# Coupling Paleoecological Data and Model-Produced Hydrology to Estimate Circa 1900 CE Conditions in Freshwater Marshes and Marl Prairies within Everglades National Park (ENP)

*Frank E. Marshall[1], Christopher E. Bernhardt[2], and G. Lynn Wingard[2]*
[1]Cetacean Logic Foundation, New Smyrna Beach, FL; clfinc@earthlink.net
[2]U.S. Geological Survey, Reston, VA

## Introduction

Paleoecological data from three sediment cores collected by the USGS from freshwater marshes and marl prairies in ENP were interpreted and coupled with model-produced data to estimate the pre-drainage hydrologic regime (stage and flow) in the Everglades within ENP.

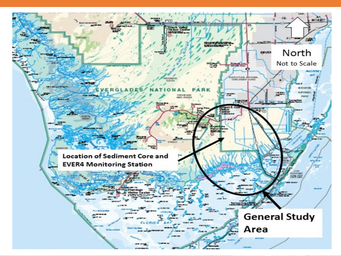
Each sediment core was located relatively close to an existing ENP stage monitoring station. The proximity of the stations facilitated the use of statistical and numeric models coupled with the paleoecological data to produce time series simulations of the pre-drainage water levels in a Shark River Slough marsh, a marl prairie community east of Shark River Slough, and a marl prairie community east of Taylor Slough.

## Objectives – Three Sediment Cores

The objectives of this research are:

1. estimate the pre-drainage freshwater wetland water levels in Everglades National Park
2. couple that information with hydrologic model output
3. use statistical models to estimate the salinity conditions in Florida Bay.

## Study Area – Sediment Core Number 3





## Methods – Three Sediment Cores

Output data from the South Florida Water Management Model Natural System Model (NSM 4.6.2) were coupled with freshwater wetland paleoecological data to estimate the 1900 CE stage in the southeastern ENP freshwater wetlands.

Down-core pollen assemblages were analyzed to estimate the approximately 1900 CE seasonal average water depth at each sediment core location.

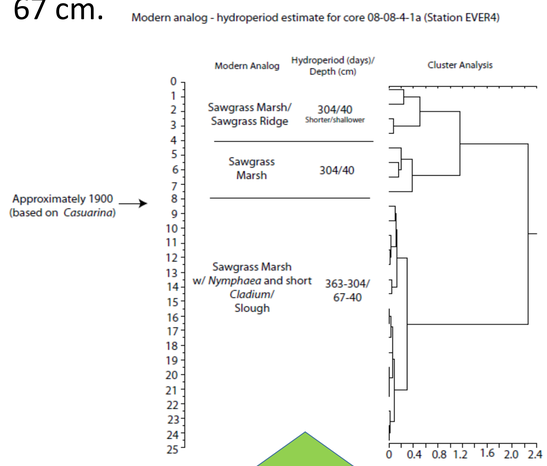
The SFWMM NSM 4.6.2 output data were adjusted to correspond to results of the USGS freshwater wetland paleoecological analyses. These paleo-based stage conditions were used with multivariate linear regression (MLR) salinity models to simulate the resulting pre-drainage salinity conditions in Florida Bay.

This procedure is a modification of methodologies developed for estuarine-based paleoecological data collected from Florida Bay (Marshall et al., 2009).

## Methods – Three Sediment Cores

Step 1: Analyze sediment core

Result: Pre-drainage conditions are a hydroperiod of 304-363 days with an average max. depth of 40-67 cm.




Step 2: Using NSM 4.62 match the pre-drainage conditions in the sediment core with statistics of time series (daily) data distribution – range and median of 304-363 day hydroperiod with water depths of 40-67 cm. A 22 cm adjustment to NSM is best fit to these characteristics.

**Hydroperiod (days) By Year from Adusted NSM 4.6.2 (N_22 means a 22 cm adjustment)**

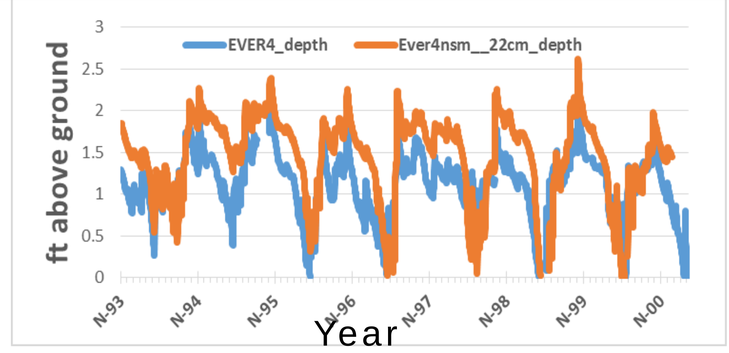
| year | N_17_5 | year | N_20 | year | N_22 | year | N_24 | year | N_29 |
|---|---|---|---|---|---|---|---|---|---|
| 1990 | 139 | 1990 | 149 | 1990 | 156 | 1990 | 166 | 1990 | 185 |
| 1989 | 144 | 1971 | 165 | 1971 | 169 | 1971 | 174 | 1971 | 190 |
| 1971 | 149 | 1989 | 166 | 1989 | 182 | 1989 | 197 | 1965 | 220 |
| 1985 | 196 | 1985 | 204 | 1985 | 208 | 1985 | 215 | 1989 | 231 |
| 1965 | 212 | 1965 | 214 | 1965 | 215 | 1965 | 216 | 1985 | 234 |
| 1987 | 212 | 1987 | 217 | 1975 | 222 | 1975 | 228 | 1975 | 236 |
| 1975 | 215 | 1975 | 220 | 1987 | 223 | 1987 | 230 | 1987 | 252 |
| 1974 | 221 | 1974 | 224 | 1974 | 227 | 1974 | 235 | 1974 | 254 |
| 1981 | 249 | 1981 | 255 | 1981 | 257 | 1981 | 259 | 1981 | 268 |
| 1976 | 282 | 1976 | 293 | 1976 | 298 | 1976 | 305 | 1973 | 315 |
| 1991 | 290 | 1991 | 298 | 1973 | 305 | 1973 | 307 | 1976 | 315 |
| 1973 | 299 | 1973 | 304 | 1991 | 305 | 1991 | 312 | 1986 | 324 |
| 1972 | 301 | 1988 | 309 | 1988 | 312 | 1988 | 316 | 1967 | 329 |
| 1988 | 303 | 1986 | 314 | 1986 | 314 | 1986 | 317 | 1984 | 329 |
| 1986 | 306 | 1984 | 316 | 1984 | 318 | 1984 | 323 | 1988 | 330 |
| 1984 | 310 | 1967 | 320 | 1967 | 321 | 1967 | 325 | 1991 | 330 |
| 1967 | 317 | 1999 | 323 | 1999 | 324 | 1999 | 326 | 1999 | 333 |
| 1999 | 318 | 1972 | 324 | 1972 | 332 | 1977 | 336 | 1968 | 343 |
| 1977 | 327 | 1977 | 331 | 1977 | 332 | 1968 | 339 | 1977 | 346 |
| 1968 | 334 | 1968 | 337 | 1968 | 338 | 1972 | 339 | 1972 | 354 |
| 1982 | 337 | 2000 | 342 | 2000 | 345 | 1979 | 349 | 1979 | 354 |
| 2000 | 337 | 1982 | 345 | 1979 | 348 | 2000 | 350 | 1970 | 357 |
| 1992 | 342 | 1979 | 347 | 1992 | 349 | 1992 | 352 | 1992 | 358 |
| 1979 | 343 | 1992 | 347 | 1982 | 350 | 1970 | 353 | 2000 | 358 |
| 1970 | 345 | 1970 | 349 | 1970 | 351 | 1982 | 353 | 1982 | 361 |
| 1993 | 351 | 1993 | 354 | 1993 | 355 | 1993 | 356 | 1993 | 363 |
| 1997 | 354 | 1997 | 363 | 1966 | 364 | 1966 | 364 | 1966 | 364 |
| 1998 | 361 | 1998 | 364 | 1969 | 364 | 1969 | 364 | 1969 | 364 |
| 1966 | 364 | 1966 | 365 | 1978 | 364 | 1978 | 364 | 1978 | 364 |
| 1969 | 364 | 1969 | 365 | 1983 | 364 | 1983 | 364 | 1983 | 364 |
| 1978 | 364 | 1978 | 365 | 1994 | 364 | 1994 | 364 | 1994 | 364 |
| 1983 | 364 | 1983 | 365 | 1995 | 364 | 1995 | 364 | 1995 | 364 |
| 1994 | 364 | 1994 | 365 | 1997 | 364 | 1997 | 364 | 1997 | 364 |
| 1995 | 364 | 1995 | 365 | 1998 | 364 | 1998 | 364 | 1998 | 364 |
| 1980 | 365 | 1980 | 366 | 1980 | 365 | 1980 | 365 | 1980 | 365 |
| 1996 | 365 | 1996 | 366 | 1996 | 365 | 1996 | 365 | 1996 | 365 |
| Legend | | median | | | mid of core range (333) | | | wthin range of core | |

Step 3: Apply adjustment to NSM 4.6.2 time series by adding 22 cm to each daily depth value.

Step 4: Input adjusted NSM 4.6.2 to MLR salinity models to simulate paleo-based salinity (see Results next column).

## Results – Sediment Core Number 3

**Step 3 Results:** Observed water levels @ EVER4 (EVER4_depth) compared to simulated water levels from NSM minus 22 cm adjustment (based on sediment core analysis)




Step 4 Results: Paleo-based salinity @ FL Bay stations using adjusted NSM as input to MLR salinity models vs observed

| FL Bay Salinity Station | N | Obs. Salinity (psu) | EVER4_paleo-based salinity (psu) | Difference: obs - paleo |
|---|---|---|---|---|
| Long Sound | 9126 | 20.18 | 11.83 | -8.35 |
| Joe Bay | 8061 | 14.54 | 6.57 | -7.97 |
| Little Madeira Bay | 9006 | 23.88 | 13.73 | -10.15 |
| Trout Cove | 9215 | 20.18 | 13.33 | -6.85 |
| Duck Key | 8479 | 30.14 | 13.40 | -16.74 |
| Butternut Key | 8700 | 31.50 | 13.50 | -18.00 |
| mean values | | 23.40 | 12.06 | -11.34 |

## Conclusions – Three Sediment Cores

1. In the sawgrass marshes of southeastern ENP the paleo-based information from this study suggests a circa 1900 CE hydroperiod of 304-363 days with a water depth of 40-67cm, i.e. pre-drainage water levels were about 0.15 m higher and hydroperiods were about two times longer than existing.
2. Our study indicates that a 22 cm adjustment is needed to NSM 4.6.2 to match the hydroperiod characteristics of the EVER4 sediment core (an additional 22 cm of water depth).
3. MLR salinity models using NSM 4.6.2 data with a 22 cm adjustment suggest that a return to pre-drainage (circa 1900CE) conditions in northeastern and central Florida Bay result in salinity reductions of 7-18 psu compared to existing conditions.
4. The EVER4 paleo-based estimates of salinity compare well to the p33 and NP206 paleo based mean salinity values.
5. The results of both Florida Bay estuarine and freshwater wetland paleoecological investigations provide corroborating information on the closely-coupled Everglades coastal system.

Citation: Marshall, F.E., G.L. Wingard, and P. Pitts. 2009. *A simulation of historic hydrology and salinity in Everglades National Park: coupling paleoecologic assemblage data with statistical models*. Estuaries and Coasts 32: 37–53.

`