Timpanogos Cave National Monument
Sampling Design and Site Selection Report

Defining the Upland Resources for Monitoring

Discussion with TICA resource management staff identified subalpine meadows, mixed conifer forests, and Gambel oak shrublands as priority communities for long-term monitoring. Due the small area of the monument and the steep slopes over much of this area, opportunities for upland monitoring at TICA were extremely limited. During a field visit in October 2008, TICA resource management staff identified three areas, one in each priority vegetation type, with gentle slopes and enough area to fit upland monitoring plots.

Accessibility

An accessibility map based on road and trail access was created for TICA using the NCPN Landscape Accessibility Model (Figure 1). Steep slopes ($\geq$ 50%) and areas isolated due to steep slopes (e.g., mesa tops) are considered inaccessible. The southeast corner of the monument, shown as surrounded by steep slopes in Figure 1, is actually accessible via a 2 km cross country hike over National Forest Service land south of the park. Including this section, the total accessible area of TICA is only about 14 ha.

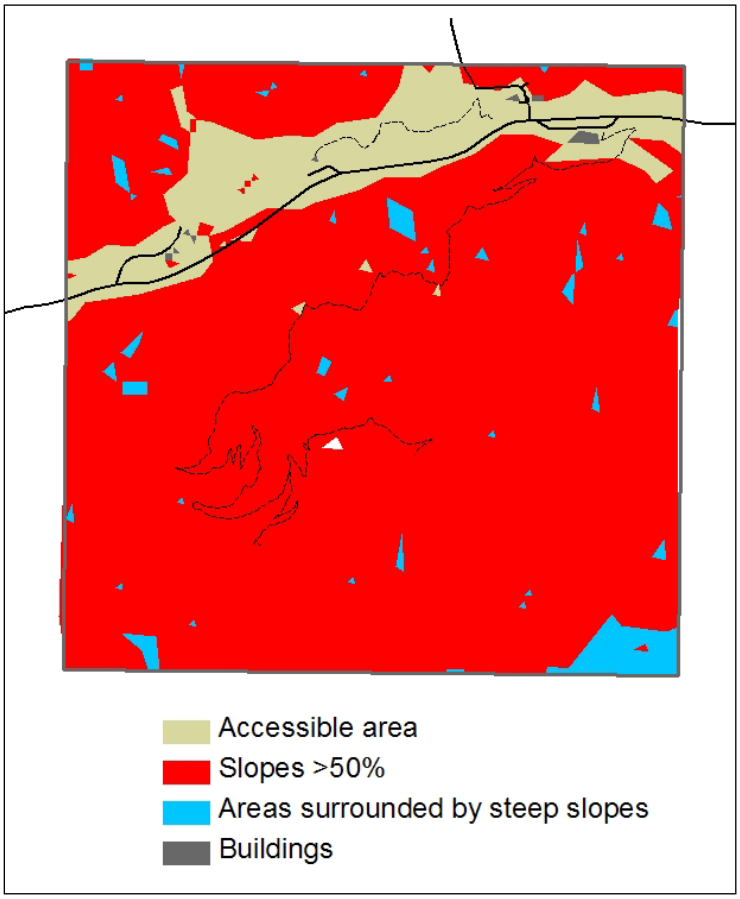

Figure 1. Accessible area of Timpanogos Cave National Monument.

Monitoring Site Selection

Due to the limited area available for upland monitoring, three monitoring plots were established so that they best fit the areas selected for monitoring. The location of each monitoring plot is shown in Figure 2. There is no sampling frame for TICA, and therefore, no inference beyond the individual plots.

TICA_upland_master.shp contains site tracking information for TICA upland monitoring (Table 1).

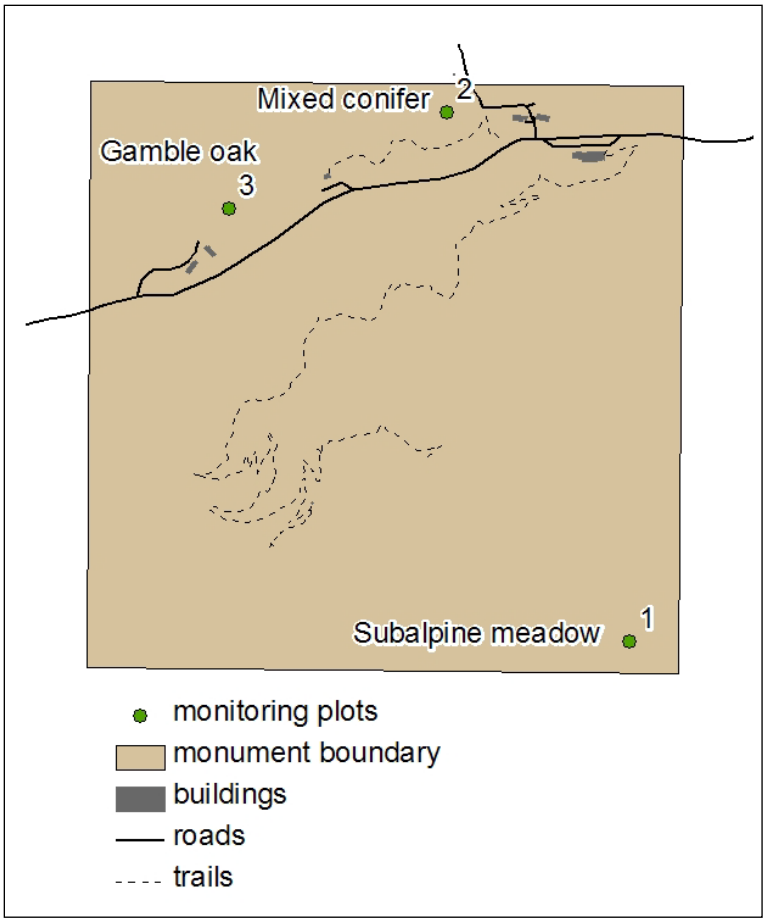

Figure 2. Upland monitoring plots at Timpanogos Cave National Monument.

Table 1. Attributes of TICA_upland_master.shp for tracking upland monitoring locations in Timpanogos Cave National Monument.

Field	Description
Veg_Type	Vegetation type for upland sampling methods (forest or oak)
EcoType	Vegetation type (subalpine meadow, mixed conifer, Gambel oak)
MasterStrat	Indicates groups for analyzing data (meadow, conifer, oak)
PlotID	The plot number
panel	Panel that plot is associated with in the revisit design
PanelYear	Year(s) that panel is sampled
EvalStatus	Ultimate status of a plot (estab = established)
S_Action	Status of plot determined in the field and recorded on GPS (accept or reject)
EvalReason	Describes why a site was accepted or rejected
Estab_Date	Month, day, and year of plot establishment
Soil_MU	na; no soil survey for this area
xcoord	UTM E (NAD83, Zone 12)
ycoord	UTM N (NAD83, Zone 12)
Hike_km	Hiking distance to plot in kilometers
AreaDescr	General area of the park where the plot is located
Comments	Miscellaneous
X	UTM E (NAD83, Zone 12)
Y	UTM N (NAD83, Zone 12)

Revisit Design

Initially, all three monitoring plots will be visited each year starting in 2009. After 3-5 years of data, a long-term revisit schedule will begin with plots sampled every 3-5 years.

Response Design

The response design for TICA is based on NCPN upland monitoring protocols and varies by vegetation type. The mixed conifer plot is monitored using the forest response design, the subalpine meadow plot is monitored using a slight variation of the forest response design, and the Gambel oak plot is monitored using the oak response design (Table 2).

Table 2. Response design for vegetation monitored in Timpanogos Cave National Monument.

Method	Subalpine meadow	Forest	Oak
Transects	3 – 50 m transects	3 – 50 m transects	3 – 20 m transects
Plot establishment	Rebar at transect ends, plot side slopes, optional witness trees	Rebar at transect ends, plot side slopes, optional witness trees	Rebar at transect ends, optional witness trees
Photos	Transect origin and end	Transect origin and end	Transect origin and end
Point-intercept	0.5 m intervals	0.5 m intervals	0.25 m intervals
Gap intercept			
Soil stability			
1-m belt transect (shrub and seedling density, exotic frequency)	X	X	Seedlings and exotic frequency only
1-m belt transect (richness)	X		
5-m belt transect (sapling density)	X	X	
Tree census	Quadrat 1 only	Quadrat 1 only	Entire plot & include Quegam >10 cm DBH
Spherical densiometer	X	X	
Fuels		X	
Site Impact	X	X	X