

Paleoecology of the Great Plain of Martha's Vineyard

Preliminary report on analyses from Duarte Pond

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The Great Plain of Martha's Vineyard is a broad and gently sloping sandplain that comprises the south-central half of the island. Due to the coarse, sandy nature of the soils the area supports a relatively unusual series of plant and animal communities dominated by species adapted to xeric conditions. Although much of the area is in private ownership a considerable amount of land is under various forms of protection and managed by diverse state and town agencies and private organizations. The most notable parcel is the 5200-acre Manuel F. Correllus State Forest, which is managed by the Department of Environmental Management and represents the single largest, and arguably most important conservation property on the island.

Despite the large amount of "protected" land on the plain there are many issues that raise concern about the long-term viability of the unusual plant and animal species and assemblages. Foremost among these is selection of appropriate approaches for long-term management of these properties. In particular, most assessments of sandplain vegetation conclude that these species and communities are maintained by a combination of harsh edaphic conditions and chronic or episodic disturbance and that therefore they may require ongoing disturbance or management for their maintenance. In order to develop appropriate management or disturbance regimes for these areas conservationists and land managers require background on the history and dynamics of these systems. In particular it is essential to understand the long-term history of the vegetation (and where possible the animal communities) and the history of natural and human disturbance processes and environmental change that have shaped these through time.

In earlier studies we used extensive historical research supplemented by modern studies and previously published material to investigate the history of the Great Plain in the context of the long-term history of the entire island of Martha's Vineyard (Foster and Motzkin 1999). Those studies made a number of interesting conclusions:

- (1) Pollen records and historical data suggest that the Great Plain was probably wooded with trees and shrubs throughout the pre-historical period and remained wooded and scrubby throughout the historical period.
- (2) Despite the long history of intensive land use on the island, the MFCSF portion of the Plain received relatively low intensity impacts from human activity and, in particular was not cleared or used to any large extent for crop cultivation. The area was burned intensively and frequently through the historical period and was probably used heavily for a source of fuelwood.
- (3) As a consequence of this history the area of the MFCSF retained its native vegetation and flora in a surprisingly intact fashion until acquisition by the Commonwealth.
- (4) Extensive planting of non-native conifer species by the Commonwealth disrupted the natural structure of the vegetation, but due to the actual methodology employed, it allowed retention of the native flora in the understories of the new plantations.

Despite this extensive historical data many questions remain, particularly concerning the exact nature of the vegetation and disturbance regime in the 17th and 18th C and the pre-settlement period before good historical information becomes available. These questions can only be addressed using paleoecological approaches which enable us to examine transitions in vegetation, disturbance and environment from the lengthy pre-European period into the European period and up to the present. A large number of paleoecological sites were examined by Andrea Stevens that provide a good context for many island-wide and coastal issues. However, Steven's sites are predominantly coastal or morainal and therefore present little direct insight into the dynamics of vegetation and the environment on the Plain itself (Foster and Motzkin 1999).

In order to fill this large gap in our information base and to provide historical insights that are directly relevant to ongoing management concerns we proposed to examine sediments from Duarte Pond, a small ice-block depression located on the Plain and just north of MFCSF. Duarte Pond has some excellent qualities for such a study. It is small, with no inflowing or outflowing streams and therefore should receive a relatively large percentage of "local" pollen and charcoal from vegetation and sites with 100s of meters of the basin. Duarte Pond is located at the northwestern part of the Plain, a location that should experience a relatively high frequency of fire due to the prevailing northwesterly winds during the summer months. In particular we would expect this location to very well-suited to characterize the changing fire regimes from pre-history to the present. In addition, although Duarte is currently bordered by agricultural fields on one side it has not experienced major development or land-use activity that should confound or distort the stratigraphic record.

Ultimate goals of the analysis of Duarte Pond sediments include:

- (1) To develop a fine-scale chronology of vegetation and charcoal from pollen and charcoal analysis covering the past 1500 years.
- (2) To interpret this chronology in terms of archaeological, historical, and modern data on human activity and environmental change.
- (3) To convey these interpretations to land management and conservation agencies involved in the development of restoration and management approaches for the area.

During 1999 we undertook field and laboratory studies in order to develop preliminary results and to ascertain that Duarte Pond was a useful and promising site. Specifically we set out to:

- (1) Obtain a complete sediment core from the deepest portion of the pond.
- (2) Undertake preliminary analyses of organic material, charcoal, and pollen.
- (3) Develop a chronology to match the stratigraphic profile using C-14.
- (4) Evaluate these records in light of other paleoecological data and historical information as a basis for deciding whether the site warranted continued, detailed analyses.

Preliminary Results - 1999

- A 5.8 m core was obtained from the center of Duarte Pond in about 3 m of water. The core was intact with all appearances of containing a continuous stratigraphic record for much of the post-glacial period. There were no obvious discontinuities, breaks or evidence of erosional episodes. The entire core was transported back to the Harvard Forest for long-term storage.
- The upper 100 cm of the core were sub-sampled for pollen, loss-on-ignition, and charcoal.

- Diagrams of pollen, organic content, and charcoal were produced for the upper sediments. These show all the signs of a good, reliable, and continuous record for the pre-settlement period analyzed to-date to the present. In particular, relatively sharp but continuous changes suggest that the record provides good possibilities for fairly fine-resolution analyses, does not suffer from extensive mixing of sediments, and will yield a continuous record.
- Although no dates have been obtained yet it appears that the upper 100 cm covers approximately the last 500-600 years. Thus, for a small pond Duarte appears to have a fairly fast rate of sedimentation, again suggesting that it is a good site for detailed, fine resolution analyses.

Preliminary Interpretation

The sedimentary record from Duarte Pond yields some surprises, especially when compared to the diagrams resulting from Andrea Steven's work and the historical and modern record from our previous study. (However, definitive comparison of the various diagrams on the Vineyard, Nantucket and the Cape await our standardizing all of them using similar pollen sums, charcoal methods, etc. We are in the process of undertaking this in collaboration with Bill Patterson, Peter Dunwiddie and Marge Winkler). Particularly notable features include:

- The pine pollen percentages are high at the time of settlement and then decline progressively with evidence for European land use. These suggest that pine may have actually been more important in the Plain landscape than previously interpreted. Comparison with the Lagoon Pond site of Stevens, which had the highest pine values among her cores, will be very useful and interesting. At Lagoon Pond pine values were somewhat lower (25%) than at Duarte, but they show a similar decline with European activity. In contrast, Steven's other site have low pine and little to no change with settlement. Intriguingly, it is possible that pine was most abundant on the island at the northern edge of the Plain and on the northern moraine, rather than across the Plain and towards the southern edge. Pine also apparently declined considerably as a result of human land use.
- Oak values decrease and then return to relatively high values in the historical period, basically mirroring the changes in herb pollen and reflecting changes in land use and forest/shrub cover.
- Grass pollen values are low (5%) during the pre-settlement period and then rise dramatically with European land use. This grass and herb pollen sequence suggests that open grassy area, grasslands, savannas, etc. were not important before European settlement. In contrast, it appears that extensive grassy, weedy areas were generated by European activity. In particular NAP (non arboreal pollen) levels are extremely high in the European period indicating extensive clearing and agriculture around the pond (which is apparent in historical maps and in the modern landscape).
- In similar fashion, values for ericaceous species (heath plants) were also very low before European settlement. Although the ericads are noted for being underrepresented in pollen diagrams, at Duarte Pond they only become apparent, and just barely so, after European activity. Thus there is no evidence for extensive heathland or heath-dominated vegetation at the site at any time.
- In contrast to essentially every site on MV and most on Nantucket, charcoal values at Duarte increase substantially after European settlement stay high for much of the period and then

decline over recent decades. Current charcoal values are approximately the same as pre-European values. Thus it appears that historical fire frequency was greater than during the pre-European period.

- Various pollen indicators suggest substantial changes occurred in the pond ecosystem following European settlement. Notably, *Nymphaea* declines, *Myriophyllum* increases, and the percentage of organic material plummets.

- A number of early features in the record are puzzling and raise the potential for pre-European human impact or extremely early European impact on the vegetation and area around the pond. Notably at approximately 70-75% (well before the major increases in NAP) there are traces of agricultural weeds and a pronounced dip in organic matter (LOI), indicative of local disturbance.

Conclusions and Recommendations for Further Work

- Duarte Pond provides an excellent record for determining the very long-term history of fire, vegetation and environment on the Great Plain. The record appears particularly relevant to current management concerns on MFCSF. Completion of dating and analyses should provide an informative record that is complementary to prior historical studies and ongoing fire ecology studies. Specifically, we recommend:

1. Development of a detailed chronology using Pb-210 and C-14.

The detailed nature of the emerging record demands that a very detailed chronology be developed such that changes in the physical and palynological characteristics of the stratigraphy can be matched to emerging historical records and archaeological data.

2. Additional palynology.

There is need to enhance the detail in critical areas of the existing stratigraphy, such as the very early NAP rise, and to extend the stratigraphy to somewhat greater depth so that pre-settlement changes can be understood.

3. Complete macroscopic charcoal analyses.

The availability of equipment to determine the macroscopic charcoal will allow us to better resolve local vs. regional charcoal inputs and to improve our understanding of the local fire regime.

4. Integrate archeological and historical information into the interpretation.

Recent assessments of all of the available archeological material and information by Mitch Mulholland at UMass should provide an excellent context for assessing the early changes in the diagram. In addition the study by Foster and Motzkin of MFCSF did not exhaustively cover the area around Duarte Pond. The detailed nature of the Duarte Pond stratigraphy warrants collection of all available information.