pleistocene snail has been found in the past. The ecological term “viable population” in the recovery plan is quantified as at least 500 individuals or as a population that is not decreasing. The term “stringently protected” is used both to describe protection that permanently restricts activities on the algific talus slope and in upland buffer areas adjacent to the slope.

We will refrain from using the term “colony” after Section 2.2.3 recovery criteria description paragraph, to avoid confusion, because the recovery plan lists multiple colonies for some algific talus slopes that may not be biologically distinct subpopulations. A new genetics study will start in 2013 to help determine whether there are separate colonies on some algific talus slopes (see Section 2.3.1.3).

The number of known locations for the Iowa Pleistocene snail has remained at 38 sites since the completion of the 2009 5-year review (the number increased from 19 sites identified in the 1984 recovery plan). There are some algific talus slopes that have multiple locations or sites where the Iowa Pleistocene snail has been found in the past by sampling the leaf litter. These 38 known sites for the Iowa Pleistocene snail are actually on 31 geographically isolated algific talus slopes (Appendix B). A more careful spatial and geophysical analysis is needed to determine the exact number of geographically distinct algific talus slopes that are occupied by the Iowa Pleistocene snail.

Viable Population

There are not any prescribed methods in the recovery plan to determine whether the population status is viable, stable, or increasing. We are currently developing new methods that are minimally destructive of the fragile habitat to monitor the population status by verifying the presence or absence of the species over time on the accessible reaches for the occupied algific slopes (see Priority Recommendation Number Two in Section 4.0).

Stringently or Permanently Protected

The terms “stringent protection” and “permanent protection” used in the recovery plan remain undefined as they relate to both the algific talus slopes and to the upland buffer areas. It is interpreted that these terms were meant to convey the need to control the access and restrict land use that can lead to habitat degradation (e.g., timber clearing, roads, quarrying) and provide protection of the upland sinkhole areas. Recovery action 1.2 in the recovery plan is to determine the requirements for upland buffers. This recovery action was apparently based on the concern for pesticide contamination and air circulation problems (e.g., filling) at sinkholes in the uplands. These concerns may not be critical for survival of the species based on the results of this review as outlined in the next paragraph below. Buffers are very important features to preserve the integrity of conservation core areas like the algific talus slopes, help achieve resource management objectives, and to bring the slope boundary out to accessible ground, but may not be a priority for survival of the species. See Shafer (1999) and Henry et al. (1999) for more on the use and functions of conservation buffer lands.

Pesticide or other chemical contamination from agricultural crop fields into the upland sinkholes is not a direct or indirect threat to the Iowa Pleistocene snail. The chemical contamination from surface run-off into the sinkholes and eventual transport to groundwater springs and seeps at the base of some slopes does not come in contact with the Iowa Pleistocene snails on the algific talus slopes, because their habitat is around cold air vents and not around groundwater springs or seeps (USFWS 1984). The Iowa Pleistocene snail is not dependent on groundwater, springs, or seeps for moisture. Pesticide drift from crop fields over algific talus slopes is a concern. See Section 2.3.2.1 for more details on threats related to pesticides and other contaminants.

Geologists do not believe that there is the absolute need for a connection between the cold air vents on the algific talus slopes and the upland sinkholes to produce cold microclimates on the slopes. Algific talus slopes in Appalachia circulate cold air solely within the talus and underlying voids without any connection to solutional bedrock sinkhole and cavern systems (Andrews 2003).

There are no prescribed methods to determine whether the upland buffer area is critical for preserving the cold air circulation patterns of the down gradient algific talus slope. The profile of an algific slope may be divided into three zones. The lower zone includes the base or toe of the slope with thicker deposits of soil and less exposed talus. The mid-sections of the slope have thin deposits of soil, older talus - some of which with exposed outcrops, and lichen and bryophyte cover. In general, it is the lower and mid zones of the slope that are the sections that support the Iowa Pleistocene snails. The upper reach of the slope has minimal to no soil deposits, young talus, minimal bryophyte cover, and a steep eroding limestone face against the uplands. The uplands above the eroding limestone may have sinkholes.

It is recognized that there is the potential for the talus vents and voids in the mechanical karst on the slope to be connected to the caverns and sinkholes in the solutional karst underlying the uplands, but that it may not be a requirement to produce the cold air on the slopes (USFWS 2012). There may also be mechanical sinkholes on the upper reach amongst the fresh talus

eroding off of the limestone face against the uplands. See Section 2.3.1.6 below for more details on cold air circulation patterns.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information

The Iowa Pleistocene snail can be considered for reclassification from endangered to threatened status if permanent protection of 16 of the existing colonies [locations] can be achieved and documentation [of] and stable or increasing populations at these sites can be provided by a monitoring program. Delisting of the species can be considered if documentation of stringent protection for at least 24 or more sufficiently dispersed viable breeding colonies [populations] is obtainable.

Protection of Supporting Habitats

Protection of 16 of the existing locations supporting habitat has been met. There are 38 known Iowa Pleistocene snail locations on 31 geographically isolated algific talus slopes in Iowa and Illinois (USFWS 2009) (Appendix B). There may be a 39th location (Frest #81-124) in Clayton County, but searches completed during the early 2000s by Cathy Henry former manager at the Driftless Area National Wildlife Refuge, did not locate the algific talus slope even though it was described by an investigator during the 1980s. There may be a mapping error in the original notes.

Fifteen of the 31 geographically discrete algific talus slopes are within government or non-government conservation organization (e.g., The Nature Conservancy) properties with the remaining 16 on privately-owned properties. Three of the 16 algific talus slopes within privately-owned properties have restrictive conservation easements held by the State of Iowa. One more algific talus slope of the 16 within the privately-owned properties is listed as an Illinois Natural Heritage Landmark with a voluntary conservation agreement (<http://www.dnr.state.il.us/conservation/naturalheritage/inhd.htm>). The Landmark agreement is voluntary and is not considered as protected for this review.

There are 18 geographically discrete occupied algific talus slopes out of the total 31 that are permanently protected by either being within public lands or private lands with easement restrictions (USFWS 2009) (Appendix B). The first recovery criterion for reclassification (16 protected algific talus slopes) is achieved with the 18 occupied algific talus slopes under permanent protection strategies.

Some of these 18 protected algific talus slopes also have upland buffer areas above the algific talus slopes, based on the review of property boundary maps by the author for this review. The recovery plan suggests that an upland buffer area above the algific talus slope is needed to be considered permanently and strictly protected. The upland buffer area was required, because it was once thought that protection of the upland sinkholes was needed to prohibit chemical contamination and filling of the sinkholes with debris or soil. As explained in Section 2.2.2.1, there is not a pathway between the upland karst solutional sinkholes and the talus vents that support the Iowa Pleistocene snail. A site inspection is needed at each of the 18 occupied algific

talus slopes and upland areas by a team of qualified biologists, geologists, and meteorologists to determine the site specific needs if any (indicating whether the need is critical or recommended, and size of the buffer area, when appropriate) for the upland buffer.

It is recognized that buffers around conservation preserve and reserve areas are an important feature for the protection of sensitive habitats and species biodiversity and should be pursued using available tools including land acquisition and conservation efforts on private lands (Soule and Simberloff 1986). The Comprehensive Conservation Plan for the Driftless Area National Wildlife Refuge outlines interest in conservation buffers for the purposes of a safe zone around the fragile algific talus slopes and to allow recreational activities on public lands outside of the slope habitat (USFWS 2006).

Stable or Increasing Populations

The Iowa Pleistocene snail's population status is not fully known and documented, and therefore, this criterion is not met. The information in the Iowa Pleistocene Snail Recovery Data Call Trends Status AdHoc Report (USFWS 2013) indicates that the overall population status is stable. This status is mostly based on a mark and recapture survey by Clark and others (2008) and that no known acute threats beyond global climate change exist at the protected occupied algific talus slopes. We have not been able to make an informed decision of whether the populations on the various occupied algific talus slopes are actually stable or increasing for this criterion, because many of the algific talus slopes have not been surveyed. Past surveys and estimates show that some occupied algific talus slopes had very high numbers of individual snails and some other slopes had low abundance (USFWS 1984; Anderson 2000; Clark et al. 2008; USFWS 2009). The population growth rate of Iowa Pleistocene snails on some occupied algific talus slopes was more stable while there were other slopes with annual fluctuations in abundance that made it uncertain as to whether they were stable (Clark et al. 2008). An alternative method is under development that is rapid, inexpensive, and less intensive compared to mark and recapture surveys (see Priority Recommendation Number Two in Section 4.0). The alternative survey method may be used during the interim periods between the 5-year reviews. The survey results may be used to detect the loss of populations on the algific talus slopes within the species range.

Sufficiently Dispersed Protected Habitats

The delisting criterion is almost met with the current distribution of protected occupied algific talus slopes being dispersed around the species range, but as mentioned above, the viability of these populations is not known. The entire species range is within six counties of Iowa (Clayton, Clinton, Fayette, Delaware, Dubuque and Jackson) and one county in Illinois (western Jo Daviess). The known distribution of the species consists largely of the algific talus slopes along stream valleys through major limestone escarpments of the region, based on the comparison by the author of the species distribution map with the surface geology map and hydrology maps. The east to west boundary of the species range includes the width of the Galena Limestone Escarpment and Silurian Limestone Escarpment of Iowa and in Illinois.

The geographic distribution of the 18 protected occupied algific slopes covers the east to west and nearly the north to south geographic range of the species. The only part of the species range

that does not include any protected occupied algific talus slopes is in the far south section in Clinton County, Iowa and southeastern section in Jo Daviess County, Illinois) (Appendix B). It may be important, if not critical, to protect the occupied algific talus slopes in the southern and southeastern part of the species range and their genetic diversity to meet the standard of sufficiently dispersed.

There is one known occupied algific talus slope at the southern edge of the species range (northern Clinton County, Iowa). This slope is on private land without an easement or agreement (Appendix B). There is one known occupied slope at the southeastern edge of the species range (western Jo Daviess County, Illinois). This slope is on private land and enrolled into the Natural Heritage Landmark program that is not restrictive (Appendix B).

These south and southeastern slopes are within the current acquisition boundary of the Driftless Area National Wildlife Refuge (USFWS 2006). There are also alternatives to fee title acquisition of the unprotected occupied algific talus slopes. Ultimately, we are interested in limiting the impacts of certain land uses that degrade the habitat, such as timber clearing, filling, or quarrying. There are a variety of conservation tools (e.g., easements, incentives, and other agreements) for privately-owned lands with endangered species that may be of use for protecting the south and southeastern occupied algific talus slopes if fee title acquisition is not an option (Doremus 2003).

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

No changes. The Iowa Pleistocene snail has a small flattened shell up to eight millimeters in diameter (USFWS 1984). This land snail species requires cold moist conditions during the summer and not extreme cold winters based on their latitudinal distribution. They feed mostly on decaying birch and maple leaves in the forest floor litter. The species matures during its third year and lays clutches of up to six eggs multiple times per year under logs or bark or just into the soil. The average life expectancy is less than several years (Clark et al. 2008). They are hermaphroditic and they may be able to self-fertilize (Ross 1999; Clark et al. 2008). The species aestivates at warm temperatures and hibernates for short periods during the winter. Recruitment was more important than survival for population growth on slopes with low abundance (Clark et al. 2008). Their predators include the short-tailed shrew (*Blarina brevicauda*) and predatory beetles.

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

No changes. Past surveys suggest that snail abundance on the various occupied slopes ranges from 50 up to 205,000 individuals per colony or slope (USFWS 1984; Ostlie 1992; Wallendorf and Clark 1992; Anderson 2000; Clark et al. 2008). Some slopes support many more snails than

others. This may be due to the scale of the algific slope, slope habitat quality (e.g., geographic aspect, flora, predators), habitat heterogeneity, and/or temperature regime. There have not been surveys on all of the algific talus slopes and there was high spatial and temporal variation within the population on some algific slopes making it challenging to classify the whole population as decreasing, stable, or increasing. There is the need to balance data collection with the impacts of trampling on the sensitive slope habitat. Human foot traffic dislodges the loose thin soil layer and impacts the fragile bryophyte cover on the rocks.

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

No changes. Ross (1999) found that the snail populations tested had high genetic diversity that segregated into demes associated with watersheds for the algific talus slopes. A new genetic investigation will start in 2013 to determine the relationship between the locations on an algific talus slope and between slopes. This investigation is being funded out of an Endangered Species Act Section 6 grant to Dr. Kevin Roe at the Iowa State University.

2.3.1.4 Taxonomic classification or changes in nomenclature

No changes. The genus is in the family Discidae, order Stylommatophora, class Gastropoda, and phylum Mollusca (Frest 2004).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.)

No changes. One can only speculate at this time about the dispersal mechanisms for the Iowa Pleistocene snail during interglacial periods while in the climate refugia within the modern fragmented landscape. Individual snails may be washed or carried in the wind into down gradient locations from storms. Animals may carry snails either in their grasp or inadvertently on their body to cover greater distances. Birds, as carriers, are viewed as a dispersal mechanisms for the island biogeography of land snails (Vaguolgyi 1975). Wada et al. (2012) found that snails can pass through the guts of birds alive. Shrews also capture and cache live land snails in borrows for reserved food resources (Ingram 1942). It is possible for individuals from one location to be held in a shrew cache near another location, only to escape and immigrate into the new population.

There have not been any recent explorations to inventory more algific talus slopes to determine whether they are occupied by the Iowa Pleistocene snail. The search for more Iowa Pleistocene snail locations is an identified recovery action in the recovery plan.

There have not been any attempts to culture the land snail for introducing the species into other unoccupied, yet suitable algific talus slopes or to augment the existing slopes, although the Iowa Pleistocene snail has been cultured in the laboratory by Frest (1981). Captive propagation and release into the wild are identified recovery actions in the recovery plan.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)

Proposed changes. There is new information for the species' habitat conditions. The new information includes the mechanism for cold air circulation and the results from the temperature monitoring that was just getting started at the time of the last 5-year review.

Cold Air Circulation

A workshop was held in Moline, Illinois on January 24, 2012, on the Iowa Driftless Area and algific talus slope conservation (USFWS 2012). The invitee list for the workshop included experts in Iowa geology, karst topography, cave geology, and talus slope geology. The experts' opinions were that there was not going to be perennial ice deposits in caverns, and that air circulation at the upland solutional karst sinkholes is not connected to the air flow out of the vents on the algific talus slope (USFWS 2012). There may be persistent ice deposits deep in the talus of an algific slope that faces north. The mossy cover over the rock surface provides an insulation layer to help preserve the ice deposits on north facing algific talus slopes later into the summer. It was their opinion that cold air production can occur without the perennial ice deposits by the cooling of the rock surfaces. A research project on cold air circulation at an algific talus slope in West Virginia (Ice Mountain) confirmed this mechanism for an eastern algific talus slope (Andrews 2003).

This view has the potential to change the conceptual model for the summer cold air circulation as it can occur wholly within the mechanical karst of the slope face. The need for sinkhole protection was influenced by the original conceptual model that included the upland solutional karst and sinkhole pathways. It is not critical to protect the solutional karst sinkhole or upland area above the algific talus slopes if the area does not contribute to the cold air circulation of the slope (USFWS 2012).

Temperature Monitoring

In 2002, Cathy Henry, former Driftless Area National Wildlife Refuge Manager, initiated a temperature monitoring project on eight algific slopes (USFWS 2009). The temperature monitoring methods included soil measurements and data loggers for surface measurements on the interior sides of sinkholes and cold air vents. Temperature monitoring was maintained on the Refuge units until 2011 by Tim Yager, McGregor District, and Upper Mississippi River National Wildlife Refuge Manager. Monitoring on some of the algific talus slopes had shorter duration periods.

Mike Coffey, biologist from the Rock Island, Illinois Ecological Services Field Office, has begun to analyze the temperature data available from the slopes and from various other sources for this region. The preliminary results of the temperature data analysis are summarized below. Mike Coffey and Lisa Maas, biologist for the Driftless Area National Wildlife Refuge, re-started the temperature monitoring program in 2012 by installing temperature data loggers at cold air vents on selected slopes and it continues in 2013.

The initial analysis of the temperature logger data by the author indicated that of the eight slopes, five slopes tested with slight increasing temperature trends, two slopes with a decreasing temperature trend, and one slope as having stable temperatures. The five slopes with slight increasing temperature trends included Hickory Creek, Howard Creek, Bankston, Pony Hollow, and Lytle Creek. The two slopes with decreasing temperature trends included Buck Creek and Pine Creek. The one slope with stable temperature trends was Cow Branch. The peak maximum summer temperature for all tested slopes was 62 degrees Fahrenheit. The maximum air conditioning effect (difference from ambient temperature and cold vent temperature) was 20 degrees Fahrenheit. The algific slope temperatures during the winter were up to 7 degrees Fahrenheit warmer than the ambient air. A more detailed report will be published by the Service.

Temperature records have been kept at the Dubuque, Iowa lock and dam along the Mississippi River since 1895 up to the current date (Iowa State University 2013). Dubuque is in the middle parts of the Midwest Driftless Area. A review of the annual average temperature (yearly low plus yearly high, divided by two) shows a slight increasing temperature trend with a difference of about +0.5 degrees Fahrenheit.

The summer temperature conditions at the cold air vents for the above mentioned algific talus slope locations remained within the tolerance range for the Iowa Pleistocene snail. Frest (1981) found while culturing Iowa Pleistocene snails that the snail became inactive above 70 degrees Fahrenheit (aestivation). The temperature in which the snail displayed the greatest activity, including breeding, was at 55 degrees Fahrenheit. The snails became inactive at below 40 degrees Fahrenheit (hibernation).

2.3.1.7 Other

Proposed changes. The narrative below is proposed for the recovery plan as a clarification for the use of the term “protected” supporting habitat. Currently the term “protected” is not defined in the recovery plan, but is one of the recovery criteria.

The term “protection” in the recovery plan includes qualifiers such as upland buffer areas around sinkholes, signage, fencing, easements, fee title acquisition, and permanent and stringent. The term “protected” in the 2009 5-Year Review includes qualifiers such as ownership, permanent, and buffer areas around sinkholes. The use of these terms implies the end goal of acquisition that controls access, and upland buffer areas around the sinkholes or equivalent stringent conservation easements as deed restrictions to be permanent for the reclassification and delisting criteria. As described in Section 2.3.1.6 above for cold air circulation, it is not critical that the upland solutional karst sinkholes be secure to protect the algific talus slope. The proposed change for the recovery plan is to define the term “protected” to include the mechanical karst talus slope and associated mechanical karst sinkholes. The upland solutional karst sinkholes would not necessarily need be included.

A variety of programs, some of which are new for landowners, are provided to help conserve federally listed endangered species on private lands as an alternative to acquisition or deed restrictions to help met the first recovery criterion of protecting supporting habitat. The programs include Recovery Credits and tax deductions. Non-governmental organizations and

State agencies have comparable programs. The use of these programs can assist towards the protection of existing/viable breeding locations when acquisitions of fee title or deed restriction opportunities are limited. These alternatives to acquisition may be particularly useful for the protection of upland buffer areas where private landowners may be reluctant to sell pieces of the upland properties with economic potential compared to the rocky slopes with lower economic potential.

It is possible that the algific talus slopes may be considered as more marginal property by many landowners making them more easily obtained at fair market value or for conservation agreements. The slopes may be considered marginal, because they may be too steep to farm, they lack high economically valuable natural resources, and have limited access (narrow deep stream valleys). The upland areas above the algific talus slopes may be considered as prime property, because of the potential for timber harvest, agricultural use, and scenic views for residential housing. Recovery actions should consider the exact needs and types of conservation buffers to better coordinate with private landowners given the economic incentives for growth and development (Langpap et al. 2006).

There is the need for continued relationships with the private landowners regarding protection of algific slopes on their properties and to stay in touch with potential willing participants. Private ownership of the algific talus slopes with agreements that restrict those land use activities that degrade the habitats may provide benefits beyond protection afforded in public lands. The benefits include isolation and strict no trespassing and sustained wildlife conservation (Smith 1981). The benefits also include financial profits for the landowner (Benson 2001). A balanced approach between public land and private land conservation may best help conserve biodiversity and recover the Iowa Pleistocene snail (Smith 1981).

2.3.2 Five-Factor Analysis

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

The threats outlined in the recovery plan and discussed in the 2009 5-year review still apply, with the exception of sinkhole pollution and groundwater contamination. There is not a chemical exposure pathway from the pesticide contamination to the karst topography and groundwater to the Iowa Pleistocene snail. The Iowa Pleistocene snail is not in contact with groundwater or in the water of seeps and springs, but uses the rocky slopes, leaf litter, and plant ground cover (USFWS 1984).

Pollution threats are often poorly characterized in recovery plans and it is important here to fully characterize the threat of environmental contamination (Lawler et al. 2002). The exposure pathway to the Iowa Pleistocene snail and its habitat is through application of pesticides or pesticides that drift over native habitats, or from pesticides that have volatilized and re-deposited in the rainfall (Hatfield et al. 1996). Other atmospheric pollutants such as nitrogen and mercury may also be deposited on the algific slopes due to their higher elevation and for aspects that face prevailing wind conditions.

The soil, detritus, and leaf litter may contain elevated concentrations of heavy metals given the environmental history of lead and zinc mining in the Driftless Area and heavy metals can enrich soils and accumulate in biological tissues. An ecological risk assessment may be completed to determine whether these contaminants are potential hazards. Others recognize that all potential threats should be a primary focus in recovery plans, but it is equally important to exactly characterize the real threats to the species to derive appropriate mitigation strategies such as fencing strategies (Clark et al. 2002).

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

Recreational hiking, scientific investigations, and educational programs have the potential to over utilize algific slopes resulting in trampling from human foot traffic and dislodging of the fragile bryophyte cover over the thin soil and rock surfaces.

2.3.2.3 Disease or predation

There are no data available to indicate the extent of the effects that disease and predation may have on the population.

2.3.2.4 Inadequacy of existing regulatory mechanisms

The Iowa Pleistocene snail is protected through the Endangered Species Act on public land and private land. The algific slopes within the Driftless Area National Wildlife Refuge and on some of the other public lands are closed to the public, but there is not any regular law enforcement patrolling which may affect the ability to detect impacts to the land snails.

2.3.2.5 Other natural or manmade factors affecting its continued existence

Global Climate Change

The recovery plan did not contemplate the threat of extinction from modern human induced global climate change and warming climate conditions (Thomas et al. 2004). The Iowa Pleistocene snail may be resilient to climate change (USFWS 1984). The recovery plan recognized that this glacial relict species is surviving at interglacial period refugia only to likely expand during continental glacial periods (USFWS 1984). The Iowa Pleistocene snail was widespread in the Central United States in boreal forest habitat during the Ice Age of the Pleistocene epoch (USFWS 1984). It is currently found at the climate refugia of the algific talus slopes in the Driftless Area (USFWS 1984).

Past climate trends and prediction models for Iowa indicate an annual rise in temperatures especially during the winter, increase of extreme precipitation, and increase in humidity (Iowa Climate Change Impacts Committee 2011). Ambient temperatures in Iowa may be several degrees Fahrenheit warmer by the year 2050 (Ray Wolf, National Weather Service, Davenport, Iowa, personal comm., 2013). The climate changes predicted for over the next few decades for Iowa do not necessarily change the cold microclimate conditions on the algific talus slopes that support the Iowa Pleistocene snail. The winter conditions under the climate change scenarios

may still produce sufficient quantities of ice deep in the talus through winter precipitation for circulation of cold air well into the summer months. The occupied algific talus slopes are north or northwest facing so they are more shaded from direct sunlight and solar heating to help sustain the deep ice deposits that produce the cold air. Detailed climate modeling and species vulnerability assessments are needed to help resolve uncertainties and understand the potential for impacts from global climate change.

Warming climate in the current species range of the Iowa Pleistocene snail may first make the algific talus slopes in the southern part of the species range less suitable. The evolutionary rate of dispersion for colonization into new suitable habitat (e.g., further north) may not be sufficient with modern human induced climate change in a highly fragmented landscape without intervention (Wakther et al. 2002). Stocking propagated land snails further to the north on unoccupied and otherwise suitable algific talus slopes may prove to be an important adaptation strategy or insurance policy for more severe global climate change predictions.

The cold climate species on Iowa's algific talus slopes are vulnerable to other direct and indirect effects of global climate change (Iowa Climate Change Impacts Committee 2011). The other effects include interactions among species, timing of life cycles, and shifts in the ranges of other species to the north. Many of these kinds of effects are non-reversible.

There is another example of a land snail using climate refugia in Europe with a fossil record showing widespread distribution during colder climatic conditions of the Pleistocene Epoch (Pinninger et al. 2003). Nekola (1999) suggests that the modern species assemblages in refugia are reflections of colonization history and that systems may not yet be stable even after 10,000 years for the biological refugia. More no-analog communities are predicted for future ecosystems under global climate change (Williams and Jackson 2007).

Ruhl (2008) promotes policies that focus expenditures on endangered species that have a chance of survival beyond the global climate change transition. It appears that the Iowa Pleistocene snail has a chance of survival especially if the species can be introduced at algific talus slopes found further to the north in Allamakee County, Iowa and in southeastern Minnesota as global climate change increases the temperature regime at the current latitudes.

The survival of these species on the fragile refugia of the algific talus slopes affords society an opportunity to better understand evolutionary and ecological processes (Hampe and Junpe 2011). Conservation of this glacial relict species in temperate zones also provides resource managers a unique opportunity to study and predict the effects of modern global climate change. The algific talus slope ecosystem appears to be a good candidate for a multispecies conservation planning to preserve biodiversity of climate relict and boreal disjunct species.

Invasive Species

Invasive plant species have encroached into the habitats of the Iowa Pleistocene snail (Cathy Henry, U.S. Fish and Wildlife Service, Wapello, Iowa, pers. comm., 2013). The invasive plant species include garlic mustard (*Alliaria petiolata*) and stinging nettle (*Urtica sp.*). Competition for nutrients and light by the invasive plant species over the natural climate relict plant

assemblage of bryophytes, golden saxifrage (*Chryso-splenium americana*), and Canada yew (*Taxus Canadensis*) may have yet undetermined adverse effects on the suitability of the habitat for the Iowa Pleistocene snail (C. Henry pers. comm., 2013).

2.4 Synthesis

The Iowa Pleistocene snail was listed as a federally endangered species in 1978 based on only one known location threatened by direct pesticide application for land clearing. Today there are 38 known sites where the species is found. The species has survived many interglacial warming periods during the Pleistocene Epoch and other warming or dry periods during the Holocene Epoch, so we should recognize the species resilience. The recovery of the Iowa Pleistocene snail is feasible and reasonable even considering global climate change threats.

It is a small land snail that is found on a unique talus slope ecosystem of a rocky plateau known as the Paleozoic Plateau in the Midwest. This plateau was not fully covered by the last advances of the Pleistocene continental ice sheets and deposition of soils by glaciers known as drift. Hence, the naming of the region as the Driftless Area.

The algific talus slopes are forested with an understory of bryophytes and rock surfaces. The warm air in the summer cools on the talus surfaces and sinks into the voids beneath the slope. The sinking cooler air pushes out cold air at the base of the slope through surface openings between the talus. The cold air producing (algific) talus slopes create a microclimate for snail species and plant species that were once found in front of the Pleistocene continental ice sheets in the Central United States. There are other glacial relict and boreal disjunct species found on the algific talus slopes of the Driftless Area.

The adult Iowa Pleistocene snail is seven to eight millimeters. They can live for several years. The land snails mature during the third year. The eggs are deposited in small clusters under logs, under bark, or in the soil. They aestivate at warm temperatures and hibernate at extreme cold temperatures. The land snails are preyed upon by shrews and beetles. The land snail diet is predominately birch and maple leaves on the forest floor.

The recovery criteria for the Iowa Pleistocene snail include protection of the algific talus slopes and land snail propagation for reintroduction on to other suitable algific talus slopes. The criterion for delisting the species is 24 protected locations with sufficiently dispersed viable breeding populations that are stable or increasing in size. There has been a focused effort during the past few decades to acquire slopes by County governments, The Nature Conservancy, the Iowa Department of Natural Resources, and the Service. The conservation partners were able to obtain funding to acquire a number of properties. The use of private lands conservation tools has been underutilized lately. Stocking propagated land snails further to the north on unoccupied and otherwise suitable algific talus slopes may prove to be an important adaptation strategy for global climate change.

The reclassification criteria outlined in the recovery plan have been partially met as 18 of the 31 occupied algific talus slopes are protected. This satisfies the first part of the criterion of 16 protected algific talus slopes, but the overall population status is not fully understood and not

documented by monitoring results from throughout much of the population. The endangered status of the Iowa Pleistocene snail should remain, because most of the original threats outlined in the final listing rule and recovery plan are present on the 12 algific talus slopes that are not protected. The snail continues to meet the definition of endangered throughout all of its range and therefore, no change in the classification is recommended.

3.0 RESULTS

3.1 Recommended Classification

No change is needed

3.2 New Recovery Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The completion of the recommendations below may help provide for a change in listing status.

Highest Priority Recommendations for the next 5-Year Review

Priority Recommendation Number One

Review and revise the National Iowa Pleistocene Snail Recovery Plan and include operational definitions for the terms “colony”, “protected”, and “stable” population. The review should consider the threat of global climate change and whether it is necessary to include new objectives to mitigate this threat.

Priority Recommendation Number Two

Initiate periodic, rotational snail presence - absence surveys on the accessible reaches of the protected slopes to determine population status for making recovery decisions. Some parts of the talus slopes are too fragile or steep to approach easily by foot without causing injury to the surface. Surveys on private land slopes are encouraged. Relate the number of colonies to geographical, geological, metrological, and ecological parameters. The survey methods should be based on inputs from population ecologists and geneticists.

Priority Recommendation Number Three

Support the genetics study by the Iowa State University by providing sufficient numbers of individuals for testing to help determine viable population size, subpopulation structure, and genetic diversity throughout the species range

Priority Recommendation Number Four

Inspect the occupied algific talus slopes with qualified biologists, geologists, and meteorologists to determine the need and size of upland buffer requirements to preserve the cold air circulation. Determine the potential for site specific threats such as invasive species impacts, encroachment, and human disturbance.

Create a conservation atlas of each protected occupied slope and upland area that includes air photographs, topographic maps, LiDAR images, site photographs, and site specific geology, biology, ecology, ecosystem data and information plus specific threats for mitigation and conservation planning.

Priority Recommendation Number Five

Attempt to secure protection of at least six more algific talus slopes on private lands especially in the south and southeastern portions of the species range. This will bring the current number of 18 protected algific talus slopes to the delisting criterion threshold of a total of 24 protected algific talus slopes. Develop an inventory and prioritization of landowners willing to participate in conservation programs for algific talus slope protection.

Priority Recommendation Number Six

Start an artificial propagation program at reputable hatcheries, zoos, or aquariums to augment existing populations and introduce the species into new suitable habitats. Augmentation appears to be an appropriate recovery action given that recruitment significantly contributes to the population size on low population algific talus slopes. The artificial propagation program will also serve as an educational and outreach tool to help build sentiment for the conservation of cold air talus slopes, glacial relict species, disjunct species, and biodiversity.

Other Suggestions

Suggestion Number One

Continue the temperature monitoring with the following objectives.

- a. Document the variation in seasonal air circulation patterns within the mechanical karst of a typical algific talus slope.
- b. Locate other protected slopes that are currently unoccupied that could serve as suitable locations for wild caught snail translocation or introduction of propagates from artificial propagation programs.
- c. Monitor the trend of vent air temperature changes over time.

Suggestion Number Two

Complete an ecological risk assessment for contaminant hazards in the range of the Iowa Pleistocene snail.

Suggestion Number Three

Continue to search for new colonies of the Iowa Pleistocene snail when opportunities exist. The Iowa Pleistocene snail was not found at the Wisconsin and Minnesota limestone escarpments (Frest 1983). The Iowa Pleistocene snail was found on about 10% (31 occupied slopes / 316 searched slopes) of the algific slopes on the limestone escarpments in northeastern Iowa and northwestern Illinois (USFWS unpublished data). Iowa contains about 96% of the known geologic formations that support the land snail. There may be more algific talus slopes that are less accessible in the far reaches of the occupied stream valleys that have not been searched.

Suggestion Number Four

Develop a step down Global Climate Change model for the Driftless Area and use the model and available macroclimate data to predict changes to the microclimate on the algific talus slopes.

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**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of IOWA PLEISTOCENE SNAIL**

Current Classification: E

Recommendation resulting from the 5-Year Review

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Appropriate Recovery Priority Number: 8

Review Conducted By: Michael J. Coffey (Rock Island, IL Ecological Services Field Office) in coordination with Lisa Maas (Driftless Area NWR)

APPROVAL:

Richard C. Nelson, Field Supervisor, U.S. Fish and Wildlife Service

Approve  Date 8/21/13

APPENDIX A

Summary of peer review for the 5-year review of the Iowa Pleistocene snail

A. Peer Review Method: The 5-year review was emailed to reviewers with known expertise and interest in the species, habitat management, geology, and meteorology.

B. Peer Review Charge: The following request was made of the following peer reviewers.

The purpose of a 5-year review is to summarize new information for the species, ensure that the classification of species as threatened or endangered is accurate and reflects the best available information, and to identify actions required to conserve the species.

We appreciate your interest in furthering the conservation of rare plants and animals by becoming directly involved in the review process of our Nation's threatened and endangered species. Your review and comments on the best available information will also become a part of the administrative record for this species, and you can be certain that your information, comments, and recommendations will receive serious consideration.

We hope that you view this peer review process as a worthwhile undertaking. Please give me a call if you have any questions (309-757-5800 x206). Also feel free to respond by email (michael_coffey@fws.gov) or letter, whichever is most convenient.

C. Summary of Peer Review Comments

Colonies

Despite what Clark et al. said in their paper, I think more information is needed on colony structure, if it exists at all. The data we collected showed a patchy distribution but not necessarily biologically distinct subpopulations within the sites (slopes). It remains to be seen how weakly or tightly the "colonies" within slopes are linked. As I suggested above I do not think it would be wise from a conservation perspective to preserve "colonies" as the measure of viability. I think the threats are between slopes. But if you think about the structure we know about (spatially variable on slopes, some slopes with lots some with few, slopes within watersheds linked genetically, slopes between watersheds not linked) maybe the plan should focus effort on making sure a certain number of watersheds remain viable. All these reasons suggest to me that "colonies" within slopes are more like a single population which is spatially variable, rather than functioning like a metapopulation. One could argue that this is just semantics, but I'd argue that the distinction not only has biological implications but influences how you'd organize sampling and definitely how you'd try to conserve.

Genetics

While Ross' 1999 study of mitochondrial DNA variation across ten populations of *D. macclintocki* revealed high haplotype diversity and a lack of connectivity, that study did not include samples from all known populations and used a molecular marker that can produce a pattern that is not consistent with the larger nuclear genome. In order to provide conservation

managers with the most accurate information on which to base management and listing decisions further population genetic analyses of *D. macclintocki* using more variable nuclear (e.g. microsatellites, SNPs) markers are warranted. Because these nuclear markers are co-dominant and evolve quickly, they have advantages over mitochondrial DNA in resolving population structure. Improving our understanding the population structure of *D. macclintocki* will provide information to conservation managers on gene-flow within and between populations, effective population size, sustainability and other genetic attributes of extant populations. The information obtained from this study will provide managers with the necessary population genetic data to make appropriate decisions on the listing status and future management of *D. macclintocki*. If propagation of *D. macclintocki* does occur at some future point in time, an understanding of the genetic variation of all of the various populations would be critical to the success of such a program as maintaining genetic diversity and avoidance of excessive inbreeding of snails would be important objectives for the long-term survival of the species.

D. Response to Peer Review

The use of the term “colony” was removed from the 5-year review pending completion of the genetics study.

The U.S. Fish and Wildlife Service Midwest Region has funded a genetics study that addresses the above comments. The genetics study will start in June of 2013. Support of the genetics study is acknowledged in the recommendations section.

Other comments were received from peer reviewers concerning the preliminary final version of the 5-year review that discussed occupancy modeling and monitoring of the species population. The occupancy modeling and monitoring plan details were removed from this issued 5-year review pending completion of the consultation with population ecologists and completion of the genetics study.

APPENDIX B
List of Iowa Pleistocene Snail Occupied Algific Talus Slopes

Slope Name	County, State	Site Reference No.	Ownership
Bankston	Dubuque, IA	83-207, 83-206	USFWS & County
Bear Creek	Fayette, IA	86-279	Private
Bear Creek	Fayette, IA	86-280	Private
Bear Creek	Fayette, IA	86-281	Private + easement
Bixby	Clayton, IA	80-61, 80-62, 81-115	State
Bluebell Hollow	Dubuque, IA	#2 or 85-250	Private
Bluebell Hollow	Dubuque, IA	#4	Private
Brush Creek	Fayette, IA	86-291	Private + easement
<i>Brush Creek Tributary</i>	<i>Fayette, IA</i>	<i>81-124 (unable to confirm)</i>	<i>Private</i>
Buck Creek	Clayton, IA	81-98	Nature Conservancy
Buck Creek	Clayton, IA	81-99	Nature Conservancy
Buck Creek	Clayton, IA	81-103	Private
Buck Creek	Clayton, IA	81-119	Nature Conservancy
Buck Creek	Clayton, IA	81-120	Nature Conservancy
Buck Creek	Clayton, IA	81-121	Nature Conservancy
Cow Branch	Clayton, IA	85-229	USFWS
Elk River	Clinton, IA	86-302	Private
Fern Ridge (Pony Hollow)	Clayton, IA	(N) – 80-29, 81-76	USFWS
Fern Ridge	Clayton, IA	(NE) - 81-138	USFWS
Fern Ridge (Dry Mill)	Clayton, IA	81-137	Private + easement
Hewett Creek	Clayton, IA	83-167	Private
Farmersburg (Howard Cr)	Clayton, IA	85-246	USFWS
Farmersburg (Howard Cr)	Clayton, IA	85-247	USFWS
Little Maquoketa River	Dubuque, IA	Nekola LM 1	Private
Little Maquoketa River	Dubuque, IA	Nekola LM 2	Private
Louise Hollow	Clayton, IA	85-249	Private
Lyte Creek	Jackson, IA	86-297	State
Pine Creek	Jackson, IA	85-232	County
South Cedar Creek	Clayton, IA	Nekola #2	Private
Steele's Branch	Delaware, IA	85-241	Private
White Pine Hollow	Dubuque, IA	80-33, 81-83, 83-211	State
Yonker's Bluff	Jo Davies, IL	83-213	Private
31 geographically isolated slopes		38 sites	18 protected