Greater Everglades Performance Measure

Dry Events in Shark River Slough (previously GE-1)

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Acceptance Status: accepted

1.0 Desired Restoration Condition

Restore Natural System Model (NSM) (version 4.62) envelopes throughout the Greater Everglades Wetlands, except in areas where deviations from NSM have been deemed to be environmentally beneficial.

1.1 Predictive Metric and Target

The ecological target is the recovery of the predrainage patterns of multiyear hydroperiods. The NSM version 4.62 is used to develop envelopes for the number of times and mean duration in weeks that water drops below ground. The target is indicator region performance within the NSM envelopes. This performance measure (PM) is applied in Shark River Slough only (Indicator Regions 129-132).

1.2 Assessment Parameter and Target

Targets are under development. The Everglades Depth Estimation Network (EDEN) is currently active and will be used for field assessments and comparisons to model projections. Previously, assessment targets were not set because the NSM update (comparing version 4.62 vs. Sens 4.0) was not completed.

2.0 Justification

Throughout the predrainage Everglades, the depth, distribution and duration of surface flooding largely determined the vegetation patterns, as well as the distribution, abundance and seasonal movements and reproductive dynamics of all of the aquatic and many of the terrestrial animals in the Everglades (Kushlan 1989, Davis and Ogden 1994, Holling et al. 1994, Walters and Gunderson 1994). Accretion of the peat soils typical of Shark River Slough requires prolonged flooding, characterized by 10 to 12 month annual hydroperiods, and groundwater that rarely drops more than one foot below ground surface (Tropical BioIndustries 1990). The species composition of the microalgal mats in the ridge and slough Everglades is broadly controlled by water depth, duration of surface flooding, and water chemistry (Browder et al. 1994). These algal mats are highly important as a food web base, and for oxygenating the water column. Shortened hydroperiods cause a reduction in the proportion of diatoms and green algae, and an increase in calcareous blue-green algae, thus reducing the food value of periphyton, and affecting the overall productivity of the Everglades (Browder et al. 1994).

In the predrainage system, sloughs maintained multiyear surface water hydroperiods throughout the deeper, central marshes and along the downstream, marsh-mangrove ecotone, and extensive, shallow water “edges” that varied both spatially and temporally among seasons and years. Sloughs were the

primary refugia for aquatic animals during dry periods and were the most important wading bird foraging habitats in the Everglades (RECOVER 2004a).

Flows through Shark River Slough under the current water management practices are reduced. The number, duration and timing of dry events are more likely to reflect the needs of urban and agricultural water supply and flood control than the natural patterns of rainfall, evaporation and transpiration. The result has been lower wet season depths and more frequent and severe dryouts in the sloughs and reduction in the extent of the important shallow water "edges". Where infrequent dryouts can concentrate resources that have had years to expand, drydowns that are too frequent and severe hinder the ability of aquatic animal populations to rebound. Downstream, salinity regimes in the mangrove zone, estuaries and bays are no longer tempered by appropriate freshwater inflow. The narrow salinity requirements needed by aquatic species that depend on these habitats for reproduction are no longer met. Therefore the number and duration of drying events not only directly impacts freshwater marshes but also has downstream implications to the receiving estuaries and bays.

3.0 Scientific Basis

3.1 Relationship to Conceptual Ecological Models http://www.evergladesplan.org/pm/recover/recover_docs/et/pm_report/pm_rpt_4_3_ge_cem.pdf

Drydowns (shortened hydroperiods) are identified as a stressor in the Everglades Ridge and Slough Conceptual Ecological Model (CEM) and the Total System CEM (Ogden et al 2005) (http://www.evergladesplan.org/pm/recover/recover_docs/cems/cem_total_system.pdf). Drydowns are also an important factor in most of the GE simplified CEMs including the integrated hydrology and water quality hypothesis cluster and related simplified CEMs. In each of the hypothesis clusters and CEMs, alternate terminology for drydowns such as hydroperiod, water depth, or inundation pattern may be used.

Greater Everglades Regional Conceptual Ecological Models (RECOVER 2004b). Manuscript documentation for the four GE landscape type CEMs can be found at http://www.evergladesplan.org/pm/recover/cems.aspx

1) Everglades Ridge and Slough-

Although drydowns (and/or hydroperiod and water depth) are stressors in each of the landscape type CEMs, the PM for number and duration of dry events is only applied in Shark River Slough south of Tamiami Trail in IRs 129-132.

Simplified Conceptual Ecological Models (RECOVER 2006). The following list identifies which of the ten Greater Everglades simplified CEMs are directly related to drydown number and duration.

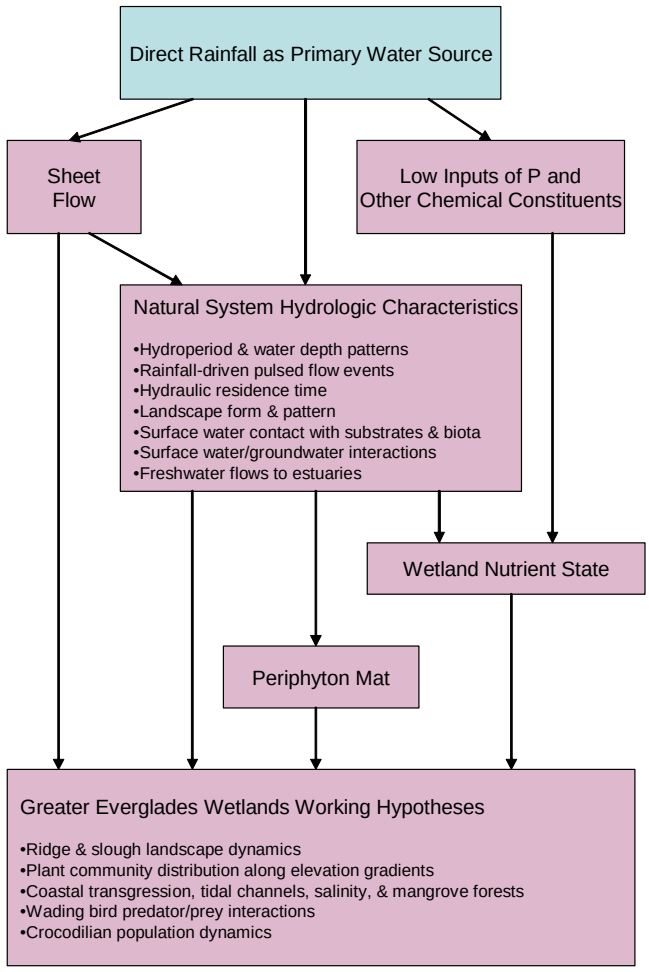
1) Integrated Hydrology and Water Quality Conceptual Ecological Model
2) Ridge and Slough Landscape Dynamics
3) Plant Communities along Elevation Gradients
4) Predator-Prey Interactions of Wading Birds and Aquatic Fauna Forage Base
5) Linkage of Periphyton to higher Trophic Levels
6) Everglades Crocodilian Populations

3.2 Relationship to Adaptive Assessment Hypothesis Clusters

For detailed information regarding each of the hypothesis clusters, including additional CEM diagrams, please see the Map II or the link below. A subset of figures and hypothesis descriptions are provided below for justification and general theory [*http://www.evergladesplan.org/pm/recover/recover_docs/et/060507_pm_report/hypothesis_clusters_ge.pdf*](http://www.evergladesplan.org/pm/recover/recover_docs/et/060507_pm_report/hypothesis_clusters_ge.pdf)

Integrated Hydrology and Water Quality Hypothesis Cluster (RECOVER 2006, Section 9.2.3)

Integrated Hydrology and Water Quality Conceptual Ecological Model



Hypothesis 1:

Rainfall and Sheet Flow as Determinants of Natural System Hydrologic Characteristics in the Everglades

The volume, timing, and distribution of sheet flow, in combination with direct rainfall, produced fundamental hydrologic and landscape characteristics of the pre-drainage Everglades that can be described by the following parameters:

- Hydroperiod and water depth patterns
- Rainfall-driven pulsed flow events
- Hydraulic residence time
- Landscape form and pattern
- Surface water contact with substrates and biota
- Surface water/groundwater interactions
- Freshwater flows supporting beneficial salinity patterns in the mangrove estuaries of Florida Bay and the Gulf of Mexico

Decompartmentalization, combined with resumption of natural volume, distribution, and timing of freshwater delivery is expected to restore sheet flow and pre-drainage hydrologic and landscape characteristics to an undivided ecosystem encompassing much of Water Conservation Area 3A, Water Conservation Area 3B, eastern Big Cypress, and Everglades National Park.

Rationale: Specific hydrologic restoration targets associated with the resumption of sheet flow and related hydrologic characteristics include:

- Multi-year hydroperiods in ridge and slough landscape
- Conditions conducive to peat formation in ridge and slough landscape
- Hydropatterns that sustain co-existing sloughs and sawgrass ridges in the ridge and slough landscape
- No distinct or persistent changes in water levels across boundaries such as canals, levees, or roads
- Large-scale surface water flow directions that follow the historic landscape directionality
- Hydropatterns that support the long-term stability of tree islands in ridge and slough landscape
- Hydroperiods from two months to less than one year conducive to marl formation and muhly grass (*Muhlenbergia filipes*) community persistence in Southern marl prairies
- Persistent pools of fresh to oligohaline water along the interface of the freshwater Everglades and the mangrove ecotone of Florida Bay and the Gulf of Mexico
- Dry season water recession patterns conducive to successful wading bird foraging
- Multi-year flood and drought cycles supporting formation of wading bird super-colonies
- Absence of harmful regulatory releases of excess fresh water to the Greater Everglades
- Freshwater flow discharges to Florida Bay and the Gulf estuaries that maintain a near shore salinity gradient characteristic of pre-drainage conditions.

*Please note this performance measure is also directly related to Hypotheses 1-3 in the Wetland Landscape and Plant Community Dynamics (RECOVER 2005) hypothesis cluster of the Assessment Strategy (RECOVER 2006).

4.0 Evaluation Application

4.1 Evaluation Protocol

A table of values is generated showing the number, duration (in weeks) and percent period of record (PPOR) of dry events for NSM, Base conditions, and each alternative to be evaluated. The table is accompanied by box-and-whisker plots which represent the NSM v 4.62 (target) distributions for #, duration and PPOR for ridge and slough habitat south of Tamiami Trail.

Values displayed on the whiskers represent the upper and lower 10 percent of the NSM distribution, while the remaining 80 percent of values make up the box. The box is divided into four categories, each encompassing a 20 percentile grouping of the cell values. The box-and-whisker plot includes labels or a legend off to the side indicating the percentage categories. A scale is included so that reviewers can see the percentage values that define the box-and-whisker areas. The mean and median values of the distribution are also calculated and shown (mean = x, median = y) at the top of the graph.

Scoring is accomplished by comparing the position of the indicator region value for each alternative on the box-and-whisker background to the position of the NSM (target) value for that indicator region. An "A" grade is assigned if the indicator region value for the alternative falls in the same 20 percentile category as predicted by NSM for the indicator region. A "B" grade is assigned if the indicator region value for the alternative falls in a 20 percentile category directly adjacent to the NSM target category. A "C" is assigned for performance two categories away, and a "D" for performance three categories away. Indicator region performance within or beyond the whiskers generally receives a failing grade. In some cases where the target falls on the whiskers or the edge of the box, further discussion may be necessary to justify scoring. The final score for an indicator region is represented by the combination of scores for # and duration of events. It should be noted that using PPOR provides insight into the total change in performance but PPOR alone does not provide independent information on the number and duration of dry events or the distribution and timing of these events, both of which are ecologically meaningful. Any scoring method used, including the method suggested above, should be consistently applied across alternatives and should reflect best professional judgment about what differences in performance are ecologically significant.

For areas with NSM envelope targets, a failing grade indicates that the alternative would not be expected to support a sustainable natural Everglades landscape within the range of the landscape type. Any "passing" grade of A-D indicates that the alternative produces conditions within the indicator region that may be expected to support a sustainable natural Everglades landscape within the range of the landscape type. Higher grades indicate the alternative is expected to support a sustainable natural Everglades landscape closer to that found in the indicator region area historically.

The calculations for average depth, dry event, and average duration of dry events are as follows:

1) Period of record = 1965-2000 simulation period

a) Non-Leap Years -> last eight days of calendar year used for weekly average

b) Leap Years -> last nine days of calendar year used for weekly average

2) The average depth for a given week in a given year is calculated for each grid cell within the indicator region and these values are averaged over the cells within the indicator region to obtain an average depth for the indicator region for that week

3) A dry event (DE) is calculated as a discrete segment of time from the point at which water levels fall below ground surface until the time they rise above ground. Minor events where water rises above ground slightly, less than 0.2 feet, do not determine the end of a dry event at that moment until it continues to rise above 0.2 feet. If water does continue to rise above 0.2 feet, then the dry event is counted as ending when the water level first rose above ground.

4) Average duration of dry events (weeks per event) is the average number of weeks in a DE for the period of record: average duration of dry events = sum [duration of each DE in weeks] / (number of DE).

4.2 Normalized Performance Output

Normalization of output is currently being discussed by the GE sub-team and module teams

4.3 Model Output

4.4 Uncertainty

Natural system hydrologic restoration targets are necessarily qualitative due to uncertainty regarding pre-drainage hydrology. Successive iterations of the Natural System Model (NSM) quantify these targets for planning purposes despite high levels of uncertainty. Successful restoration of natural system hydrologic characteristics as CERP is implemented ultimately must be guided by Adaptive Management based on measured responses of the ecosystem to hydrologic changes.

Recognition of model uncertainty is needed when interpreting the ecological significance of model output. The Model Uncertainty Workshop Report provides guidance on the potential implications of uncertainty on model output interpretation (RECOVER 2002) (http://www.evergladesplan.org/pm/recover/recover_docs/et/052402_mrt_uncertainty_report.pdf).

5.0 Monitoring and Assessment Approach

5.1 MAP Module and Section

See CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research - South Florida Hydrology Monitoring Network Module sections 3.5.3.1 - 3.5.3.3 (RECOVER 2004b).

5.2 Assessment Approach

6.0 Future Tool Development Needed to Support Performance Measure

6.1 Evaluation Tools Needed

Further work to increase the sensitivity of this performance measure is needed. Current methods, counting the number and duration of dry events over the 36-year period of record, may need to be refined to help focus on annual and inter-annual variability.

6.2 Assessment Tools Needed

7.0 Notes

The statement that "the ecological target is the recovery of the predrainage patterns of multiyear hydroperiods" is not particularly informative. The focus on the number of drydowns is good and using ground surface rather than some point below ground is an improvement. The sub-team will work with Assessment Team investigators to characterize healthy or predrainage conditions rather than to refer to a model version as the appropriate target condition.

This Performance Measure supersedes and addresses GE-1 Number and Duration of Dry Events for Shark River Slough (Last Date Revised: November 22, 2005). This PM was previously referred to as GE-1.

8.0 Working Group Members

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9.0 References

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