Site Conservation Planning for Caves and Karst Features

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Abstract

The Nature Conservancy has embarked on a major planning effort to ensure that projects designed on paper will translated into on-the-ground conservation action. Site conservation planning is a problem-solving and decision-making framework for defining site boundaries and deciding how to effectively conserve the conservation targets at a site. Site conservation planning has eight interactive components including: defining targets, identifying and engaging partners, assembling information, analyzing stresses to system, developing strategies, turning strategies into actions, determining feasibility, and measuring progress. Site conservation planning can be particularly challenging when dealing with caves and karst features. Targets may be illusive or unknown; the stresses to the systems may be difficult to define.

Several example sites are explored to demonstrate how site conservation planning can be used and is important for conserving karst sites. In some cases, protection of cave entrances may have little value in the overall conservation of the cave system. In some examples, the entire watershed the cave system is located in may be critical to the cave's conservation, in other cases only the ground directly above the cave is important. Can conservation strategies be implemented and goals realized and are actions having the intended affect? These are important questions that need to be scrutinized before just the cave entrance is purchased, gated, and considered "protected." The time put into a site conservation plan is dependent upon the complexity and importance of the site. However, even a day or two of going through this process will improve the effectiveness of your conservation actions.

Introduction

The Nature Conservancy, the largest private manager of natural reserves in the world, has embarked on a major planning effort to ensure that projects designed on paper will translated into on-the-ground conservation actions. The Nature Conservancy has termed its planning effort "Site Conservation Planning." Site conservation planning is a problem-solving and decision-making framework for defining site boundaries and deciding how to effectively conserve the conservation targets on a site (The Nature Conservancy, 1998). Familiarization with this planning technique can be helpful for managers of karst sites and can help ensure effectiveness of karst conservation actions.

Overview of Site Conservation Planning

Site Conservation Planning has seven major queries that are asked of a site to assist in organizing, analyzing, and processing information vital to management of the preserve. The seven queries include:

- What are the conservation targets and long-term goals for those targets?
- What ecological and biological attributes sustain the targets over the long term?
- What are the characteristics of the human communities at the site?
- What current and potential activities interfere with the maintenance of ecological processes that sustain the targets?

- Who are the organized groups and influential individuals at the site, what are their interests, what impacts might we have on them, and how might they help or hinder achieving site goals?
- What can we do to prevent or mitigate threatening activities, and how can we influence important stakeholders to make decisions that are favorable to the site?
- What are the areas at the site where we need to act?

Site Conservation Planning can be an important method to determine the feasibility of a project. A potential project may have a fatal conservation flaw, a bad site, or strategies or goals that are unrealistic. By going through the site conservation process, the flaws should become obvious and the feasibility of a project can be determined. Thus this planning process can identify those projects that are the most feasible, thereby saving scarce resource dollars.

In considering a Site Conservation Plan in a karst setting, perhaps the most important questions to answer are questions number one and two, which can be summarized as: what are the targets and how can these targets be sustained and managed? These can be difficult to ascertain in a cave setting, as the targets may be illusive or unknown, and the stresses to the systems may be difficult to define. Several cave examples will now be explored to examine the value of the planning process and to demonstrate the biological knowledge necessary to succeed in the planning process.

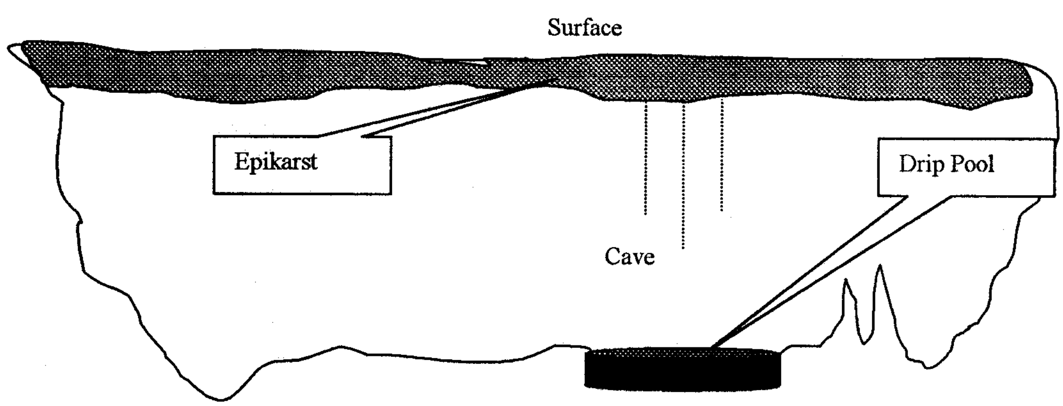
Specific Karst Examples

In examining the ecology of an area, it is often useful to describe its vegetation in terms of its community make-up, such as a beech-maple forest. The areas surrounding a cave entrance and inside a cave can also be thought of as community types Dr David Culver from American University in Washington, DC, has classified cave communities based on the way in which water and nutrients move through the cave system (Culver, 1991). Water and nutrients are the keys that sustain the unique life found in the cave, and it is important to determine how these elements enter and exit the cave.

Drip pools found in caves can be classified as one type of cave community. Often these drip pools contain endemic species. In many cases these species' true home is the epikarst found above the cave, but from time to time these species fall or "drip" from the epikarst into drip pools in the cave proper. In this example of a cave community, nutrients (and contaminants) and water move into the cave from the surface, through the epikarst.

A "threats assessment table" can then be constructed to determine: (1) what are the

Cave Drip Pool/Epikarstic Community



More Important: Protect area directly above cave, and epikarstic waters.

Less Important: Watershed or entrance to cave.

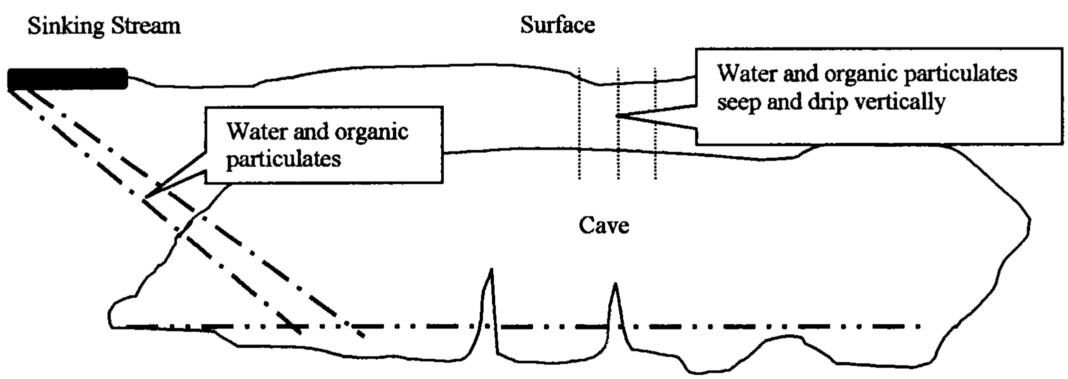
Priority System in Community: Soil column directly above cave, and drip pools in cave.

stresses to this drip pool community; and (2) what are the sources of these stresses. This table can assist in identifying actions that would need to be accomplished in order to protect the drip pool community. In the following table L = perceived Low Threat, M = perceived Medium Threat, H = perceived High Threat. Each threat level can be given a numerical value (L = 1, M = 2, H = 3), so that each stress can be averaged and prioritized.

Threats Assessment Table

	STRESS					
		Alteration of Water Flow	Alteration of Organic Matter (+ or -)	Degradation of Water Quality	Physical Destruction of Cave Habitat	
	Overall Rank					
SOURCE						
Poor Silvacultural Logging Practices		M	M	M		
Roads		H	M	M	H	
Residential Development		H	L	M		
Quarrying		M	L	L	H	
Recreational Caving			L	L	M	
Poor Agricultural Practices		L	M	M		

Cave Stream Community



More Important: Protection of watershed and area directly above cave. Requires surface and upstream protection. Delineation of subsurface karst basin needed to fully protect this cave community type.

Less Important: Entrance to cave.

Priority System in Community: Stream in cave.

In this community, the most important conservation target is the soil and surface directly above the cave. Having a good map of the cave and how it relates to the surface will be important for planning. Because the animals found in this community are transitory in nature, inventory and monitoring should be done more often than with other cave communities. Fauna distribution is very patchy in this community. Sampling of the epikarstic water should be attempted. Recreational caving such as crawling through, or stepping in, drip pools can have catastrophic effects on this community. Any change in water flow through the soil, or in water quality in the soil, will affect the drip pools. Note that large purchases of land in the cave watershed, or even controlling the entrance, may not be critical for *this particular community type.* However, if activies such as recreational caving are determined to be a major source of stress, then control of the cave entrance may be important to control access.

Another type of cave community is driven by nutrients and water coming directly from surface flow. In this cave stream community, the targets of concern may include cave fish, crayfish, salamanders, and other species dependent on the stream to bring water and nutrients into the cave.

Again, a threats assessment table can be created to organize and analyze the threats to the cave system. Information about the specific cave and its location will be important in determining the stresses and sources of these stresses, and will not be the same for every situation.

Threats Assessment Table

	STRESS					
		Alteration of Water Flow	Alteration of Organic Matter + or -	Degradation of Water Quality	Physical Destruction of Cave Habitat	
	Overall Rank					
SOURCE						
Poor Silvacultural Logging Practices		M	H	M		
Roads		H	M	M	H	
Residential Development		M	+ Septic H	M		
Quarrying		H	L	L	H	
Poor Agricultural Practices		L	H	H		

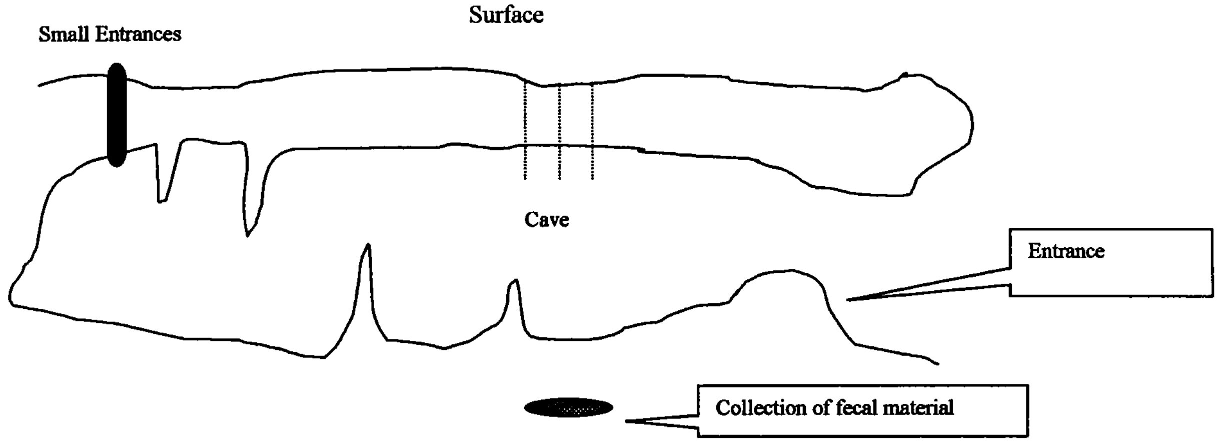
An increase in nutrients can cause an invasion of non-cave species, because cave-adapted species are usually adapted only to low nutrient levels. Logging and farming practices can cause increases in nutrients, thus allowing colonization by non-cave organisms. However, development, especially paving large areas, can cause a decrease in the nutrients reaching the cave system, which may cause the die-off of the indigenous cave organisms.

Degradation of water quality could include: decreases in dissolved oxygen; siltation; and pollution by metals, sewerage, or other industrial contaminants. This differs from alteration of organic matter within the cave. Degradation of water quality introduces toxics into the cave system.

If a cave stream community becomes a conservation priority, much more planning, analysis of the entire watershed, and money may be needed to protect the waters flowing into the cave. The actual entrance to the cave may play little or no importance to preserving the stream community.

A third example demonstrates how a cave entrance may be of importance in karst protection. In some cave systems, the major way that nutrients are introduced into the cave is by animals, such as bats, woodrats, and raccoons, or smaller species such as spiders and crickets. Their input of dung and food matter may play the major ecological role in the cave. This type of cave community, known as a transitory organic matter community, is dependent on animal imputs of nutrients.This community is quite different from those which use water flow or drip to introduce organics. In the transitory organic matter community, the cave entrance may be of critical concern.

Transitory Organic Matter Community



More Important: Protection of foraging areas around cave entrances, and entrances.

Less Important: Watershed

Priority System in Community: Animal movements through entrances which bring food inputs (fecal material and other organics) into cave.

Threats Assessment Table

	STRESS					
		Woodrat Decline	Alteration of Organic Matter (destruction of entrance area buffer forest)	Bat Decline	Physical Destruction of Cave Habitat	
	Overall Rank					
SOURCE						
Poor Silvicultural Logging Practices		M	H	M		
Roads		H	M	M	H	
Residential Development		H	L	M		
Quarrying		L	L	L	H	
Poor Cave Gate Construction		L	H	H	L	

	STRESS					
		Woodrat Decline	Alteration of Organic Matter (destruction of entrance area buffer forest)	Bat Decline	Physical Destruction of Cave Habitat	
	Overall Rank					
SOURCE						
Increased Raccoon Populations						
Poor Agricultural Practices		L	L	H		

In this community, the most important process is the flow of nutrients into the cave throught the cave entrance. Bats, woodrats, and cave crickets are three main transporters of nutrients into the cave. All three of these species need an undisturbed foraging area outside the entrance in which to feed. Woodrats and crickets are most impacted by logging or construction near the entrance. Bats are most impacted by an improperly installed bat gate.Thus, the conservation action for this cave community may include purchase of a larger buffer area around the cave entrance. Purchase of lands in the cave watershed may have little impact on this non-waterflow dependent community, unless the land is directly around the entrances.

Each of these threats tables can then be converted into a more visual model. Figure 1 displays a visual threat assessment for the Transitory Organic Matter Cave Community.

This more visual model may be of assistance in organizing how stresses and sources of stresses interact with the cave community. Once conservation threats are organized in this manner, specific actions can then be taken to alleviate the sources of stress. Success can be measured by how well the sources of stresses are eliminated.

Discussion

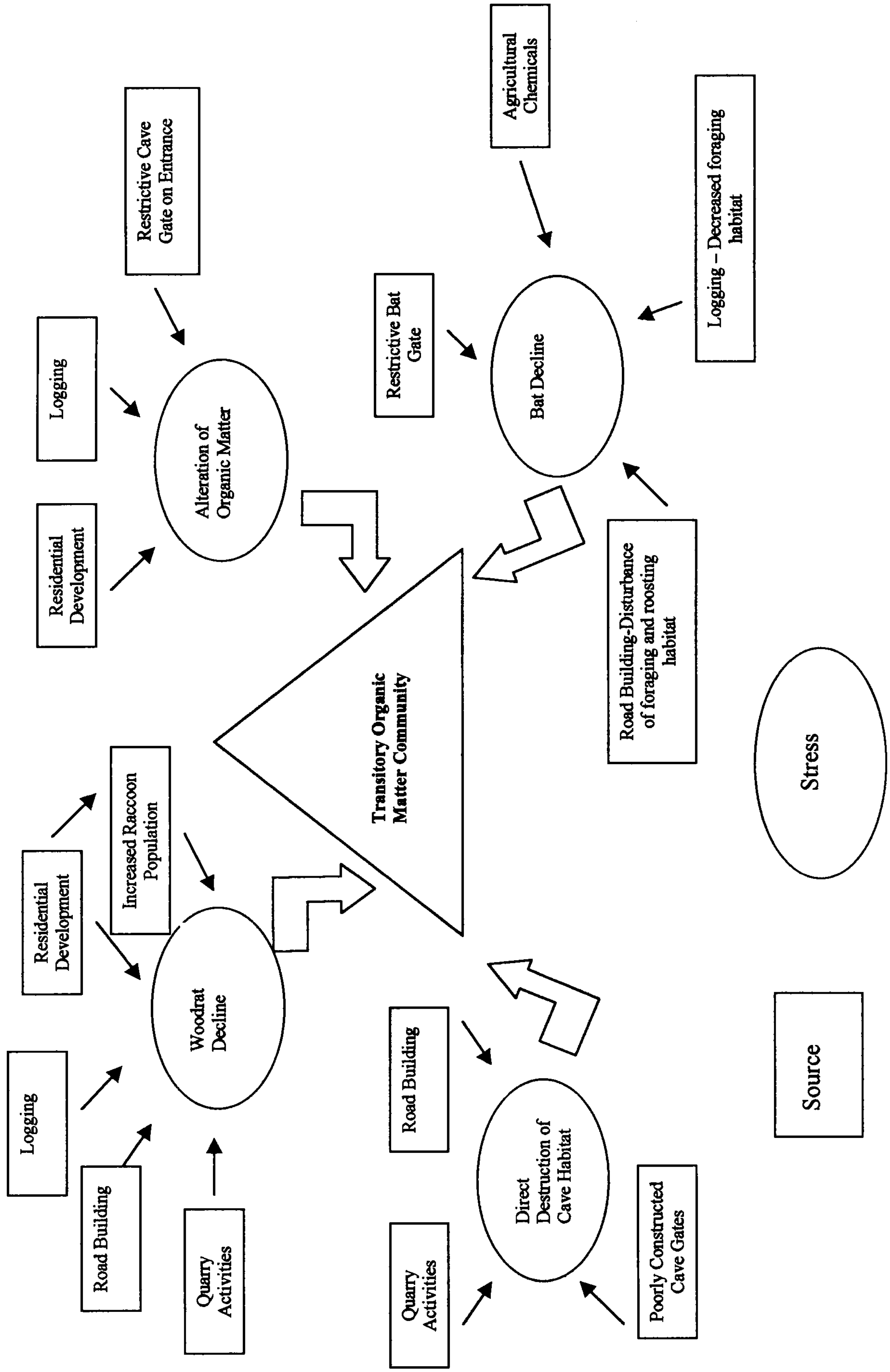
For effective cave conservation, identifying the intended targets to be protected is the first and most important step. The actions taken may be different depending on what targets are picked. Financial resources may be wasted if intended targets are not accurately identified.

In the drip pool community, the targets depend on the epikarst and soil directly above the cave. The entrance and surrounding land and watershed may play little role in the conservation of species living in the drip pool However, the area directly above the cave may be of critical importance. Logging, housing developments, and agriculture may have little impact to this cave; however, structures built over the cave or activites directly above the cave may have a major impact. Large amounts of financial resources may be spent on protecting the watershed when in fact only the land directly above the cave needs to be protected.

Other cave communities may need a much greater amount of research and/or finanical resources. A cave stream community may need dye tracing research to define the boundary of the watershed. Then a plan for protecting the watershed will need to be synthesized. This watershed protection may employ many protection tools, including outreach and education, registry, easements, and fee ownership.

Often, more than one cave community may be found within a cave. For example, organisms found in a drip pool may be protected by just protecting the area directly above a cave. A well meaning cave manager may gate the entrance of the cave to help protect the elements in the drip pool. However, there may be other communites in the cave that could be harmed by blocking the entrance. If there is a transitory organic matter community, dependent upon animals bringing organics into the cave system, blocking the entrance may have critical effects on that community. Therefore, careful identification of all communities within the cave system is of critical importance, so that actions taken to protect the community do not inadvertaintly cause harm to another.

Figure 1. Visual Threat Assessment for Transitory Organic Matter Cave Community



Summary

Site Conservation Planning can be a useful tool for planning and implementing conservation at a cave site. These are the steps that can be helpful in undertaking cave conservation:

- Identify the conservation targets in the cave system. These targets may be specific species or actual cave communities.
- When the targets are species, try to place the targets into a cave community type. Determining how water and nutrients move through the cave can be helpful in defining the cave community.
- Define the known and/or perceived threats and stresses to the cave community and its inhabitants.
- Define the sources of the stresses.
- Prioritize the degree of threat that each stress and stress source has on the community.
- Create specific action plans that will reduce the sources of the stress.
- Reassess the actions on a regular basis to determine how well the sources of stress are being reduced or eliminated.

By using these steps, cave land trusts and cave managers can more effectively plan conservation measures that will have direct positive impact on their sites, insure that money is spent judiciously, and be able to measure their success by tracking how well actions reduce sources of stress. One-solution-fits-all does not work in cave conservation, and spending time planning and researching the specific site will greatly increase the likelihood of ultimate success.

References

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