

# An Assessment of Moss Recovery in a Costa Rican Cloud Forest

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December 2007



## Summary

In a cloud forest in Costa Rica, we conducted a study of the recovery of moss following removal. We find that under shaded, moist conditions, some rock moss can recover within three years. Under less perfect conditions, however, little or no recovery occurs during the same period.

## Introduction

A descendant of early algae, mosses were among the first plants to migrate from water to land (Schofield). Mosses are integral parts of the forest and harbor a microcosm of interrelated life. Removal of moss from North and Central American forests, for sale to florists, is damaging the forest ecosystems (Tomkins). One author reports that it can take a decade or more for moss to fully recover (Kimmerer). Others dispute this, claiming full recovery within a few years. Is this true in Costa Rica? This report summarizes the results of a 3-year study of the capacity for moss to recover from deliberate removal under the favorable conditions of a montane tropical cloud forest. The study took place during 2004-2007 at Cloudbridge, a private reserve in the Talamanca mountain range of Costa Rica. Ranging in elevation from 1500m to 2750m, Cloudbridge borders the Chirripo National Park, a UNESCO World Heritage site. On 7 occasions from December 2004 to December 2007, we monitored the recovery of moss on rocks at 5 sites on the reserve. The study took place along a seldom-used forest trail in the vicinity of Casa Amanzimtoti, headquarters of Cloudbridge at an elevation of 1555 meters at approximately (9°28'N, 83°34'W). The sites were all close to the fast-running Chirripo River (Figure 1).



Figure 1. The Chirripo River

The study was motivated by a concern on the part of some conservationists that careless removal of moss could impact a forest ecosystem, and that moss does not necessarily recover as readily as the harvesters of moss claim.

### Method

The method was simple. We identified 5 easily accessible sites that represent several conditions of exposure and moisture. All had mossy covers on a vertical rock surface. All were near the Chirripo River and within about 75 meters of Casa Amanzimtoti. The first 4 sites were along the Waterfall Trail and the fifth is immediately northwest of the casa.

- We photographed and assessed the condition of the moss before removal.
- Approximately 20cmx20cm of moss was removed by hand (Ian did it -- see photo at right)
- We photographed and assessed the condition of the surface after removal of moss. We estimated the thickness of the removed section by comparing the bare patch with the surrounding moss.
- We repeated the photography and assessment periodically over a span of three years.



Figure 2. Agent of moss destruction.

At each site healthy-looking moss covered a rock surface. We photographed the site and the moss. We removed a 20cmx20cm patch of moss down to the bare rock, and re-photographed the surface. An example of the before-and-after photographs, for Site 1, is shown below in Figure 3.

Figure 3. Example of a study site before and after removal of the moss.

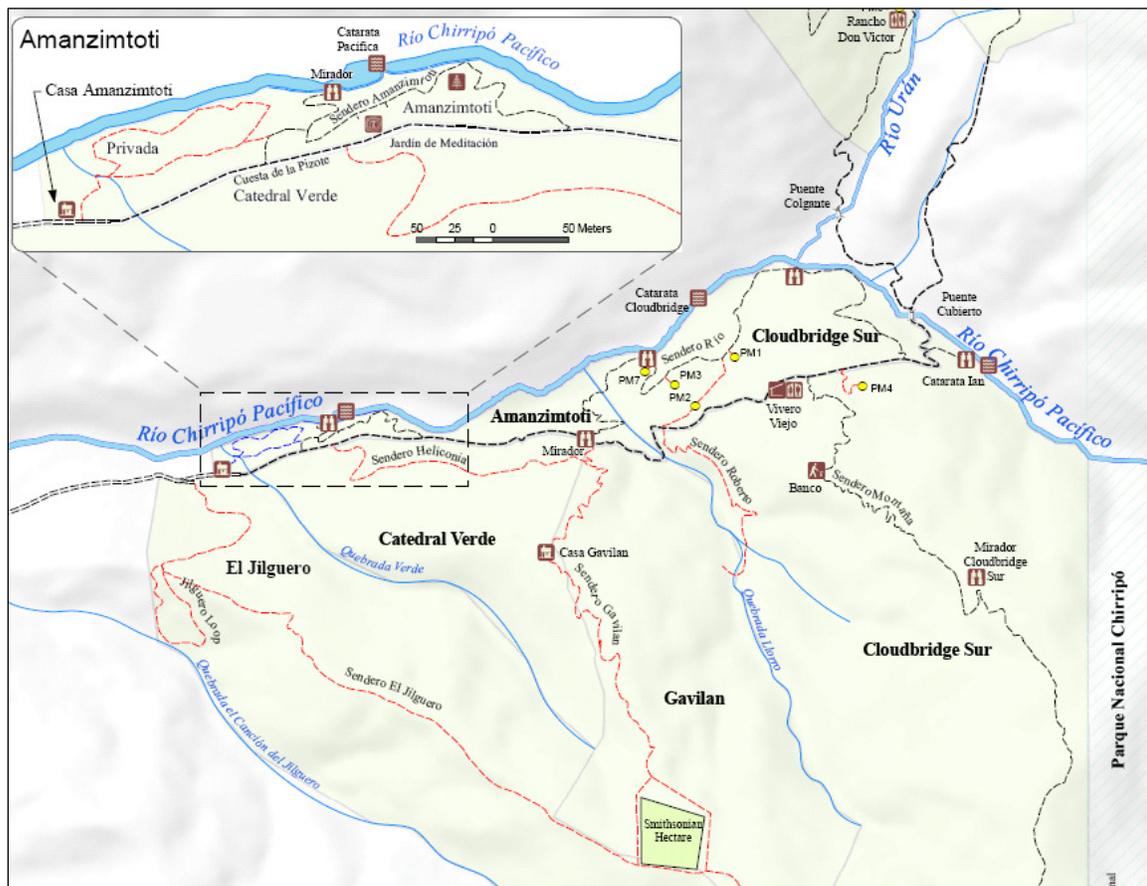


At approximately six-month intervals for the following 3 years, we photographed the sites again. In December 2007, after the last set of observations, we reviewed the chronology of photographs at each site, and assigned measures of recovery on a scale 0 to 3 where 0 is bare rock and 3 is full recovery, defined as indistinguishable from the surrounding moss.

### Sites

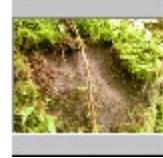
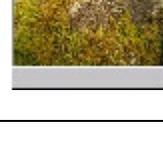
The five sites were all on the Amanzimtoti section of the Cloudbridge reserve, as shown in the inset section of the accompanying map. To avoid the impact of human disturbance, the study sites were all with the private section (marked “Privada” on the map), which was seldom frequented. Three of the five faced north; the other two, west.

Figure 4. Cloudbridge Nature Reserve, showing the Amanzimtoti section where the study was conducted.



The initial conditions of the five sites are shown in Figure 5.

Figure 5. Moss Recovery Study Sites and initial conditions.

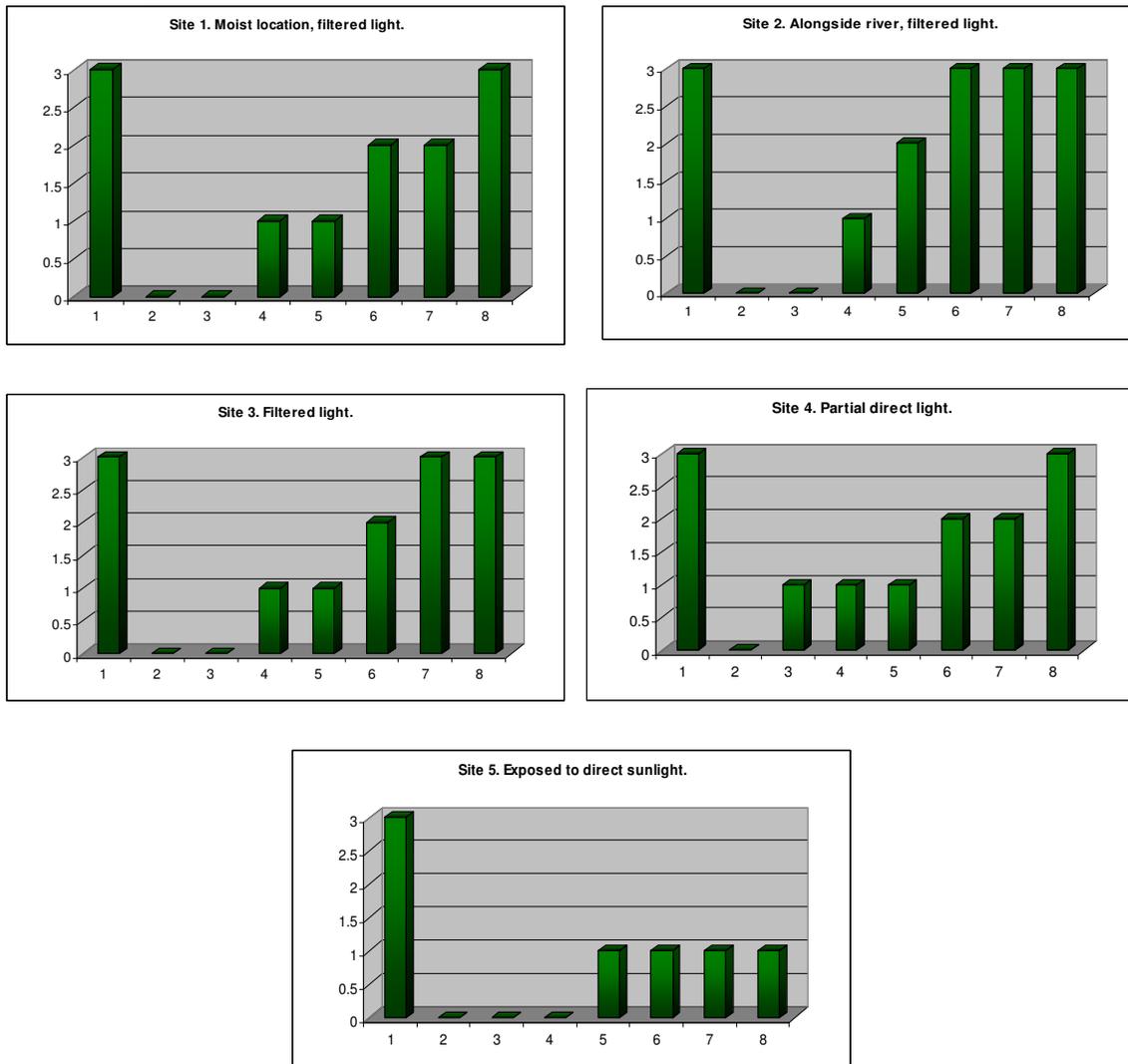
Site description	Context	Before removal	After removal
Site 1. Waterfall trail on Finca Amanzimtoti, east of trail on steep section above Genevieve Falls. West-facing vertical rock face, deep shade, moisture dripping from above. Moss moist, approx. 2cm thick.			
Site 2. Off the Waterfall Trail, down at river level at Genevieve Falls. West-facing boulder, 2m from river. Light spray. Light filtered by vegetation above. Moss moist, approx. 1cm thick.			
Site 3. On Waterfall Trail, above Laura's Falls. North-facing rock face. Light filtered by vegetation above. Moss moist, approx. 2cm thick.			
Site 4. On Waterfall Trail, above James' Falls. North-facing rock face. Good light. Moss moist, approx. 3cm thick. Very variegated. Rich soil behind.			
Site 5. Boulder in front (NW) of Casa balcony, near lower bodega. Triangular rock, north facing. Moss approx. 0.75cm thick. Bright sunlight. Moss was quite dry.			

## Results

Following the final survey, in December 2007, the sequence of photographs was compared to gauge the progress of recovery. Eight sets of photographs (two initially, and eight subsequent sets yielded 40 photographs which were scored as described above. An example of the sequence is shown in Appendix 1. The pictures depict the initial state and the subsequent stages of recovery over the 7 photo-dates. Next to each photograph is the score assigned to its recovery state. The images were scored independently by 3 researchers and the results averaged.

This process was repeated for all 5 sites. The results of the scoring are tabulated and graphed, producing the charts below, Figure 6. The underlying data and photographs are available from the authors upon request. It is evident that the moss recovered quite well after three years at most of the sites, relative to the surrounding moss. The striking exception was Site 5, which was the only one fully exposed to the sun. The fastest recovery occurred at the site close to the river, when constant mist bathed the rock.

Figure 6. Moss recovery results for Sites 1 to 5, scored 0-3 where 0 is bare rock and 3 is full recovery.



## Discussion

The results suggest that after removal, moss recovers slowly even in the ideal conditions of a tropical cloud forest. The most rapid recovery took place at a site next to a river, where the rock received filtered sunlight and was constantly subjected to a fine spray from the turbulent river. Minimal recovery was observed on an exposed sunny rock approximately 30m from the river. Other locations, all north- or west-facing shaded rock surfaces about 15m from the river, recovered reasonably well after three years. Moss, it seems, can only be safely removed in small amounts and only from areas where moist, shaded conditions permit regrowth of moss within 3-4 years. Moss should never be removed from exposed or dry locations.

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## References

Joshua Tomkins, "Moss Hunters Roll Away Nature's Carpet, and Some Ecologists Worry," *New York Times*, November 24 2004.

Robin W. Kimmerer, *Gathering Moss: A Natural and Cultural History of Mosses*, Oregon State University Press (2003)

W. B. Schofield, *Introduction to Bryology*, Blackburn Press (2001)

**Appendix 1.** Example of sequence of moss-recovery photographs with assigned scores (Site 1).

<b>Date</b>	<b>Photo</b>	<b>Score (0-3)</b>
Dec 2004 (before)		3
Dec 2004 (after)		0
Feb 2005		0

July 2005		1
Dec 2005		1
July 2006		2

<p>Jan 2007</p>		<p>2</p>
<p>Dec 2007</p>		<p>3</p>