SITE ASSESSMENT FOR ECOLOGICAL RESTORATION

Site selection & assessment

Site assessment and site selection often occurs in an iterative fashion where several potential sites undergo *preliminary assessment* and then are compared for restoration potential. These sites may be contiguous subsections of a broad area under consideration for long-term restoration or disparate sites throughout a watershed or ecoregion. During the site selection phase preliminary assessment takes a broad look at ecological, logistical, financial, cultural, political, and other site characteristics to assess potential for restoration. Certain sites may pose challenges that preclude a viable restoration during the given time frame. The remaining potential sites then can be prioritized depending on many interactive and interdependent factors down to a site (or a series of sites) selected for immediate restoration. In order to design a workable site-specific restoration plan the chosen site must undergo an assessment of its relevant ecological, physical, and cultural characteristics. The information gained through the *design phase site assessment* reveals the *functional requirements* and *constraints* that ultimately guide the implementation strategy. In order to ascertain the specific functional requirements and constrains the following site characteristics need to be assessed:

- Topography
- Vegetation
- Soils
- Habitat features
- Disturbances
- Matrix
- Human context

The first six; topography, vegetation, soils, habitat features, disturbances, and matrix, are assessed on-site and provide the ecological information needed to guide actions that remedy abiotic and biotic limitations to ecological recovery. Assessing the human context happens both on and off site and addresses the cultural, historical, sociopolitical, and economic factors that may pose constraints the scope of the restoration project. Often the ecological success of a restoration is contingent on resolving limitation placed by the human context.

Preparation for site assessment

Before setting out to perform a site assessment, you should review the request-for-proposal (RFP) and any supplemental information regarding your project site carefully. Doing so will orient you towards the project partners' vision for the site. Meeting your project partners or their representative on-site prior to or during the site assessment would be ideal, ensuring that everyone involved comes to a mutual understanding regarding the scope and direction for the work. Inquire with your project partners regarding informational documents about the site such as topographic maps, aerial photographs, plant lists, historical maps, wetland delineations, community meeting notes, photographs, etc. Often such supporting materials can be found in library archives and through governmental office records.

We have a site assessment tool kit your team can borrow containing the following tools:

- 50 m tape
- Compass w/clinometer
- 2 m 'mini-rod'
- Diameter (DBH) tape
- Survey flagging
- Basic first aid kit
- Clipboard

You will need to provide:

- Graph paper
- Pencils, graphite & colored
- Rite-in-the-rain field book
- Plant ID field guide
- Digital camera

We recommend that at least one member of your team takes responsibility for photo-documenting your project with a digital camera. Taking a plant ID field guide would also be helpful. We can help you ID unknown plants, just bring a representative portion (leaves, stem, flowers, fruit) to class or better yet take digital photos and email them to us.

Physical Site

Begin your site assessment by constructing a basic physical map of your site. The crucial elements of a site map are:

- **Boundary**
- **Relative locations and dimensions of trails, streets, buildings, bridges, parking areas, access points, drainage ditches, culverts, storm drains, and other major physical site features.**
- **Distinct topographic features such as slopes, mounds, swales, ponds, shorelines, depressions, wetlands, creeks, etc. including slope, aspect and for water direction of flow.**
- **Characteristics of adjacent land such as commercial buildings, residences, greenspace, etc.**

Methods

1. Map the boundary of your site by breaking down the perimeter into straight line sections using a meter tape to measure length and a compass to measure the direction (azimuth) of each line section. Curves can be broken down into reasonably short sections. Simply have one person hold the tail end of the tape

and have another person walking with the tape reel to the end of the segment. The person with the tape end uses the compass to take the azimuth of the tape reel person. Another person or one of the two people managing the tape should write down the section length and the azimuth. The person with the tape end then can walk to the position of the tape reel person as the tape is reeled in and then stand at that position while the tape reel person walks out to the end of the next segment. Repeat and number the segments sequentially.

2. Draw your map onto the graph paper using a scale that allows for the entire map to fit on one sheet (if possible). Most graph paper has 4 and/or 5 squares per inch. Basing your scale on the squares, for example each square represents $1m^2$ or 1m for each 0.25 or 0.2 inch side, allows you to count squares to approximate the area of your site. This is helpful when you have a site that is not in the shape of a square or rectangle

3. Start by mapping your first perimeter section and then proceed sequentially. Your azimuth readings for each line section are based on the direction of the line *relative to north NOT relative to your last azimuth reading*. So, when mapping onto graph paper you need to establish which direction is north and from the end of each line section, using a protractor, base the direction of the next line section on the azimuth reading you obtained in the field.

4. The last line section should end at the beginning of your first line section. Rarely does this actually happen when drawing your map due to inherent lack of precision in azimuth readings and drawing to scale. Fret not, as long as you are within 10° or so of making a closed perimeter, you're good, just 'fudge' your last line section so the perimeter is closed. If your last line section is substantially off from connecting to the beginning of the first line then check the angles and lengths of all your previous sections. You may find that an azimuth reading was incorrectly taken in the field and you may need to go back and re-measure the boundary.

5. Repeat this process for other major physical site features. Paths, trails, roads, bridges, culverts, drainage ditches, and other linear features can be represented as lines on your map with an approximate width noted. Major features forming polygons like buildings and parking lots should be measured as the boundary was. When measuring the site boundary, make sure to note at what point on a perimeter line section each of these features intersects and/or shares a boundary so that these features can be mapped relative to the site boundary.

6. Topographic features can be mapped as above. Creeks, shorelines, swales, etc. are linear; ponds, wetlands, slopes, depressions, mounds, etc. are polygons. Be sure to measure the slope and aspect (the direction a slope faces) of slopes including mounds. If your site is more or less a relatively featureless uniform expanse with a consistent slope then estimate slope using a clinometer and aspect using a compass.

Vegetation

This analysis should result in (1) a species list and (2) two vegetation maps; one that shows the locations of dominant native species and approximates densities or percent cover and one that shows the locations, species and densities of major invasives. You should list every species you can positively identify and note whether they are dominant, common (but not dominant), or just occasional. You need not map EVERY plant species found on site, just the dominant species by vegetative layer. Vertically in a prototypical forest there are canopy, sub-canopy and ground cover layers. Each of these layers should be represented in the site analysis, if they exist. You may only have one or two layers present. The two dimensional maps you create then will represent the horizontal characteristics of each vertical level such as patchiness, density, species composition, etc.

The critical information to gather about existing site vegetation pre-restoration is:

- What dominant plant species (both native and non-native) are present
- Where those species are located
- The density of those species
- The extent and location of canopy gaps

Ideally the vegetation analysis should be carried out in late spring through summer so that the full extent and coverage of deciduous species can be measured and the presence of flowers and/or fruit helps in identification. Even though the academic year begins during the first days of autumn most deciduous plants will still have their leaves and many plants may still have fruit or flowers to aid in identification.

Methods

Canopy

1. Either approximate or measure the location (using intercept and distance from one of the measured line sections of the boundary) of the canopy trees on site noting the species and measuring the diameter of the trunk. You can get a fairly accurate location of each tree by measuring the distance and azimuth of the tree from previously mapped points on the site boundary. Perimeter corners are good for this.

2. If you have discernable large gaps in fairly consistent canopy cover try to approximate their location and extent. You can do this in two ways: (1) Estimate the extent of the canopy cover for each tree by using a meter tape going from the trunk to the farthest extent of the tree's branches. Assume this is the radius of a circle of which the tree truck is the center and draw onto your map. Once you have drawn all the circles for each tree you mapped on the site it should give you an approximate area and location of the canopy gaps. (2) For large canopy gaps in an otherwise continuous canopy measure it as a polygon using line sections and azimuths making sure to reference one corner of the polygon to a perimeter corner.

3. In areas with consistent canopy cover you can ‘guestimate’ visually percent canopy closure by stopping at regular intervals throughout the site and looking up through a tube (a toilet paper or paper towel rolls works well!) and noting how much of the sky is obscured by tree. Ranges noted in 25% increments (0-25, 25-50, 50-75, and 75-100) is the most realistic scale for approximation using this method. Use the median of each range (12.5, 37.5, 62.5, and 87.5) to calculate an ‘average’ canopy closure. You can also use a densitometer to measure more accurately canopy closure at regular intervals across the site then average your measurements to get a percent canopy closure. We have one available for loan.

Sub-canopy/shrub

1. Approximate or measure the location of patches of dominant sub-canopy vegetation by species. A patch is a more or less discrete area of vegetation dominated by a single species. Some species are patchier than others in their growing patterns. There is no rule as to how close to each other individuals/stems/clumps of the same species must be to form a patch. In general a grouping of one species that forms 75-100% cover with discernable edges looks like a patch. Measure and map only large patches, not small groups of a few individuals.

2. Measure the extent and location of each patch in one of two ways: (1) Approximate a ‘center’ of the patch and map the location of that center relative to a perimeter corner. Then measure a radius of that patch from the center and assume a circle. (2) Take two perpendicular measurements of the patch (length and width) with azimuths and sketch onto map assuming a circle or oval. Make sure the corner where your length and width measurements intersect is mapped relative to a perimeter corner. This method is best when confronted with impenetrable thickets.

3. Use the 2m ‘mini-rod’ to approximate the height of each patch.

4. If a dominant sub-canopy species is evenly distributed throughout your site and not ‘patchy’ then use a $1m^2$ quadrat or a larger measured off square area to sub-sample in several evenly distributed locations and estimate the percent cover visually in each sub-sample.

Groundcover

1. When you have discrete patches of a dominant groundcover use the methods outlined above for the sub-canopy.

2. Visually estimate percent cover of the species in the patch. Often you may have a discrete patch made up of two or more co-dominant groundcover species. In this case visually estimate the percent cover of each species. They don't have to add up to 100%! Plants overlap, after all. If a patch is too large to visually estimate comfortably then use $1m^2$ quadrat or larger measured off area to sub-sample several locations in the patch and come up with an average percent cover for each species in a patch.

3. If a dominant groundcover species is evenly distributed throughout a site (which is often the case) then sub-sample as above noting species and percent covers.

Soils

This analysis should result in (1) a table listing soil sample locations and the characteristics of each sample (use Appendix 1 and the soils data sheet in Appendix 2) and (2) soil sample locations noted on your physical map.

Soils are often overlooked and underappreciated yet they are a highly crucial aspect of an ecosystem. Soils strongly influence which species thrive where in the landscape. The most important aspects of soil to assess pre-restoration are:

- Depth and character of organic layer
- Texture
- Color
- Moisture

It is important to remember that 'soil', strictly speaking, is just the *mineral* fraction of the soil profile. This is in contrast to any accumulation of *organic* material (OM), like leaves, twigs, cones, needles, lichens, bark, branches, logs, dead animals etc. which lies above the mineral soil. This distinction is important since most plants have their roots in the mineral soil where plants obtain their water and nutrients. Mineral soil can have highly variable organic component due to the depth and rate of decomposition of the OM accumulation above it. In general soils with a strong organic component generally have more nutrients and hold more moisture for longer periods than soils without.

Like vegetation, soil characteristics can change across a site and be patchy. Soils can change gradually or abruptly across a site. **It is not unreasonable to assume that distinct topographic features on your site have distinct soils.** They often also have distinct vegetation as a result. You should sample the soils in each of your major topographic zones esp. pronounced slopes, wetlands, creek/lake edges, shorelines, mounds, and depressions. If your site is uniform then sample the corners of your site and a few in the middle. A very uniform site can have highly variable soils, you won't know until you dig! The tools necessary for soil analysis are:

- Trowels/shovels
- Tarp
- Ruler
- Munsell color chart (optional)
- Soil texture test sheet (see Appendix 1)
- Soils data sheet (see Appendix 2)

Methods

1. For a topographic polygon dig a soil pit in near each corner and one in the center. For whole sites one point every 10 m on a grid is more than enough. Assign numbers to the points on the map so that the number refers back to soil information gathered on a separate data sheet. You needn't map soil sample locations accurately, just approximate them on the map.

2. Begin by removing the organic layer in a 15 cm (6 in) wide circle, if any, and place it on the tarp. Measure the depth of the organic layer to the mineral soil, Describe the OM in terms of composition noting leaves, needles, twigs, cones, seeds, etc. if present and the relative thickness of the upper less decomposed layer to the more decomposed lower layer (if present).

3. After removing the organic layer dig a 15 cm (6 in) chunk out of the mineral soil and place on the tarp. Note how hard it was to dig out. Was it really compacted? Is it really loose? Does it come out in one big chunk?

4. Note the moisture content of the soil. Is it dry? Is it moist to the touch? Is it saturated (can you squeeze water out of a palm-full)? It is best to test soil moisture during dry weather to give you a better feel for the moisture holding capacity for a soil when plants need it most.

5. Assess texture using the feel/moist cast/ribbon tests. See appendix 1.

6. Note the presence of coarse minerals such as rock, gravel, pebbles relative to the volume of the soil. Does it have just a few rocks here and there and is mostly soil or do you have a lot of rock and just a little soil?

7. Does the mineral soil seem to have a weak, moderate, or strong organic content as evidenced by depth of brown coloration?

8. Is your soil grey (gleyed)? If so it may be a wetland (hydric) soil. Look for reddish orange spots (mottles) that are evidence of localized oxidation due to roots oxidizing their rhizosphere and/or air drawn into pores during draw down of the water table.

9. Note the dominant vegetation associated with the soil and the depth to which

roots are found in your test hole.

10. Note the presence of macroinvertebrates such as worms, larvae, beetles, etc.

11. Note evidence of disturbance like buried wastes, off-smells, compaction, charcoal, abruptly different soil layers, etc.

Habitat features

Any habitat features should be incorporated into your native vegetation map using symbols if small or mapped as vegetation or topographic features above if large.

Habitat features refer to major structural elements which may provide habitat on site. such as

- Nurse logs, snags & stumps
- Brush piles & beaver dams
- Boulders, rock piles, & caves
- Drainages, ravines, ponds, seeps, wet patches, etc.

These elements can be simply mapped as outlined previously and noted with special attention to evidence of use (droppings, nests, sightings, claw marks, tracks, bore holes, etc.) In the case of topographic features such as boulders, rock piles, caves, drainages, ravines, ponds, seeps, wet patches, etc. it is useful to measure the aerial extent of each.

Disturbances

Produce a separate map that shows all the disturbances found on site. Map locations, extent and severity of soil exposure.

The type, intensity and extent of disturbance on site strongly direct the restoration strategy. Some major disturbances to assess are:

- Illicit trails/campsites
- Garbage piles
- Invasive species
- Erosion
- Herbivory (grazing of vegetation)
- Plant diseases
- Fire
- Toxic spills
- Flooding

Invasive plants are identified, measured, and mapped during the vegetation assessment. Other disturbances that are evident in discrete areas such chemical spills, garbage piles, fires, erosion, etc. should be mapped as polygons and an approximate extent estimated.

Matrix

The matrix refers to the area immediately adjacent to the site being assessed. What lies at the borders of your site has profound influence on the restoration strategy and success. Continued disturbance in the form of traffic or source of invasive propagules can come from adjacent areas. Conversely neighboring areas can be a source of native plant propagules, wildlife, water, nutrients, energy, and human volunteers to support rehabilitation efforts.

Adjacent land attributes should be noted on the site map including established paths, roads, power line corridors, property boundaries, etc. Note relative location and guestimate densities of adjacent native and invasive populations.

Human context

Often the human context of a site is the most difficult to assess. Your project partners may explicitly outline the human context providing historical information and a list of stakeholders who represent cultural, economic, and sociopolitical interests. Or you may have to interview your project partners to glean what is known of the human context and follow up on the leads provided. Government records and articles from local newspaper archives often reveal information about land use and ownership history as well as on-going controversies. The most interesting and relevant information about your site comes from taking the time to talk with identified and potential stakeholders. These can be neighbors living adjacent to the site, people in the immediate community, the historical property owners of the site or their descendents, people who use the site recreationally, people in charge of caretaking the site, local environmental groups, etc. Often people are very willing to talk passionately about their interests and involvement with your site. Others may find your questions intrusive or even threatening to their interests. Listen carefully, take what you can get, and treat everyone respectfully as an interested party.

Appendix 1: Soil Texture Tests

Feel test

Simply rub DRY soil between thumb and forefinger after removing coarse materials such as rocks, gravel, roots, coarse organic matter, and critters.

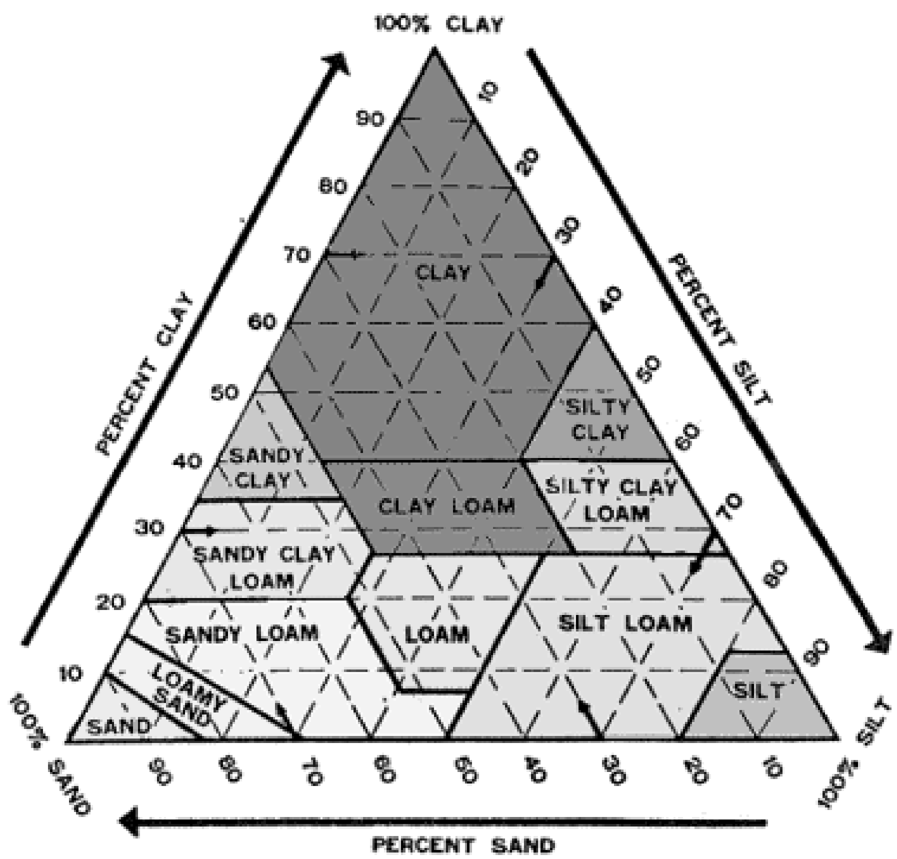
Moist cast test

Add enough water to a coarse material-free palm-sized sample to form a cohesive lump (if possible). Add just enough water to create cohesion, if there is excess water when you squeeze the sample, you added too much. Add a little more dry soil. A good 'cast' is one that bears the imprint of your hand after squeezing in your fist.

Ribbon test

Use your moist cast to attempt to form a thin ribbon using your thumb and curled forefinger. Clay dominated soils will form long ribbons, silt dominated soils will flake rather than form a ribbon and sand dominated soils fail to form any ribbon.

Soil Texture Triangle



Field Tests for Soil Texture			
Texture	**Feel Test**	**Moist Cast Test**	**Ribbon Test**
Sand	Grainy, little floury material	No cast	Can't form a ribbon
Loamy sand	Grainy with slight amount of floury material	Very weak cast, does not allow handling	Can't form a ribbon
Silty sand	Some floury material	does not allow handling	Can't form a ribbon
Sandy loam	Grainy with a moderate amount of floury material	Weak cast, allows careful handling	Barely forms a ribbon — 1.5 - 2.5 cm (0.6 -1 in.)
Loam	Fairly soft and smooth with obvious graininess	Good cast, easily handled	Thick and very short - <2.5 cm (1 in.)
Silt loam	Floury, slight graininess	Weak cast, allows careful handling	Makes flakes rather than a ribbon
Silt	Very floury	Weak cast, allows careful handling	Makes flakes rather than a ribbon
Sandy clay loam	Very substantial graininess	Moderate cast	Short and thick — 2.5 - 5 cm (1 - 2 in.)
Clay loam	Moderate graininess	Strong cast clearly evident	Fairly thin, breaks easily, barely supports its own weight.
Silty clay loam	Smooth, floury	Strong cast	Fairly thin, breaks easily, barely supports its own weight.
Sandy clay	Substantial graininess	Strong cast	Thin, fairly long, 5-7.5 cm (2 - 3 in.). Holds its own weight.
Silty clay	Smooth	Very strong cast	Thin and fairly long, 5 - 7.5 cm (2 - 3 in.). Holds its own weight.
Clay	Smooth	Very strong cast	Very thin and very long — >7.5 cm (3 in.)

Appendix 2: Site assessment data

Project name:
Project location:
Date:
Personnel:
Weather:

Site mapping

Site Boundary		polygon#		polygon#		polygon#		polygon#		polygon#	
length	azimuth	length	azimuth	length	azimuth	length	azimuth	length	azimuth	length	azimuth
notes:		notes:		notes:		notes:		notes:		notes:	

polygon#	area	slope	aspect

Site soils

polygon#	soil pit #	OM depth	texture	coarse fraction (low, moderate, high)	moisture (dry, moist, saturated)	root depth	organic component (weak, moderate, strong)	dominant vegetation	macroinvertebrates	disturbances

Site vegetation – shrub, groundcover, invasives

polygon#	species	patch#	width	length	area	%cover

Site vegetation – canopy

polygon#	species	tree#	dbh	gap#	length	width	area	avg % canopy cvr

Site assessment notes

Describe matrix (relative to site boundaries):

Describe site disturbances (note location, type, severity, and extent by polygon):

Describe habitat features (note location, type, and extent by polygon)

Summarize historical context of site (disturbances, uses, ownership, etc.)