# Wetland Restoration & Park Creation
# Parcel 11 Carolina, Coral Bay Quarter,
# St. John, U.S. Virgin Islands

**FINAL**

**Gary Ray, Ph.D.**
**Virgin Forest Restorations**

**For Coral Bay Community Council**
**Coral Bay, St. John**

**October 25, 2012**

**Sedge community of brackish marsh, Carolina Valley, Coral Bay**

## Introduction

An altered wetland segment in Coral Bay requires remediation to return its floristic structure and ecological services to minimum standard. The site, located at the corner of Rtes. 20 and 107, identified as "Portion, Parcel 11, Estate Carolina, No. 1 Coral Bay Quarter, St. John", and measuring approximately 1.57 acres, has suffered from key changes in its hydrological and ecological functioning by a recent history consisting mainly of adjacent road construction, livestock grazing, and alien species invasion. These human-caused disturbances can be remedied to a substantial degree structurally by native plant restoration, but within the confines of a hydrologic condition whereby surface and subsurface water flows have been changed in both quantity (overall net flooding) and quality (portion of sediment load contained in runoff). Presently, a small portion of the proposed restoration site consists of upland vegetation. The potential vegetation of wetland margins in this topographic position may consist of a combination of tropical dry and tropical moist forest components. Deep, damp soils of these locally raised topographies allow large, moist forest canopy trees to thrive, and a few localized areas rarely inundated by surface runoff support plants of the tropical dry forest. Yet the dominant portion of the acreage is wetland edge, originally continuous (prior to human settlement of the island) with a small "basin mangrove" grading into an adjoining "fringe mangrove" only tens of meters seaward.

The Oxholm Map of 1800 based on data compiled in 1780, shows the area as cleared for cultivation (Figure 1). Many years ago, a shallow well measuring two meters in diameter, was dug within the current marsh zone, and within 10 m of the northbound lane of Rt. 107. Although rainfall and subsurface flow might bring freshwater into the well basin, tidal influences and lowering the groundwater lens during dry periods would bring ample seawater into the well – making it brackish. At the time of this writing, it was partially filled – its surface covered with water hyacinth (*Eichhornia crassipes*), an aquatic weed.

Figure 1. Oxholm Map of 1800, based on 1780 data, depicting areas under cultivation (clear), in pasture (stippled), and in forest (gray and stippled). The restoration site is indicated by a red arrow.

The existing wetland has been heavily grazed for decades by free-roaming sheep and goats, and the floristic element altered by exotic plant species invasion. Coconut palms, a Pacific plant of sandy shores, have spread into higher margins of the area nearest the paved roads. These trees benefitted from an accumulation of sediment from higher in Carolina Valley that became entrapped at the road margin. They likely began as groves planted in-situ or proliferated by dispersal from adjoining areas. Also, it should be noted that several years ago, this the sedge-dominated area, now grown up in sedge, was cleared by VI Public Works with earthmoving equipment to bare earth, to eliminate cover for illegal activities. At that point,

there was considerable environmental concern that the area could not be restored.

Using funds granted to the Coral Bay Community Council (CBCC) from the National Fish and Wildlife Foundation Five Star Restoration Grant Program and 1:1 matching funds of local resources and volunteers, CBCC aims to restore the Parcel #11 wetland according to this restoration plan. Plan activities will restore native elements to the wetland and protect its integrity by removing exotics, planting native floral components, and installing fencing to exclude roaming livestock and other intrusions. A modest interpretive trail incorporating signage for visitor education is also intended for the site.

## Project Summary

This plan has two key components: (i) a wetland community restoration that substitutes native plants for non-natives, and (ii) a small public park that enriches the edible fruit tree offerings of the site and provides interpretive signage for appreciation of the restored wetland site while developing a small park for community residents.

The wetland restoration is intended to protect and enhance the existing wetland and restore valuable ecological services that cleanse seaward flow of storm runoff carrying terrestrial sediment and surplus nutrients that might otherwise be deposited in Coral Harbor. The plan consists of selecting exotic specimens for removal to be replaced by native species from a listing of native wetland taxa already in-hand. The consultant will advise the Coral Bay Community Council on his recommendations for wetland site protection into the future.

The small park provides a more serene and attractive space for local residents and island visitors to relax and to learn about the indigenous natural heritage of the island. This site will contain a public education component that will consist of on-site signage along a short pathway, terminating at the edge of the wetland restoration. Sign content will interpret biological and ecological features, i.e. species and their interactions with one another and to the physical surroundings – all are inherent aspects of natural communities.

The wetland and park segments will be fenced to protect them from free-roaming livestock. The cultural portion will contain a gate on the Kings Hill Road (Rt. 20) side of the parcel to allow visitors access to the cultural site. Site amenities may include benches near the entrance gate and the wetland perimeter at the terminus of the pathway.

The restoration plan details all actions necessary to implement effectively the ecological restoration, including exotics removal, fencing, planting events, pathway construction, signage installation, and maintenance plans.

Dr. Gary Ray, a restoration ecologist with more than two decades of research experience in the Virgin Islands engaged in restoration ecology, plant community dynamics, native plant propagation and rare plant population ecology designed this restoration plan.

# Wetland Restoration

## *Site Characterization*

The restoration ecologist endeavors to visualize the pre-disturbance condition of the site to be restored, and notes coarse-resolution changes over time in those conditions, based primarily on land use history (Figure 1). Also, wetlands, like other natural communities, have distinctive topographic profiles, hydrologic functions, soil types, and botanical components. What's more, wetlands are subject to daily, seasonal and long-term natural changes due to tidal influence, erratic rainfall patterns and climatic shifts over decades to centuries. Observations of these factors assist the restoration ecologist in creating a model for a natural community appropriate to the site, on which native species selection is based.

### Land Use History

Prior to human contact, the “potential vegetation” (original plant community) of the site likely was either a basin mangrove or brackish marsh along the perimeter of a fringe mangrove. This is based upon a gross assessment of the geography of the valley, its land use history, and the proximity to the coastline of this particular segment. Intensive agriculture and subsequent rural development (Figure 2) are generally responsible for contributing terrestrial sediment, which raised the elevation of site margins, adding dry and moist forest elements to the mixture of resultant local habitats.

Figure 2. Aerial photograph (1954) of eastern Carolina Valley, showing the restoration site, center-right (indicated by blue arrow). Sparsely vegetated areas were cleared as pasture. Remaining terrain was subject to intensive grazing by livestock.

More specifically, important physical changes associated with the development of a plantation era sugar works located up-valley from the site likely increased freshwater flow and reduced mangrove cover. By accepting human-induced topographic and hydrologic (water flow) modifications of the site, yet setting a goal of restoring native

components to these new habitats, we arrive at a tapestry that combines a brackish marsh community as dominant in the center of the site, with some marginal wetland habitats transitional between flood-prone and upland. These damp zones favor a spectrum of plant forms, from tall shrubs to low-growing herbs. Small annexes of upland moist and dry forest communities occur along the more elevated edges of the parcel.

The areal extent of this wetland actually includes most of the one-and-one-half acres, yet, the coconut groves, particularly the stand on the southeast section, in combination with the dense shrub cover to its immediate north, was planted and sustained by humans for years. This produced a variant community structure also shaped by re-channelization of storm water runoff to areas off the site, and changes in local climatic patterns.

## Hydrology and Climate

No measured hydrologic data is available from the literature. The author measured the water level of the open well on the site was 1.4 m below ground surface on July 15. Other areas of the site vary with regard to common wetland attributes observable on the land surface. The presence of burrowing by the local land crab (*Cardisoma guanhumi*) is scattered throughout the entire parcel, except for the topographically lowest section presently occupied by tall sedges, which indicate flooding periods of the longest duration in most years. Structural variation across the site, that is, the mixture of closed to open canopies of trees and shrubs affects the vegetative coverage of the ground layer. Closely aggregated tall evergreen trees tend to exclude sunlight from the ground surface, discouraging herbaceous and woody colonization of the ground. These areas are rich with dead and decaying branches and foliage from the canopy, but little standing vegetation on the forest floor.

While ambient temperature tends to vary only slightly, microenvironments in the ground layer vary broadly, depending on extent of overhanging canopy. The sedge zone gets markedly warmer during the middle of the day due to a lack of shade.

## Soils

The soils of the site have been mapped (Figure 3) as part of the Virgin Islands Soil Survey, commissioned and implemented by the USDA, Soil Conservation Service (presently “Natural Resources Conservation Service) of the early 1990’s. While mapping shows horizontal zonation, site conditions show a mixture of the soil map units in the vertically oriented soil profile, i.e. the gray marl and black muck shows at varying depths of a loamy clay profile – a mixture of soil types.

The soil map unit termed: “Solitude Gravelly Fine Sandy Loam, 0-2% slope, frequently flooded” covers more than 90% of the restoration site. These are light olive brown soils occurring in areas adjacent to saline marshes, containing mixtures of terrestrial and marine sediments. They are somewhat poorly drained with moderate organic matter content, low to moderate fertility, and from slightly to strongly saline. They are unsuited from crop cultivation.

The eastern margin of the site consists of “Sandy Point and Sugar Beach, 0-2% slope, frequently flooded”. These soils occur on nearly level saline marshes as a mixture of olive gray sandy clay loams and black muck near the surface with mucky clay loams with depth in the profile. It is unsuitable for crop cultivation.

The northeast corner, where the CBCC will focus on a cultural restoration and park, has been classified as Ustorthents – a map unit that includes areas “altered from their natural state by human activities” (USDA-NRCS 2000), such as filling activities to raise land levels. Soils of areas to the north and east of this site have been raised using heavy earthmoving equipment.

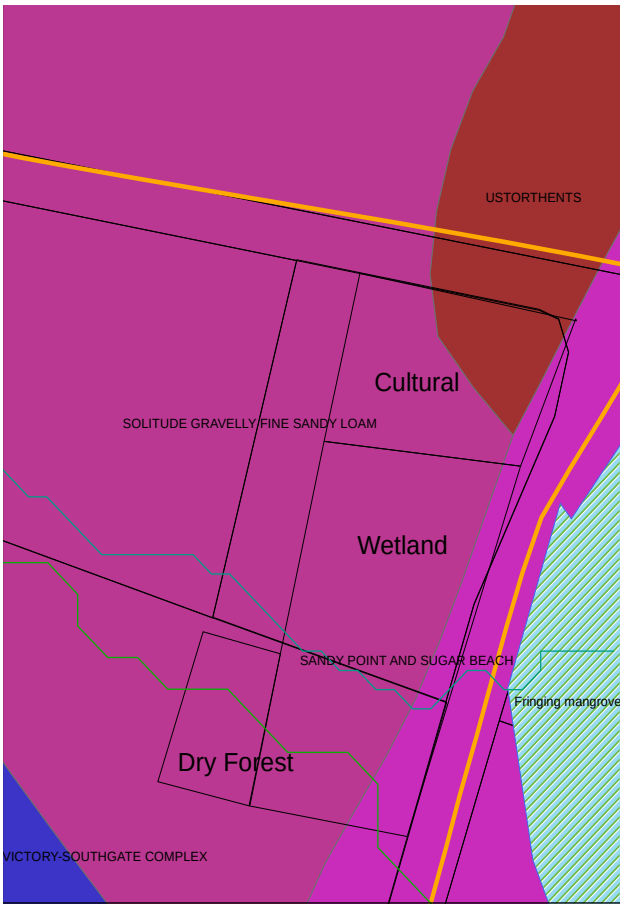


Figure 3. Soil map of the labeled restoration site, including 3 map units: Solitude (burgundy), Sandy Point and Sugar Beach (SBA, magenta), and Ustorthents (brown) (see narrative). *Sources*: USDA, NRCS Soil Survey of the U.S. Virgin Islands, UVI Conservation Data Center.

## Description of Plant Community Structure

The author compiled a list of 51 plant species occupying the site, 34 of which were native to the site (Table 1). Approximations of the relative densities of each species are also given. These species are organized into multi-species associations that distribute themselves according to numerous and complex interactions with their physical and biological surroundings.

**Table 1. List of native and introduced vascular plant species of Parcel 11, Coral Bay, St. John.**

| No. | Scientific name | Common name | Family | Vernacular Family | Habit | Nativity | Abundance |
|---|---|---|---|---|---|---|---|
| 1 | *Asystasia gangetica* | Chinese violet | *Acanthaceae* | Acanth | herb | exotic | common |
| 2 | *Ruellia tuberosa* | Christmas pride | *Acanthaceae* | Acanth | herb | exotic | frequent |
| 3 | *Annona muricata* | soursop | *Annonaceae* | Soursop | tree | exotic | frequent |
| 4 | *Cocos nucifera* | coconut | *Arecaceae* | Palm | tree | exotic | dominant |
| 5 | *Cryptostegia grandiflora* | rubber vine | *Apocynaceae* | Dogbane | vine | exotic | frequent |
| 6 | *Cleome spinosa* | spider flower | *Capparaceae* | Caper | herb | exotic | occasional |
| 7 | *Merremia quinquefolia* | rock rosemary | *Convolvulaceae* | Morningglory | vine | exotic | frequent |
| 8 | *Jatropha gossypifolia* | belly ache bush | *Euphorbiaceae* | Spurge | herb | exotic | frequent |
| 9 | *Senna bicapsularis* | stiverbush | *Fabaceae: Caesalpinioideae* | Legume | shrub | exotic | occasional |
| 10 | *Abrus precatorius* | crab's eye; jumbie bead | Fabaceae: Faboideae | Legume | vine | exotic | occasional |
| 11 | *Leucaena leucocephala* | wild tamarind; tan-tan | *Fabaceae: Mimosoideae* | Legume | tree | exotic | common |
| 12 | *Swietenia mahagoni* | West Indian mahogany | *Meliaceae* | Mahogany | tree | exotic | occasional |
| 13 | *Passiflora foetida* | stinking passionflower | *Passifloraceae* | Passion Fruit | vine | exotic | occasional |
| 14 | *Chloris barbata* | finger-grass | *Poaceae* | Grass | herb | exotic | common |
| 15 | *Cynodon dactylon* | bermuda grass | *Poaceae* | Grass | herb | exotic | common |
| 16 | *Antigonon leptopus* | Mexican coral vine | *Polygonaceae* | Seagrape | vine | exotic | common |
| 17 | *Eichhornia crassipes* | water hyacinth | *Pontederiaceae* | Water Hyacinth | herb | exotic | rare |

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|---|---|---|---|---|---|---|---|
| 18 | *Annona glabra* | pond apple | *Annonaceae* | Soursop | tree | native | occasional |
| 19 | *Coccothrinax barbadensis* | Teyer palm | *Arecaceae* | Palm | tree | native | occasional |
| 20 | *Pluchea odorata* | salt marsh aster | *Asteraceae* | Aster | shrub | native | occasional |
| 21 | *Cordia collococca* | red manjack | *Boraginaceae* | Heliotrope | tree | native | occasional |
| 22 | *Cordia rickseckeri* | orange manjack | *Boraginaceae* | Heliotrope | tree | native | occasional |
| 23 | *Quadrella cynophallophora* | Jamaica caper | *Capparaceae* | Caper | tree | native | occasional |
| 24 | *Cynophalia flexuosa* | limber caper | *Capparaceae* | Caper | liana | native | occasional |
| 25 | *Cassine xylocarpa* | false nutmeg; nothing nut | *Celastraceae* | Bitterbush | tree | native | frequent |
| 26 | *Cyperus elegans* | sticky sedge | *Cyperaceae* | Sedge | herb | native | dominant |
| 27 | *Cyperus ligularis* | flatleaf flatsedge | *Cyperaceae* | Sedge | herb | native | dominant |
| 28 | *Cyperus planifolius* | swamp flatsedge | *Cyperaceae* | Sedge | herb | native | frequent |
| 29 | *Fimbristylis cymosa* | cymose sedge | *Cyperaceae* | Sedge | herb | native | frequent |
| 30 | *Fimbristylis dichotoma* | junquito | *Cyperaceae* | Sedge | herb | native | frequent |
| 31 | *Kyllinga odorata* | kyllinga | *Cyperaceae* | Sedge | herb | native | occasional |
| 32 | *Caesalpinia bonduc* | gray nicker | *Fabaceae: Caesalpinioideae* | Legume | shrub | native | occasional |
| 33 | *Andira inermis* | angelin | *Fabaceae: Faboideae* | Legume | tree | native | occasional |
| 34 | *Crotalaria retusa* | yellow lupine | *Fabaceae: Faboideae* | Legume | shrub | native | occasional |

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|---|---|---|---|---|---|---|---|
| 35 | *Vachellia macracantha* | stink casha | *Fabaceae: Mimosoideae* | Legume | tree | native | occasional |
| 36 | *Casearia guianensis* | Guyanese wild coffee | *Flacourtiaceae* | Flacourtia | tree | native | occasional |
| 37 | *Malvastrum americanum* | cheeseweed | *Malvaceae* | Hibiscus | herb | native | frequent |
| 38 | *Ficus citrifolia* | citrus-leaved fig | *Moraceae* | Fig | tree | native | rare |
| 39 | *Eugenia monticola* | black cherry | *Myrtaceae* | Myrtle | tree | native | occasional |
| 40 | *Eugenia procera* | rockmyrtle | *Myrtaceae* | Myrtle | shrub | native | occasional |
| 41 | *Guapira fragrans* | black mampoo | *Nyctaginaceae* | Four O'clock | tree | native | frequent |
| 42 | *Trichostigma octandrum* | hoop vine | *Phytolaccaceae* | | vine | native | common |
| 43 | *Sporobolus indicus* | West Indian rush-grass | *Poaceae* | Grass | herb | native | common |
| 44 | *Coccoloba uvifera* | seagrape | *Polygonaceae* | Seagrape | tree | native | frequent |
| 45 | *Randia aculeata* | inkberry | *Rubiaceae* | Coffee | shrub | native | occasional |
| 46 | *Zanthoxylum martinicense* | white pricklyash | *Rutaceae* | Citrus | tree | native | occasional |
| 47 | *Zanthoxylum monophyllum* | yellow prickle | *Rutaceae* | Citrus | tree | native | rare |
| 48 | *Guazuma ulmifolia* | West Indian elm | *Sterculiaceae* | Cacao | tree | native | rare |
| 49 | *Waltheria indica* | marsh-mallow | *Sterculiaceae* | Cacao | shrub | native | occasional |
| 50 | *Citharexylum fruticosum* | fiddlewood | *Verbenaceae* | Vervain | tree | native | occasional |
| 51 | *Cissus verticillata* | pudding vine; season vine | *Vitaceae* | Grape | vine | native | common |

One such association is defined by the abundance of sedges (Figure 4) – grass-like herbs of the sedge family, (*Cyperaceae*), that mostly favor frequently flooded sites. The subsoil content is typified by a high amount of gray marl. Plants adapted to the longest periods of flooding, and thus tolerate low oxygen soils, dominate the lowest areas of the local terrain. These species include flatleaf flat-sedge (*Cyperus ligularis*), a 5-foot tall herb growing in tight aggregations some two feet in diameter favoring the more flooded sites, and sticky sedge (*Cyperus elegans*), a smaller herb with similar tolerance of flooding, that fills areas not occupied by the taller sedge. Other sedges include swamp flatsedge (*Cyperus planifolius*), which is similar in height to flatleaf sedge, but far less tolerant to inundation during wet periods. Other rush-like herbs, featuring a very tall, narrow habit include cymose sedge (*Fimbristylis cymosa*) and junquito (*Fimbristylis dichotoma*), are mixed with the taller sedge species on the wettest microsites. A sixth sedge species, scented kyllinga (*Kyllinga odorata*) occurs along the roadside margins. This sedge association is largely intact with few introduced species found within.

Figure 4. Sedge community dominated by flatleaf flat-sedge (*Cyperus ligularis*) and sticky sedge (*Cyperus elegans*) at the center of the wetland restoration site, Parcel 11, Coral Bay.

A second association (Figure 5) is a mixture of shrubs and trees in a zone that is exposed less often to flooding, and contains soils and more land crab holes (burrow entrances) than the sedge zone. This association is variable and highly disturbed by human-related activities, and it cannot be characterized as part of moist forest or dry forest communities. The most frequent shrub is the native salt marsh aster (*Pluchia odorata*). Non-native shrubs include numerous scattered belly-ache bushes (*Jatropha gossyip*ifolia), and stiver bush (*Senna bicapsularis*). None of these species are palatable to sheep and donkeys; their abundance testifies to intensive grazing pressure. This is a highly anthropogenic (human-engendered) plant community due to domination by these two “disturbance increaser” plant species. Coconut groves are also a significant structural presence, and copious falling fronds and fruits shifts conditions of the ground layer to favor weedy exotics. Soursop trees are scattered throughout this zone.

Figure 5. Intermittent canopy of tall coconuts provides feeble shade for more robust growth of shrubs, many of them non-native, in this mixed association at the center of the restoration area.

Figure 6. Moist forest area at the southeast corner of the parcel, view to west. Soils are sufficiently deep to retain moisture, and partial flooding clears the ground layer.

A moist association (Figure 6) relies on deeper soils that retain moisture, yet dry out periodically to maintain oxygen content. This community is somewhat abbreviated on the parcel, occupying mostly the southeast corner and a narrow strip along the south boundary. Native trees include angelin (*Andira inermis*), black mampoo (*Guapira fragrans*), white prickly-ash (*Zanthoxylum martinicense*), yellow prickle (*Zanthoxylum monophyllum*) and West Indian elm (*Guazuma ulmifolia*). Scattered through the area were Guyanese wild coffee (Casearia guianensis), and tan tan (*Leucaena leucocephala*). Non-native components include coconut and Jumbie bead (*Abrus precatorius*).

A fourth association is a tiny fragment of upland dry forest located in the southwest corner of the parcel. Most of this area was altered recently by wholesale clearing of the adjacent lot (and associated piling of slash into this zone) to advance an agricultural project. The light regime has been greatly enhanced by canopy removal. The evaporation rate, and localized light regime has risen greatly, attributable to the clear-cutting of forest. Successful restoration of this small, dry woodland will depend somewhat on the disposition of slash pile. Woody slash may be chipped into mulch, which could be deposited at the perimeter of the agricultural plot to mitigate erosion from agricultural land clearing. Non-natives rubber vine (*Cryptostegia grandiflora*), and hoop vine (*Trichostigma octandrum*) are dense in the shrub layer and also are found climbing into a few trees. Most of the pre-existing dry forest species have been destroyed subsequent to the site inventory. The native species recorded were shrubs and woody vines such as brazilet (*Erythroxylum brevipes*), rock-myrtle (*Eugenia procera*), black cherry (*Eugenia monticola*), limber caper (*Cynophalia flexuosa*), and inkberry (*Randia aculeata*). Trees included Teyer palm (*Coccothrinax barbadensis*), citrus-leaved fig (*Ficus citrifolia*), orange manjack (*Cordia rickseckeri*), red manjack (*Cordia collococca*), fiddlewood (*Citharexylum fruticosum*) and false nutmeg (*Cassine xylocarpa*). The shrubs, except brazilet, are evergreen; the trees are deciduous, excepting the Teyer palm.

A small well measuring about 3.3 m in diameter is located in the sedge zone. The water level is variable, depending on rainfall and subterranean discharge and recharge rates, but when measured in mid-July was 1.3 m (about 4 ft) below ground surface. The surface standing water is covered with water hyacinth (*Eichhornia crassipes*). A rim wall rises approximately one foot above the ground surface. It water quality is likely to be low for irrigation due to its proximity (about 60 feet) to the sea. This well should be stocked with mosquito fish (*Gambusia holbrooki*) to control mosquito breeding.

***Vegetation Mapping***

Superimposed upon a base map of the site, the restoration specialist depicts the layout of (a) woody and herbaceous exotics to be removed, (b) special protection for native plants valuable to retain during replanting (these are seed sources for the restoration planting and subsequent community recovery), and (c) areas designated for native planting, whose specimens have been propagated off-site. The source of base maps is varied. We used a GIS library consisting of aerial images (Figure 7) of the ground and covering vegetation, but with numerous other components, called "layers", such as soils, slope, and integraded rainfall data Satellite images published on Google Earth offer an aerial perspective, but also an historical one, since older aerial images may be downloaded – contributing insights on recent land use. We begin with a recent aerial from Google Earth. We divide the parcel into vegetation zones, whose boundaries were located with the aid of "ground-truthing" the site (Figure 7). The cultural restoration is located in the northern section of the parcel bordered on the east and north by Routes 107 and 20, respectively. The brackish marsh, dominated by sedges stretches across the center section. An unsorted area consisting of moist forest species, mostly scattered in the southeast corner and along the south boundary, and shrubby vegetation interrupted by some open areas of weedy herbs covers the southern half of the parcel (Figure 8).

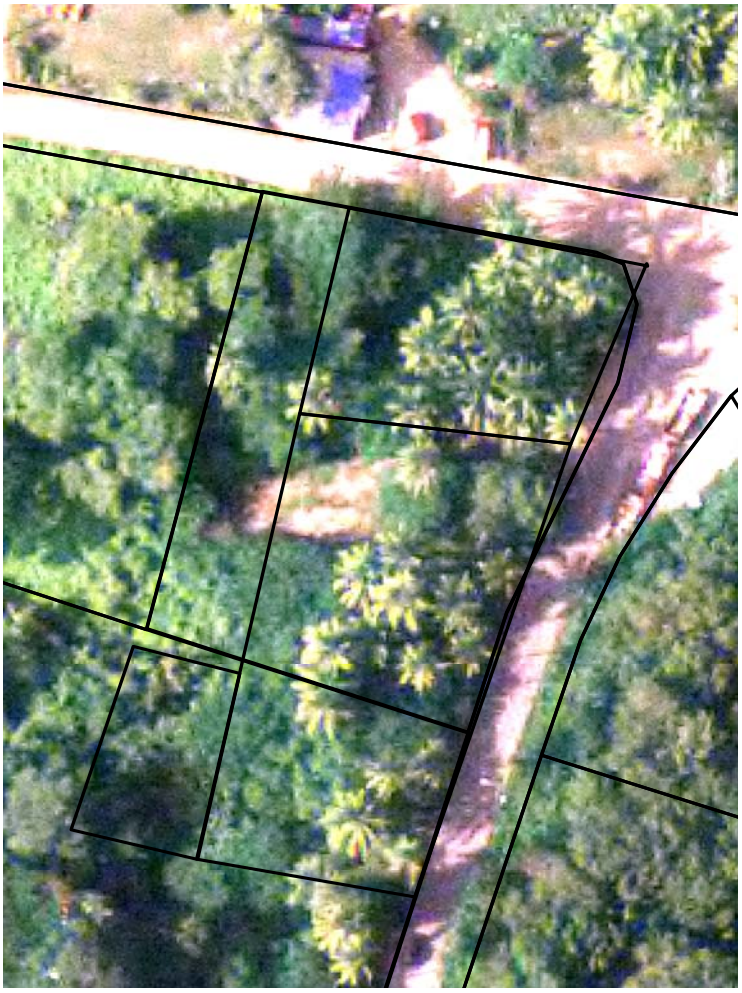

Figure 7. Aerial image of site (parcels are indicated by black lines). Image clearly shows the barren marsh zone, at center, and coconut groves along the eastern section of the site.

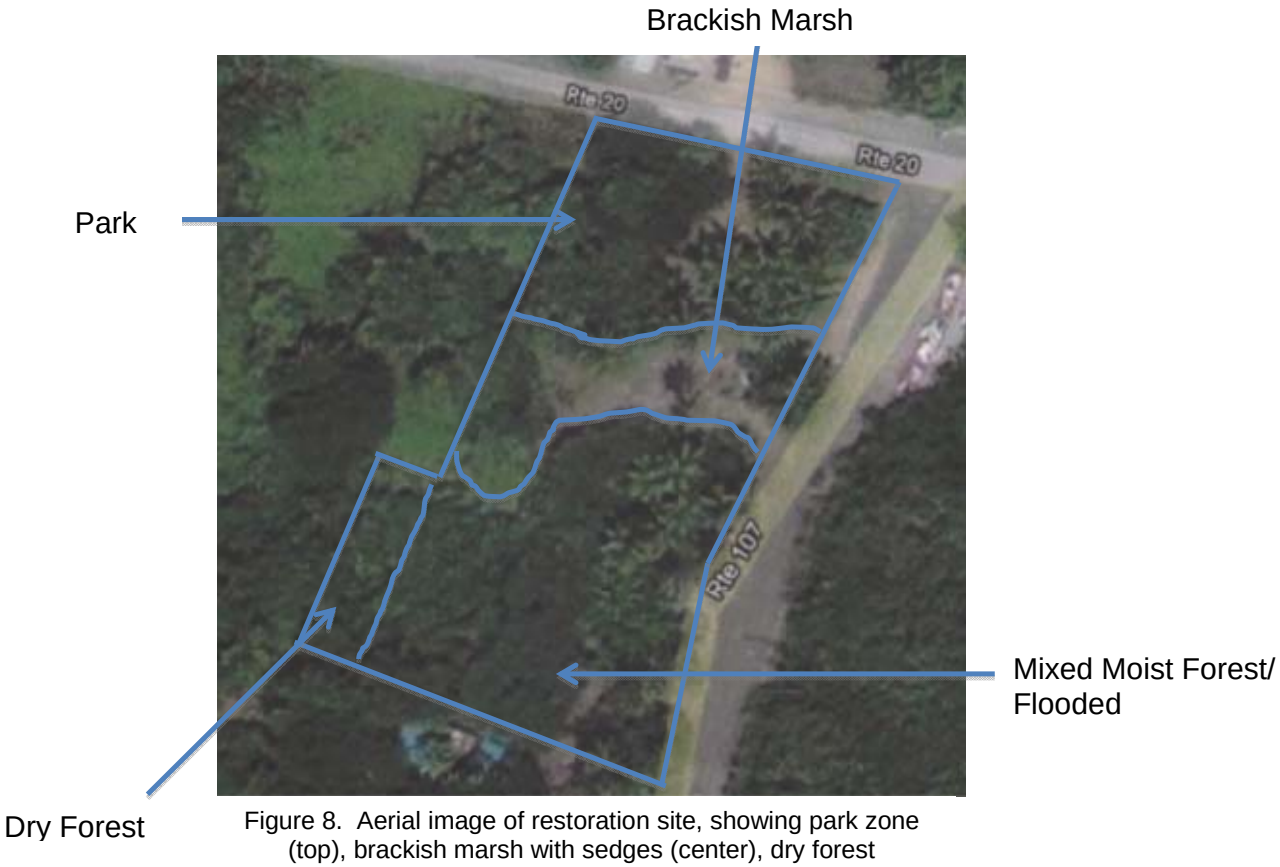


Figure 8. Aerial image of restoration site, showing park zone (top), brackish marsh with sedges (center), dry forest association (left or southwest corner), and mixed moist forest occasionally inundated (southeast section), as indicated by blue arrows.

## Implementation Approach

### Native Species Selection for Restoration

The author has selected twenty-one native species to be propagated and planted on the restoration site (Table 2). The planting zones are indicated in Table 2. After exotics removal, but prior to planting, the exact planting positions for all propagules will be indicated on the site with flagging stakes. Each stake will be coded for the number of the species (1-21) intended for planting at that location. Seedlings will be planted by hand using volunteer assistance.

**Table 2. List of native vascular plant species selected for restoration, Parcel 11, Coral Bay, St. John, indicating the planting zones for all selected species.**

| No. | Scientific name | Common name | Planting Zone | Habit | Price | No. Specimens | Amount |
|---|---|---|---|---|---|---|---|
| 1 | *Coccothrinax barbadensis* | Teyer palm | dry forest | tree | $25 | 4 | $100 |
| 2 | *Cordia rickseckeri* | orange manjack | dry forest | tree | $20 | 4 | $80 |
| 3 | *Quadrella cynophallophora* | Jamaica caper | dry forest | tree | $25 | 2 | $50 |
| 4 | *Quadrella flexuosa* | limber caper | dry forest | liana | $19 | 3 | $57 |
| 5 | *Cassine xylocarpa* | false nutmeg | dry forest | tree | $16 | 4 | $64 |
| 6 | *Cyperus elegans* | sticky sedge | marsh | herb | $12 | 12 | $144 |
| 7 | *Cyperus ligularis* | flatleaf flatsedge | marsh | herb | $12 | 6 | $72 |
| 8 | *Cyperus planifolius* | swamp flatsedge | marsh | herb | $12 | 10 | $120 |
| 9 | *Fimbristylis cymosa* | cymose sedge | marsh | herb | $15 | 6 | $90 |
| 10 | *Fimbristylis dichotoma* | junquito | marsh | herb | $18 | 4 | $72 |
| 11 | *Kyllinga odorata* | kyllinga | marsh | herb | $10 | 10 | $100 |
| 12 | *Andira inermis* | angelin | mixed moist forest | tree | $30 | 1 | $30 |

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| No. | Scientific name | Common name | Planting Zone | Habit | Price | No. Specimens | Amount |
|---|---|---|---|---|---|---|---|
| 13 | *Ficus citrifolia* | citrus-leaved fig | mixed moist forest / marsh | tree | $30 | 1 | $30 |
| 14 | *Eugenia monticola* | black cherry | dry forest | tree | $35 | 2 | $70 |
| 15 | *Eugenia procera* | rockmyrtle | mixed moist forest / marsh | shrub | $20 | 3 | $60 |
| 16 | *Guapira fragrans* | black mampoo | mixed moist forest / marsh | tree | $35 | 6 | $210 |
| 17 | *Randia aculeata* | inkberry | dry forest | shrub | $14 | 1 | $14 |
| 18 | *Zanthoxylum martinicense* | white pricklyash | mixed moist forest / marsh | tree | $40 | 1 | $40 |
| 19 | *Zanthoxylum monophyllum* | yellow prickle | mixed moist forest / marsh | tree | $35 | 1 | $35 |
| 20 | *Guazuma ulmifolia* | West Indian elm | mixed moist forest / marsh | tree | $40 | 1 | $40 |
| 21 | *Citharexylum fruticosum* | fiddlewood | dry forest | tree | $20 | 6 | $120 |
| | | | | | | 88 | **$1,598** |

Perennial forbs and shrubs may be planted in areas transitional between ponded and upland soils, which includes most of the southeast and west-central portion of the site. These include the capers, such as limber caper (*Quadrella flexuosa*), an evergreen shrub that scrambles into other trees and shrubs where available, changing form into a woody vine (liana), and Jamaica caper (*Quadrella cynophallophora*), a small evergreen tree that is salt-tolerant with an elegant growth habit. Both of these plants attract nocturnal moth and bat pollinators. Birds and bats disperse their fruits. False nutmeg (*Cassine xylocarpa*) is another evergreen, salt-tolerant tree of coastal sites whose fruits are consumed and dispersed by bats.

Basin moist forest tree species may be planted in areas with deep soils not influenced by saltwater intrusion, located on the south section of the site and intergrading with the southwest area, which is slightly higher terrain. This moist association is depleted of natives except for some large trees, including angelin (*Andira inermis*), white pricklyash (*Zanthoxylum martinicense*), yellow prickle (*Zanthoxylum monophyllum*), West Indian elm (*Guazuma ulmifolia*), and black mampoo (*Guapira fragrans*). We will plant a selection of these species in this location, as available.

Dry forest woody plants may be planted in upland areas, mostly restricted to the southwest corner of the site. Species selected for site enrichment, encountered in the vicinity, but outside the target site boundaries, include guavaberry (*Myrciaria floribunda*), rodwood (*Eugenia biflora*), pink cedar (*Tabebuia heterophylla*), turpentine tree (*Bursera simaruba*), water mampoo (*Pisonia subcordata*), frangipani (*Plumeria alba*), citrus-leaved fig (*Ficus citrifolia*), and white bark (*Casearia decandra*). These are a blend of deciduous and evergreen trees from understory (white bark) to canopy trees (turpentine and water mampoo) to canopy emergent (pink cedar). Enrichment of the species composition will add some ecological stability to this patchy habitat.

With shifts in rainfall patterns, the boundaries of the described associations migrate to accommodate the balance between freshwater and seawater, and corresponding oxygen and nutrient availability in the soils. Overall, we seek to increase the species composition of native plants to better accommodate the changing site conditions. Some portion of the planted cohort will not survive planting. The strategy is to plant at a slightly higher density than a natural community would tolerate, and allow natural mortality and interspecific competition to sort out the final plant distributions. The number of woody (shrubs and trees) propagules planted is estimated at 80 plants – 60 of these are woody (shrubs, trees and woody vines), the remainder are herbaceous (sedges). We will make every attempt to prevent damage to existing sedges during weed removal and planting. Sedges propagated in the nursery and transplanted to the site will be planted after all other woody plants are installed, unless we find some convenient pathways that allow volunteers to avoid these sensitive areas.

## Exotics Removal

Seventeen of the 51 plant species (33%) tabulated in the restoration site are non-native. Most of these exotics are not aggressive, but a few can alter the species

balance of the larger plant community. Rubber vine (*Cryptostegia grandiflora*) thickly covers the dry upland zone. Mexican coral vine, an herbaceous creeper, blankets the area in three dimensions, covering the ground surface, but also climbing atop the canopies of most other species, robbing them of sunlight during the growing season. Others, such as belly ache bush (*Jatropha gossypifolia*), Chinese violet (*Asystasia gangetica*) and stiverbush (*Senna bicapsularis*), are unpalatable to sheep, goats and donkeys, so these introduced species tend to proliferate in response to intensive grazing (Figure 9a). These plants are distributed throughout the site and cannot be mapped. Therefore, the weed extraction process should be overseen by the consultant and by Patricia Reed.

From throughout the parcel, we intend to remove all of the invasive exotics, and as many of the less aggressive exotics as achievable, using volunteer assistance. Mexican coral vine, rubber vine, bellyache bush, and Chinese violet are the key target species for removal. Following these, stiver bush, finger grass (*Chloris barbuta*) and jumbie bead (*Abrus precatorius*) will be removed. All exotics except coconut will be controlled or removed. Two to three coconut trees may need to be removed in the area planned for public use & children's play (Figure 9b).

Figure 9a. Feral donkeys and free-roaming livestock heavily graze the site, altering plant species composition to favor non-palatable weeds, while spreading weeds from other areas in their fecal piles

Figure 9b. Coconut (a Pacific Rim species introduced to the island in the 16th century) is present near the roadside at Rt. 107, some attaining heights of nearly 100 feet, presenting some danger to people spending significant time in the park.

## Fencing

The area is fenced along its south border with barbed wire. We will seek permission to tie-in with field fencing to exclude wandering livestock., It is assumed that the Virgin Islands Department of Agriculture will have erected its fence along the western border so that CBCC can tie into both these fences. This project will then build a fence consisting of 4" x 4" field mesh along the parcel's east and north sides along Routes 107 and 20, respectively.

The east side fence line measures 325 feet, the length of the north side is 123 feet, and the divider on the north side of the wetland restoration is 123 ft, for a total perimeter fence total of 571 feet, including the park. With ten foot spacing, we will need about 46 posts. Alternating 4 x 4 foot wooden posts, salvaged from the ARRA signposts slated for disassembly, and 7-foot steel posts, we can build an attractive

fence for the parcel perimeter. The 4 x 4 posts will add stability, and we can further strengthen the fence by setting the bases in concrete. On the north side, near the center of the fence, we will install a 4 feet wide gate with a spring closure to keep livestock out. With volunteer labor, and based on a fencing and post cost of $3.50 per foot, we estimate the cost of this fence to be approximately $2,000.

**Native Plant Acquisition**

The consultant's business growingA local grower of St. John native plants, Virgin Forest Nursery, is willing to provide the specimens to be planted (Table 2). All planted specimens will originate from seeds or cuttings collected on St. John of species indigenous to the island's natural communities. Propagation is being conducted in Coral Bay. A total of 88 specimens, costing $1,598, will be planted into the restoration area. These plants canwill be delivered by the Nursery and will be planted in mid- to late-October.

## Park Creation

Some 58 years ago, historic aerial photos show the area with coconut palms along the eastern margin with most of the remainder of the site consisting of herbaceous plant cover (Fig. 6). The only edible fruit other than coconut likely to have occupied the site at the time was soursop (*Annona muricata*). Today, the site exhibits extremely tall coconut palms, some approaching 100 feet, and a plant community infested with weeds and often inhabited by roaming livestock and feral donkeys.

Many Coral Bay residents have expressed an interest in developing community gardens and parks in the flat area near the center of town that stretches around the perimeter of Coral Harbor. The "Sisters' Garden" site has been the object of much discussion as a park or public garden over the years. Along with the coconut palms, a number of soursop (*Anona muricata*) trees are found scattered around the cultural zone. These are choice edible fruits important to St. John residents. We thought we would try to enhance the cultural value by supplementing the existing exotic fruit trees while creating a more tranquil, attractive setting.

A goal of the Cultural Restoration is to provide a small park for community recreation, education and awareness of natural heritages, and general aesthetic appeal. Activities to be conducted as part of the wetland restoration include construction of a self-guided path to the wetland installation with interpretive signs conveying information on plant communities and specimen trees, and planting edible fruit trees throughout the park. In the future, CBCC plans to provide benches for resting, a small play area for young children, and an attractive fence and gate on the King's Hill Road (Rt. 20) side of the park.

Toward our aim to increase the diversity of edible fruit trees in this setting, Mr. Raymond Thomas, Director of the St. John Station of the VI Department of Agriculture, is contributing 12 specimens of six species of edible fruit trees to the cultural restoration. These include coco plum, sugar apple, mango, West Indian cherry, and sapodillo (Table 3). These 12 fruit tree saplings will be planted at opportune locations in the cultural restoration zone.

The pathway will wind from the gate, located at the center of the north side (see Amenities Layout – Appendix I) toward the center section containing the wetland restoration. Its exact corridor will depend on availability of materials, such as pavers for installation into the ground. Along the path, four interpretive signs will cover descriptions of i) the fruit trees, ii) the coconut groves, iii) the purpose for livestock exclusion, and iv) information on the rain tree (*Samanea saman*), which dominates the cultural zone on its western side. As the pathway proceeds toward the brackish marsh zone, it will approach but not reach a 123-feet long field-mesh divider fence stretching from the east to west fence lines. The path will run parallel to the divider fence as it terminates. At this location, approximately at the midpoint of the divider fence, we will place a bench and a larger interpretive sign describing the purpose of the wetland restoration. Three nearby signs will identify key species of the sedge zone, the mixed mesic zone, and the dry forest upland fragment. Costs of signage and their creative content are to be determined.

**Table 3. List of edible fruit trees contributed by the VI Dept. of Agriculture to public park area of Parcel 11, Coral Bay, St. John.**

| No. | Common name | Scientific name | No. of plants |
|---|---|---|---|
| 1 | Coco plum | *Chrysobalanus icaco* | 1 |
| 2 | Guava | *Psidium guajave* | 3 |
| 3 | Sugar Apple | *Annona squamosa* | 3 |
| 4 | Mango | *Mangifera indica* | 3 |
| 5 | West Indian Cherry | *Eugenia uniflora* | 1 |
| 6 | Sapodillo? | *Manilkara zapota* | 1 |
| | | | 12 |

## Project Maintenance

The restoration area will require weeding, some plant replacement for anticipated mortality estimated at approximately 10-15% of plants installed, and repairs to fencing. Plant maintenance is divided into 3 general categories: exotics removal, pruning and re-planting of dead propagules. Exotics extraction and pruning should be done semi-annually during Spring and Fall rainy periods. Replanting should be done annually during the autumn rains. Most of this should be implemented using volunteer labor. Monitoring of restoration should be contracted out to an experienced restoration ecologist. It will require about $1500 per year in professional consulting fees. Clearing of litter and other debris should be achieved at least twice per year, or as required. Repair to signage, pathways and benches, as needed, will require additional funding and volunteer assistance.

## Project Implementation Schedule

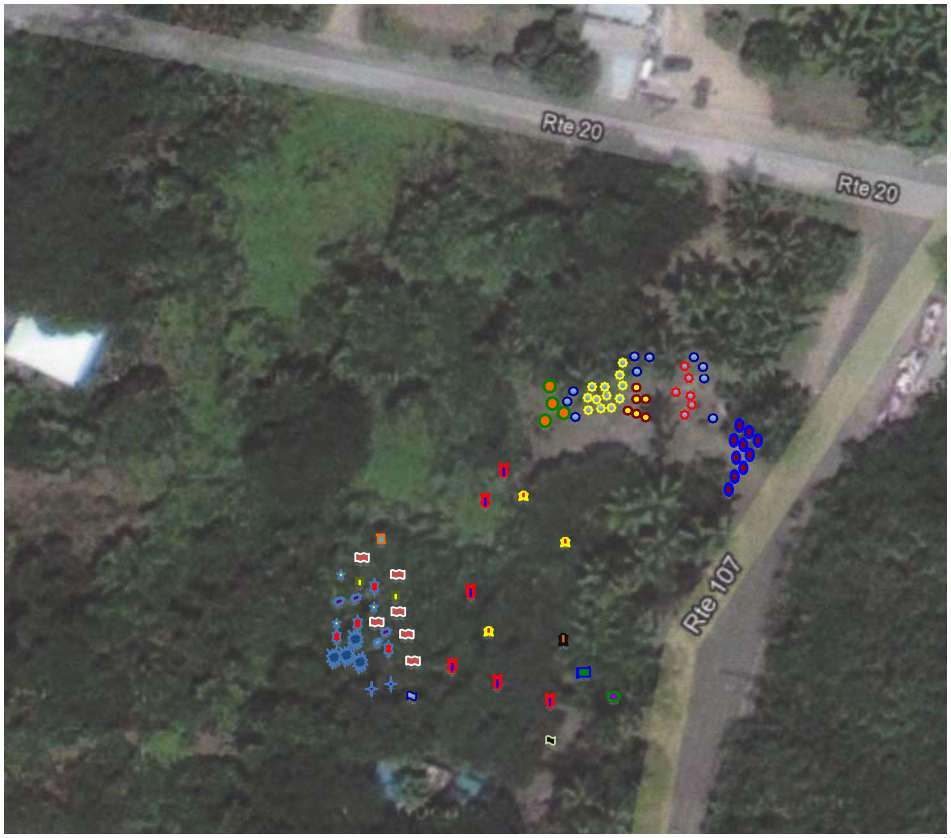
Following the initial public meeting on June 18, the author will submit the draft planting design on July 1 for agency review as of July 2, 2012. The final planting design will be submitted by September 7. Exotic plant removal may commence anytime in August, but should be done by September 15th. Fence construction may run concurrently with exotics removal, but should be completed by October 1. Following fence completion, we can finish cleaning the site around October 15. This clears the way for planting of natives during late October.

Once plants are established, we can install signage by late-November. Project maintenance commences following signage installation and continues through July 2013.

**Table 4. Proposed implementation schedule for the Riparian Restoration and Wetland Protection Project for Parcel 11, Coral Bay, St. John, Virgin Islands.**

| Task | Date |
|---|---|
| Public meeting | 18 Jun 2012 |
| Draft planting design | 1 Jul 2012 |
| Complete planting design | 7 Sept 2012 |
| Agency review meeting | 14 Sept 2012 |
| Non-native/invasive species removal | 15 Sep – 1 Oct 2012 |
| Fence construction | 15 Sep – 1 Oct 2012 |
| Cleanup of Parcel 11 | 1 Oct – 15 Oct 2012 |
| Native and fruit tree planting effort | 15 Oct – 31 Oct 2012 |
| Signage installation | 30 Nov 2012 |
| Project maintenance period | 30 Nov 2012 – 31 Jul 2013 |

# APPENDIX I : Map of Wetland Restoration Planting Locations




| | Scientific name | Common name | Plant community |
|---|---|---|---|
| 1 | *Coccothrinax barbadensis* | Teyer palm | dry forest |
| 2 | *Cordia ricksecker*i | orange manjack | dry forest |
| 3 | *Quadrella cynophallophora* | Jamaica caper | dry forest |
| 4 | *Quadrella flexuosa* | limber caper | dry forest |
| 5 | *Cassine xylocarpa* | false nutmeg | dry forest |
| 6 | *Cyperus elegans* | sticky sedge | marsh |
| 7 | *Cyperus ligularis* | flatleaf flatsedge | marsh |
| 8 | *Cyperus planifolius* | swamp flatsedge | marsh |
| 9 | *Fimbristylis cymosa* | cymose sedge | marsh |
| 10 | *Fimbristylis dichotoma* | junquito | marsh |
| 11 | *Kyllinga odorata* | kyllinga | marsh |
| 12 | *Andira inermis* | angelin | mixed moist forest / marsh |
| 13 | *Ficus citrifolia* | citrus-leaved fig | mixed moist forest / marsh |
| 14 | *Eugenia monticola* | black cherry | dry forest |
| 15 | *Eugenia procera* | rockmyrtle | mixed moist forest / marsh |
| 16 | *Guapira fragrans* | black mampoo | mixed moist forest / marsh |
| 17 | *Randia aculeata* | inkberry | dry forest |
| 18 | *Zanthoxylum martinicense* | white pricklyash | mixed moist forest / marsh |
| 19 | *Zanthoxylum monophyllum* | yellow prickle | mixed moist forest / marsh |
| 20 | *Guazuma ulmifolia* | West Indian elm | mixed moist forest / marsh |
| 21 | *Citharexylum fruticosum* | fiddlewood | dry forest |