San Francisco Estuary
Wetlands Regional Monitoring Program

# Data Collection Protocol
# Plant Community Structure of Intertidal--Upland Ecotone

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## Introduction

This protocol is designed for assessing the ambient condition of vegetation and the effectiveness of vegetation management in the ecotone between intertidal areas and uplands.

The intertidal-upland ecotone of San Francisco Bay functions as a refuge for intertidal wildlife (Goals Project 1999, Baye 2008), including the endangered California clapper rail and salt marsh harvest mouse (USFWS 1984). It tends to be especially rich in plant species (Goals Project 2000, Baye 2008), although non-native species are often abundant (Fetscher et al, 2009).

This ecotone has been severely impacted by the conversion of tidal wetlands into agricultural lands and commercial salt ponds, or the filling of marshes for residential and industrial development (Collins and Grossinger 2004). Bayshore development has encroached into or through the ecotone in many areas. Hundreds of miles of levees have been constructed atop the ecotone to protect adjacent land development from extreme high tides. Railroads, pipelines, and transmission corridors commonly trace the ecotone along the bayshore and have disrupted the ecotone to varying degrees. Much of the existing ecotone corresponds to the bayward faces of earthen levees and road grades. The relatively intact remnants of the historical ecotone have been subject to decades of intensive farming or ranching.

The ecological functions of this ecotone have been gaining recognition within the regional community of natural resource scientists and managers. This is evident by the increasing number of efforts to restore and protect the ecotone. However, there are scant data about the success of different restoration approaches and plans. Carefully collected data about the success of different plant species at different positions within the zone under different management regimes is needed to inform restoration design. This information can be developed through dedicated research and from restoration projects that use standard methods of data collection to track restoration outcomes. This protocol is intended to meet the need for standardized data about the responses of the ecotone plant community to onsite vegetation management. This protocol can also be used in broader surveys of the ambient condition of the ecotone. Standardized use of this protocol will allow comparisons between management actions and ambient conditions.

In this protocol, plant community structure is assessed in terms of the vegetative cover (i.e., the percent of a specified area of land surface within the transition zone that is covered by each plant species living in the ecotone), the maximum height of the species, and the relative abundance of non-native species. These data are particularly useful for characterizing the distribution of common species that make up the bulk of the biomass in the ecotone and less valuable for identifying rare species. These data can also help assess the value of the ecotone as wildlife habitat. Data on vegetative cover that are collected before and after restoration efforts can be used to assess their progress or performance.

With the advent of global positioning systems (GPS), web-based Geographic Information Systems (GIS), data collection in the field can be integrated with data management and visualization. This protocol is designed to encourage collaborative efforts to learn from restoration projects by standardized applications of conventional scientific methodologies and new Information Technology (IT) to compare projects to each other and over time. This protocol compliments the one for monitoring tidal marsh vegetation (Vasey et al., 2002).

## Definition of the Tidal Marsh Ecotone

In concept, the tidal intertidal-upland ecotone is a zone of decreasing tidal influence extending landward from tidal marshland or tidal flat. The breadth of the zone decreases as its steepness increases. Steep shores have very narrow ecotones. Long alluvial valleys sloping gently to the intertidal zone can have very broad ecotones (Collins and Grossinger 2004). Due to the shape of the tidal curve (i.e., the pattern traced by plotting the rise and fall of the tides over time), plus friction caused by vegetation through which the tidal waters flow, the frequency and duration of tidal inundation decreases exponentially with distance landward through the ecotone. The vegetation of the lower limit of the ecotone tends to resemble the adjacent tidal marsh plain. With distance landward, the vegetation quickly shifts to species indicative of the upper limits of regular tidal action, and then to mixtures of these species and upland species. The upper limit of the ecotone is indicated by only traces of vegetation affected by the tidal waters. The width of the ecotone can be increased by wave run-up, boat wakes, extreme high tides during storms, and the deposition of salts picked-up from the Bay and carried landward by onshore winds.

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For the purposes of this protocol, the ecotone is defined as the area extending bayward from the backshore onto the adjoining marsh plain or tidal flat for a distance of 2.0m, and extending landward from the backshore to whichever of the following two elevation contours is lower: (A) the top of any earthen levee, road grade, or other artificial topographic feature that can support vegetation or (B) an elevation contour 2.0m above the height of the adjacent marsh plain, or 2.5m above the height of the adjacent tidal flat, if there is no adjacent vegetated marsh plain (Figure 1).

Also for the purposes of this protocol, the backshore is defined as the approximate landward extent of daily tidal processes that influence the distribution and abundance of plant species indicative of the local tidal marsh plain. A marsh plain is defined as a flat area at least $100m^2$ having essentially uniform slope that is subject to regular tidal inundation and that supports at least 5% cover of vegetation, 75% of which consists of plants restricted to tidal marshes. Tidal flats meet all these criteria except that they lack 5% cover of vegetation. The indicative species of the tidal marsh plain vary with salinity regime. To identify these plant species for any tidal marsh, the interior reaches of the marsh plain equidistant from any tidal marsh channels or pannes must be examined. Typical marsh plain flora for saline and brackish regimes include, but are not limited to, *Salicornia virginica* (pickleweed), *Jaumea carnosa* (fleshy jaumea), *Distichlis spicata* (salt grass), *Juncus balticus* (Baltic rush), *and Triglochin maritimum* (seaside arrowgrass). In the case of tidal marsh restoration sites that do not yet support 5% cover of tidal marsh vegetation, the backshore is defined as the landward extent of the non-vegetated tidal flat. However, most restoration sites have at least a narrow band of marsh vegetation that can be used to delineate the backshore based on the field indicators provided below (see discussion of Sample Strata in section on Sample Design).

There are not a lot of data to validate the prescribed spatial limits of the ecotone. The National Ocean Survey found the average upper limit of salt-tolerant vegetation to be 0.8m above local Mean High Water (MHW) at Point Pinole in San Pablo Bay (NOS 1975). For tide gauges around the Bay (http://ports-infohub.nos.noaa.gov/hq/bench_mark.shtml?region=ca), extreme high water events (the highest observed water levels) range in elevation from about 0.4m to 1.2m above local MHW, and from about 0.2m to 0.9m above local Mean Higher High Water (MHHW), with a regional average of about 0.7m ± 0.16m above MHW and 0.5m ± 0.2m above MHHW. The upper marsh limit reported by NOS for Pinole Point is consistent with nearby observations of maximum high water levels, which suggests a relationship between extreme high tide events and the landward limit of marsh plants. A summary of known elevations of tidal marsh plains found that they gain elevation as they age, and that the elevations of mature plains range from about MHW to about 0.2m above MHHW (Goals Project 1999). Assuming that most marsh plains have an average elevation about half way between MHW and MHHW, and that the minimum upper limit of the ecotone is equal to the maximum observed water level, then the upper limit of the ecotone has a minimum height of about 0.6m above the marsh plain. Assuming that the lower limit of tidal marsh vegetation (i.e., the upper limit of tidal flats) corresponds to local Mean Tide Level (MTL) (Atwater and Hedel 1976), and given that the average difference in elevation between marsh plains and MTL around the Bay is about 0.6m (based on the tidal gauge records), then the upper limit of the ecotone has a minimum height of about 1.4m (0.6 + 0.8) above the tidal flat.

However, tidal marsh vegetation is frequently observed at elevations greater than 0.6m above adjacent marshland. At Palo Alto, Hinde (1954) observed pickleweed (*Salicornia virginica*) at about 1.2m above the average marsh plain. NOS (1975) observed alkali heath (*Frankenia salina)* more than 1.3m above the marsh plain. In uplands sloping gently to, and downwind from tidal marsh, the lead author has found *Frankenia salina* and salt grass (*Distichlis spicata*) mixed with upland grasses more than 3m above the marsh plain. Furthermore, the ecotone is not defined by tidal marsh vegetation alone. In a recent description of the tidal-marsh-upland ecotone of San Francisco Bay (Baye 2008), field photographs clearly show the ecotone, as defined by distinctive vegetation, extending at least 2m above the marsh plain at China Camp (San Pablo Bay), and elsewhere. Ecotone restoration projects commonly consider the entire bayward faces of shoreline levees as areas of potential ecotone, and these faces commonly extend more than 2m above nearby tidal marshland. Coyote brush (*Baccharis pilularis*) is considered a tidal marsh plant species (Baye 2007), in part because it occupies natural levees along tidal marsh sloughs, although it also occurs in uplands. It is commonly regarded as a species well-suited for the upland reaches of the ecotone. Given these observations, the elevation limits of the ecotone as prescribed for this protocol are reasonable, if not conservative. The limits should be revisited as new information about the height of the ecotone is developed.

## Personnel

Anyone who can identify wetland vascular plant species and who understands this written protocol should be able to conduct this sampling, if provided with appropriate orientation and supervision.

All field personnel must adhere to practices that ensure their well being and the health and safety of plants and other wildlife. All personnel must know and adhere to the policies and laws that govern access to, and activities within, the ecotone. For example, access can require written permission to cross private lands, and activities within the ecotone might be constrained by policies protecting threatened or endangered wildlife.

## Sampling Design

### Overview

A stratified-random sampling approach is used to characterize the plant community of the ecotone with regard to four parameters for individual elevation strata:

- Cover type relative abundance;
- Species richness;
- Maximum height of species; and
- Relative abundance of native and non-native species.

### Assumptions

The underlying assumptions of this approach are:

- The indicators of plant community structure are sensitive to restoration project design and management practices, including removal and/or planting of vegetation, fertilization, irrigation, mowing, and herbicide application;
- The response of these indicators to management actions can vary with distance through the ecotone away from the adjoining tidal marsh or tidal flat.

### Sample Universe

The sample universe (aka sample frame) depends on the purpose of the assessment. For example, when the protocol is applied to an ambient survey, the sample universe consists of all areas of the tidal marsh-upland ecotone within the geographic scope of the survey. When the protocol is used to assess individual vegetation management projects, the sample universe includes the entire ecotone within the project area that is subject to management. The sample universe of a project can grow as the activities expand across the project.

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### Sample Site

A sample site is a continuous portion of ecotone at least 50m long, but not longer than 500m, and having essentially the same height, width, and overall appearance of the plant community. The following criteria should be used to decide on the end points of sample sites.

- A site should be between 50m and 500m long.
- The plant community must have the same overall appearance throughout.

- A site must not incorporate major differences in restoration design or current vegetation management practices (e.g., differences in irrigation, species removed or planted, etc.), or elapsed time since the management activity being assessed was initiated. The complete history of a site is seldom known. But, major differences in historical treatments or impacts should not be incorporated into a site.
- Each upland sample stratum within a site (see section title “sample strata” immediately below) must be between 1m and 3m wide. A change in topographic slope that causes the ecotone to be either too narrow or too wide for three upland strata indicates a change in sample sites. Some ecotones are so broad that they consist of more than 3 strata. Others are too narrow for more than a single upland stratum (see item 3 in section titled “Sample Strata” immediately below)..

**Sample Strata**

Each sample site shall be separated into elevation strata. The purpose of these strata is to characterize the relationship between tidal elevation (i.e., frequency and duration of tidal inundation or wetting) and the condition of the ecotone or the performance of ecotone management practices. The following procedure shall be used to stratify a site.

1. For each sample site as defined above, identify and mark the approximate location of the backshore. The backshore is an elevation contour; the entire backshore of a site has the same elevation. In concept, the backshore is the landward extent of daily tidal processes that directly affect the distribution and abundance of marsh plain plant species. Boat wakes, extreme high tides associated with winter storms, and the landward distribution of salt deposited by onshore winds are not regarded as daily tidal effects, and are therefore disregarded in backshore identification. The backshore has a variety of field indicators that should be used together to identify the likely position of the backshore (Figure 1). These indicators include the following.
    - In general, the backshore is slightly higher than the adjacent marsh plain (or tidal flat if there is no adjacent marsh plain).
    - The shoreline often has a wave-cut bench or other break in slope created by tidal action. The top of the bench is usually slightly lower than the backshore.
    - The landward extent to which plants indicative of the marsh plain comprise at least 75% relative cover tends to indicate the backshore in mature ecotones.
    - Native shrubs such as gum plant (*Grindelia stricta*) and coyote brush (*Baccharis pilularis*) sometimes inhabit the backshore. The bases of the trunks of the lowermost individuals of these species are a good indicator of the backshore.
    - In the absence of shrubbery, fencing or other obstructions to the landward distribution of wrack (i.e., floating trash, wood and plant debris, and other detritus deposited by the tides), the average height of the wrack line tends to be slightly higher than the backshore. Where shrubbery or other obstructions prevent wrack from freely moving landward to the limits of the tides, the wrack tends to settle on the marsh plain and is therefore somewhat lower than the backshore.
    - Independent delineations of the backshore by different workers at a site should differ from each other by a distance less than 50cm.


Figure 1: Conceptual diagram of the likely position of the backshore in relation to various field indicators.

2. Determine the average width of the portion of the transition zone that extends landward from the backshore. The average width should be based on three measurements made through the air parallel to the ground surface: one at each end of the site and one in the middle. Each measurement must extend from the backshore to the landward limit (i.e., upper edge) of the ecotone.
3. The objective of this step is to determine the number of upland strata and their standard width. Divide the average ecotone width from step 2 above by three. If the resulting quotient is between 1m and 3m, the upland portion of the ecotone will have 3 strata with a width equal to the quotient thus calculated. If the quotient is less than 1.0 m, then divide the average ecotone width by 2 instead of 3. This will reduce the number of upland strata from 3 to 2. If the original quotient is greater than 3, then divide the ecotone width by 4 instead of 3. This will add one stratum to the upland portion of the ecotone. If the ecotone is too wide for four upland strata, then divide the width by 5 or 6 to determine the number of upland strata that are each 1m to 3m wide. If the width from step 2 is too narrow for more than one upland stratum, then make sure the upland limit of the ecotone has been correctly identified, and if so, then the ecotone has a single upland stratum. If the width is less than 1m then, for the purposes of this protocol, there is not ecotone.
4. The lower-most stratum always consists of an area of the intertidal marsh or tidal flat 2.0m wide that adjoins and parallels the backshore (Figure 2).

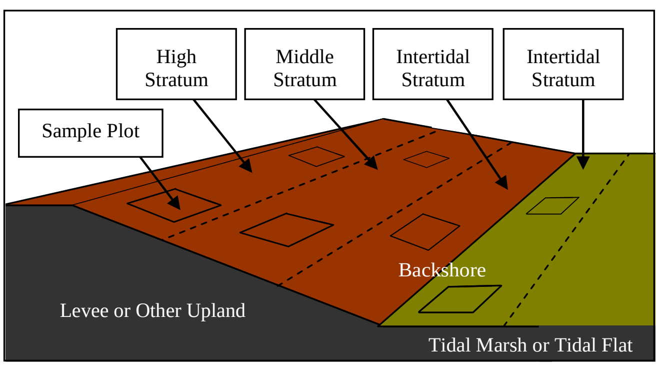


Figure 2: Conceptual diagram of tidal marsh-upland ecotone sample strata, showing some sample plots (black rectangles) in each stratum (see Figure 3).

**Sample Plots**

Sample plots are square areas $1m^2$ in size (100 cm to a side) that are randomly selected for each of the sample strata.

**Sample Size and Sample Plot Selection**

Sample size is the number of plots per stratum at one site. The total number of plots per stratum should represent 10% of the stratum surface area. Each stratum at each site should have equal sample size, but the sample size can vary between sites.

Sample plots are randomly selected for each stratum at each site according to either of the two following procedures. One alternative procedure uses high-resolution aerial imagery in a Geographic Information System (GIS). However, use of such technology requires access to it plus expertise that are not essential for this protocol. The field alternative can be used when a GIS is not available.

*GIS Alternative*

1. In a GIS, draw the boundaries of the sample strata on recent-vintage, 1-m pixel resolution or higher resolution digital aerial imagery (i.e., recent NAIP imagery or suitable site-specific imagery).
2. Overlay a $1m^2$ grid across the entire sample site.
3. Using the GIS, estimate the total area of each stratum in the sample site.
4. Determine how many $1m^2$ cells equal 10% of the surface area of each stratum at the site. This is the sample size.
5. Assign a unique alpha-numeric code to each cell in the grid for each stratum. For each stratum, randomly select the number of cells equal to the sample size.
6. Mark the latitude and longitude of each selected cell on the grid and mark each selected cell on the imagery to produce a map of the sample plots.
7. The sample plots can be located in the field by inputting their unique latitude and longitude coordinates as way-points into a Geographic Positioning System (GPS) with 1m horizontal accuracy, or by using the sample plot map from Step 6 immediately above.

*Field Alternative*

1. Stretch a 100m tape along the backshore. Make sure the tape follows a single elevation contour, plus or minus about 10cm in elevation. The backshore can be surveyed using a simple optical level. Leave the measuring tape in place until all the strata are sampled. It can be helpful to stake the backshore at regular intervals and to attach the tape to the tops of the stakes above the vegetation. A survey level can be used to stake the backshore.
2. Based on the width of the stratum determined above (see step 3 in section titled “sample strata”), and the stratum length from Step 1 immediately above, calculate the area of each stratum in $m^2$.

3. Determine the sample size as the total number of $1m^2$ plots equaling 10% of the stratum area, using the following formula:

   stratum area x 0.1 = sample size; round to the nearest whole integer.

4. The length of the stratum in meters is equal to the maximum possible sample size. Randomly select the number of plots required for the sample, as determined in Step 3 immediately above. One method is to separately number equal-size slips of paper from 1 to the number equal to the length of the stratum in meters (i.e., if the stratum is 100m long then separately number 100 pieces of paper from 1 to 100), mix the pieces of paper thoroughly in a hat or other suitable container, and withdraw the number of slips equal to the sample size, one slip at a time, re-mixing the remaining slips between each withdrawal. Each selected slip of paper identifies one distance in meters along the measuring tape where one plot will be located.

5. Repeat steps 1-4 for each stratum of each site. It is essential that the sample plots be randomly selected separately for each stratum. Note that for each site, all the upland strata will have the same width, same length, and the same number of sample plots (i.e., Steps 1-3 only need to be done once per site), but the locations of the plots will not necessarily be the same because they are randomly selected separately for each stratum.

**Sample Timeframe and Sample Period**

The sample timeframe is the time of day and time of year when the field data should be collected. All data should be collected after most of the perennial vegetation has added its annual biomass and before annual vegetation has senesced. The data for the intertidal stratum should be collected at a time of day when the stratum is not inundated with water.

The sample period is the portion of the timeframe when data are actually collected. All data for all strata and sites for a project should be collected during the shortest period possible to maximize their comparability.

For the purpose of assessing the effects of management activities, baseline data should be collected before the activities ensue and annually thereafter. The length of the monitoring effort (i.e., the number of years of monitoring) will vary from project to project.

**Data Collection**

Data collection entails field-based measurements of the selected parameters of plant community structure for all the sample plots during one sample period. For each site, the following sampling steps shall be conducted in the following order.

1. Begin data collection at the plot closets to the starting end of the tidal stratum. You are at the starting end if, while looking down the length of the stratum, the upland portion of the ecotone is to your right.

2. Go to the first sample plot (the lowest number drawn for the tidal stratum) along the tape that has been laid along the backshore. At this location along the tape, extend a second tape 1.0 m perpendicular to the backshore onto the marsh plain. A square plot frame having an area of $1m^2$ (100 cm per side) is carefully lowered onto the marsh plain, such

that the 1.0m mark of the tape is at the center of the frame,  without undo disturbance to the plant cover. Do not disturb the adjoining strata Each tidal stratum plot should cover the distance across the marsh plain from 0.5m to 1.5m away from the backshore.

3. Collect the following data for each and every sample plot:

    a. Visually estimate the absolute percent cover of each non-vegetation cover type (see datasheet for types). These are not mutually exclusive and their percentage should tally to 100% for each plot. For example wrack or dead algae could be overlaying mulch.

    b. Visually estimate the absolute percent cover of each plant species. These are not mutually exclusive. Since plants can overlap each other, their percentage can tally to a number greater 100% for each plot.

    c. Measure the maximum height of the tallest individual of each plant species in the plot, to the nearest cm. Height is measured without straightening or otherwise manipulating any vegetation.

    d. After the data are entered into the database, each species observed is automatically classified as (1) native or non-native, according to the Jepson Manual (Hickman, 1993); (2) planted or not planted, based on site-specific list of planted species; and (3) removed or not removed, based on a site-specific list of species that were removed. Planted individuals are not assessed separately from natural recruitment. The net effect of recruitment can be assessed as the difference between the first and subsequent samples.

    e. The visual estimates of percent cover are made using a modified Daubenmire cover class system (Daubenmire 1959) using a 7-point scale, as indicated below.

    f. All data must be recorded on the standard datasheet for this protocol (see Appendix).

Daubenmire cover class system

| Estimated cover categories | Cover class |
|---|---|
| >0-1% | 1 |
| >1-5% | 2 |
| >5-25% | 3 |
| >25-50% | 4 |
| >50-75% | 5 |
| >75-95% | 6 |
| >95-100% | 7 |

4. Complete all the sampling for the tidal stratum before proceeding to the “low stratum” i.e., (the lowermost of the upland strata).

5. For the “low upland stratum”, randomly select the number of plots that together represent 10% of the total area of the stratum (see step 3 in section titled “Field Alternative” above). Begin sampling the low upland stratum at the randomly selected plot with the smallest number (i.e., the plot closest to the starting end of the stratum). You are at the

starting end if, while looking down the length of the stratum, the upland portion of the ecotone is to your right. Go to the distance along the tape at the backshore that corresponds to the distance along the low upland stratum for its first sample plot. Extend a second tape uphill and perpendicular to the backshore tape to the middle of the low upland stratum. Carefully lower the sample frame such that it is centered in the middle of the stratum, with the downhill edge of the plot parallel to the backshore. Minimize any disturbance of the plant cover. The end of the second tape should be at the center of the sample plot (see Figure 3 below). Collect data from the plot according to step 3 immediately above. Repeat this step 5 until the low stratum is completely sampled.

6. Repeat step 5 for the other upland strata.

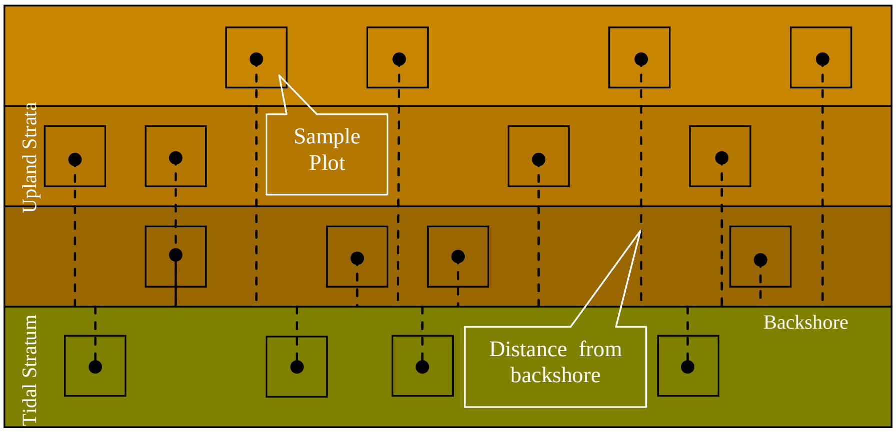


Figure 3: Schematic diagram of sample plot lay-out within each stratum at randomly selected distances along the backshore. The distances are randomly selected for each stratum. The combined area of all plots within a stratum is equal to 10% of the total area of that stratum.

**Basic Field Equipment**

- ✓ 100m transect tape to lay along the backshore
- ✓ Survey level for sighting the backshore
- ✓ 25m transect tape for locating sample plot centers perpendicular to the backshore
- ✓ $1m^2$ plot frame divided into 100 equal-size cells (10cm to a side)
- ✓ GPS unit
- ✓ Camera
- ✓ PVC markers and hammer
- ✓ Plant press for collecting reference specimens
- ✓ Data sheets

**Data Analysis and Interpretation**

Species-area curves should be developed for each stratum of each site to assess the adequacy of the sample size for assessing species richness. The curves can be constructed during data collection by plotting the cumulative number of new plant species observed from the first through the last sample plot for each stratum (Figure 4). If the curve for a stratum is not achieving an asymptote (i.e., is not “leveling-off”), then follow the steps for plot selection to randomly add additional plots until an asymptote is achieved.

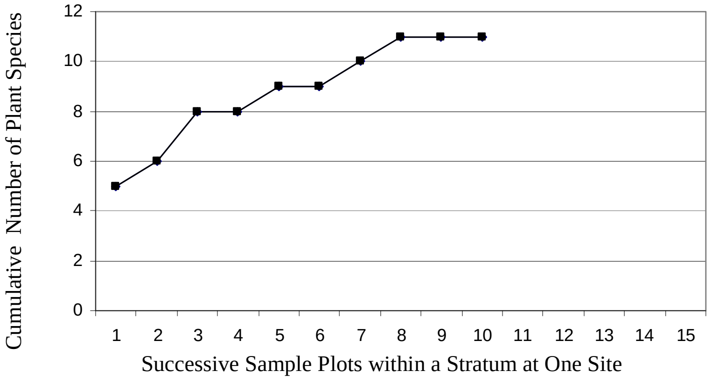


Figure 4: Example plot of a species-area curve showing an asymptote at eight sample plots.

Given that the ecotone might vary in width among sites, then the number of strata might also vary among sites. Given that the number of plots needed to adequately assess plant species richness might vary among strata, then the number of plots might vary among strata and among sites. These differences in sample design among sites do not effect the comparison of one stratum to another within a site, nor the comparison one site to itself overtime, but they do limit the ways in which one site can be compared to another site.

To be more specific, there are technical problems with comparing sites that have different numbers of strata. The strata represent different portions of the tidal curve, meaning they represent different durations and frequencies of tidal inundation. Higher strata represent less frequent inundation of shorter duration. Broad ecotones have more strata than narrow ecotones, and thus have more subdivisions (i.e., categories) of the tidal curve. Different sites can be compared based on their tidal strata because they represent approximately the same part of the curve. But, for sites of different width, the upland strata represent different parts of the curve and are therefore not directly comparable.

For example, consider Site A that is relatively narrow, having only two upland strata labeled 1 and 2, and a broader Site B that has 4 upland strata labeled 1-4. Stratum A1 represents a larger portion of the tidal curve than Stratum B1, and therefore the two strata are probably not comparable (Figure 5). Perhaps strata B1 plus B2 can be combined and equated to A1, and perhaps B3 and B4 can be combined and equated to A2, but this assumes that the tidal curve has the same form at both sites, which will not always be true. Therefore, sites of different width should be compared based on their tidal strata, and based their overall condition for all upland strata combined (i.e., for the upland portion of the ecotone as a whole), but not on the basis of individual upland strata.

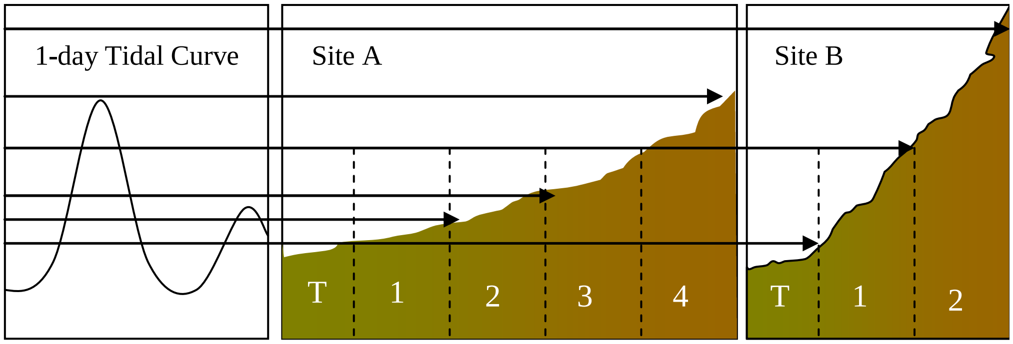


Figure 5: Schematic Diagram of two hypothetical sites, A and B, of different width showing how the tidal strata of the two sites represent the same portion of the tidal curve whereas upland strata A1 and B1represent different portions of the curve, as do strata A2 and B2.

The data generated by this protocol are categorical. That is, they describe conditions within categories of the tidal curve at each site called sample strata. For each parameter of the data, each stratum has a population of data points with a mean and variance that can be used to statistically test for differences between strata at a site, between different time periods for the same stratum at a site, and between comparable strata between sites. The appropriate statistical tests for these comparisons will be analyses of variance. Relationships between two or more parameters measured at the same plots can be explored using regression analyses (Figure 6).

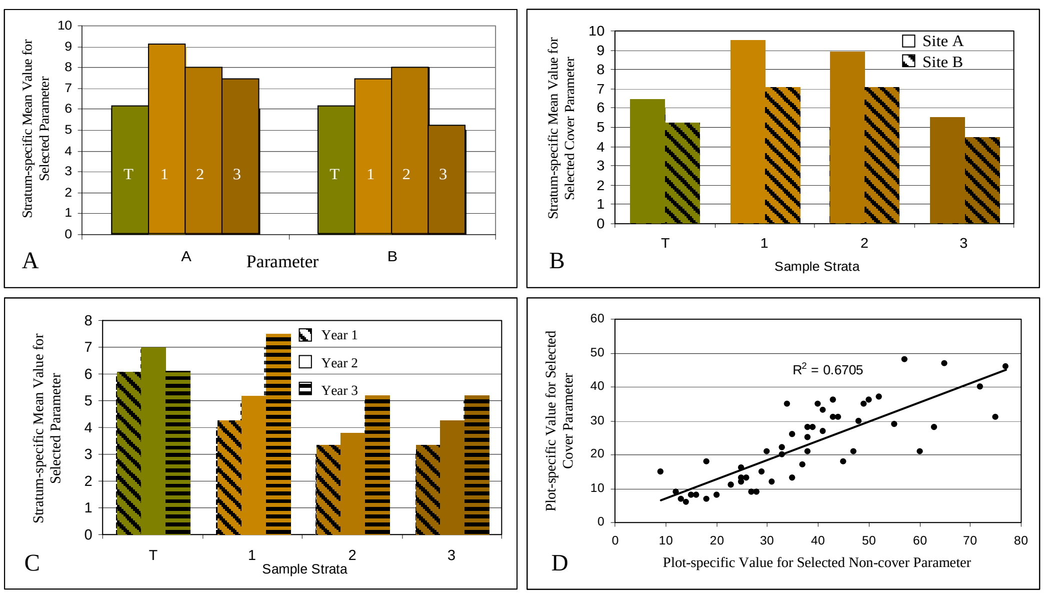


Figure 6: Example plots of hypothetical results showing (A) comparison of two parameters at one site; (B) comparison of two sites based on one cover parameter; (C) changes over time for one parameter at one site; and (D) correlation between non-cover and cover parameters at one or more sites.

Each stratum and site will be analyzed for the frequency of occurrence and percent cover of each plant species and non-vegetation cover type, maximum plant height per species, and percent cover of non-native species. The results can be used to assess how the distribution and abundance of plant species indicative of the tidal marsh plain vary among sites having different salinity regimes, and how the plant community the upland portion of the intertidal-upland ecotone varies with distance away from and above adjoining marshland or tidal flat. This will assist in determining which plant species are best suited for each elevation stratum within and among sites. Using this protocol at different projects will, over time, provide a basis for assessing the interactions among plant species, tidal regime, and vegetation management practices.

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Project Name: ______________________________ Begin Lat:_________________________ Datum:___________________________

Sample Site Name: ___________________________ End Lat: __________________________ SamplePlotSize_m2:_______________

Date: ________________________ Beginning Long: ________________________ Field Staff:________________________

Start Time: ____________________ End Long:_______________________________

End Time:_____________________

| Species Code | Value | Maximum Plant Height (cm) | Native | Sample Site Code | Stratum | Sample Plot Code | Comments |
|---|---|---|---|---|---|---|---|
| Example1: SALV %CS | 3 | 3 | yes | 116 | High | MLKH1 | |
| Example1: DISS %CS | 2 | 2 | yes | 116 | High | MLKH25 | |
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| Species Code | Value | Maximum Plant Height (cm) | Native | Sample Site Code | Stratum | Sample Plot Code | Comments |
|---|---|---|---|---|---|---|---|
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SpeciesCode: first three letters of the genus and the first letter of the species e.g. SALV for Salicornia virginica.
Abiotic Cover Code: MLCH (mulch), THCH (thatch), SDST (sand, silt or clay), GRAV (gravel), COBB (cobble), BLDR (boulder), RPRP (riprap), TRSH (trash)
Strata (from low to high elevation): Tidal (T), Upland A (UA), Upland B (UB), Upland C (UC), Upland D (UD); there are normally three upland strata (UA-UC)
SamplePlotCode: 3 letter acronym of site name , first letter Strata, plot number (e.g. MLKT1, MKLT4, MLKUA3, MLKUA1, MLKUC3, etc)

| Estimated cover categories | Cover class Value |
|---|---|
| >0-1% | 1 |
| >1-5% | 2 |
| >5-25% | 3 |
| >25-50% | 4 |
| >50-75% | 5 |
| >75-95% | 6 |
| >95-100% | 7 |

**Definitions of Cover Types**

*Since cover types can overlap, their combined values of percent cover can exceed 100% per plot.*

**Biotic**

Species: plant species occurring in a plot
Fauna: sessile communities of invertebrates, such as shellfish or barnacles

**Abiotic**

Mulch: purposefully deposited non-living organic ground cover
Thatch: naturally occurring non-living organic ground cover
Sand-Silt-Clay: particles less than 2mm minimum circumference
Gravel: particles 2mm to 64mm minimum circumference
Cobble: particles 64mm to 256mm minimum circumference
Mixture: heterogeneous mix of organic and/or inorganic materials
Boulder: Rock greater than 256mm minimum circumference
RipRap: Rock or other boulder-size material purposely placed as revetment