Greater Everglades Performance Measure

Sheet flow in the Everglades Ridge and Slough Landscape (a) timing of flows (b) distribution of flows (c) flow continuity and (d) flow volume* - *currently the PM focuses on a, b, and c above; later development will focus on flow volume*

Last Date Revised: February 22, 2008

Acceptance Status: Accepted

1.0 Desired Restoration Condition

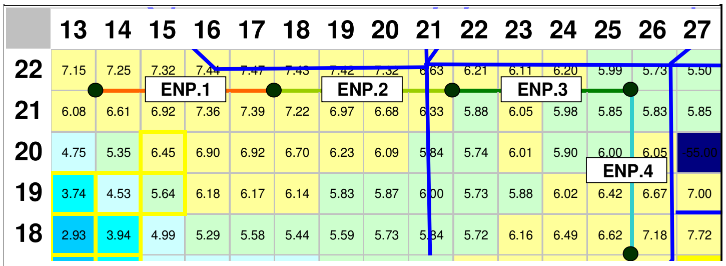
The desired restoration condition for the Everglades ridge and slough landscape as it pertains to this performance measure is to restore the natural patterns of distribution (given that much of the eastern edge of the central Everglades has been lost), timing, continuity (N-S) and volume of sheet flow.

Resumption of sheet flow and related patterns of hydroperiod and water depth will significantly help to restore and sustain the microtopography, directionality, and spatial extent of ridges and sloughs and improve the health of tree islands in the ridge and slough landscape, without significantly infringing on adjacent marl prairies, where short-hydroperiod, tussock growth habitats will persist.

1.1 Predictive Metric and Target

1.1.1 Timing and distribution of flows:

Restore Natural System Model (NSM v4.62) timing and distribution of flows throughout the Greater Everglades Wetlands, except in areas where deviations from NSM have been deemed to be environmentally beneficial. Currently this PM is expected to be applied at three geographically distinct locations, with additional areas added as supporting documentation is developed. This PM will be applied to a set of transects near Tamiami Trail which correspond to the already established SFWMM transects 26, 17, 18, and 19 with some slight modifications (see Figures 1 and 2). The overlap in these transects has been removed in order to limit potential for double counting of flows (modifications: ENP 3 represents transect 18 with the eastern 2-miles truncated to avoid double-counting water that may be coming across transect 19 from the east and ENP 4 represents transect 19 with the northern 2-miles truncated to avoid double-counting water that may be coming across transect 18 from the north (Figure 1)). Additionally, the timing and distribution components of this PM will be applied at a northern set of transects that cross WCA 3A and WCA 2A (near the overland and groundwater flow transects 2, 5, and 6 noted in Figure 2 below). The metric is expected to be applied to a third set of transects within Everglades National Park that include central Shark Slough and Taylor Slough. The exact locations for these transects have not been identified. Coding of the PM will be flexible such that revisions to transects requested by RECOVER can be made with minimal effort.



	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
22	7.15	7.25	7.32	7.44	7.47	7.43	7.42	7.32	6.63	6.21	6.11	6.20	5.99	5.73	5.50
21	6.08	6.61	6.92	7.36	7.39	7.22	6.97	6.68	6.33	5.88	6.05	5.98	5.85	5.83	5.85
20	4.75	5.35	6.45	6.90	6.92	6.70	6.23	6.09	5.84	5.74	6.01	5.90	6.00	6.05	-55.00
19	3.74	4.53	5.64	6.18	6.17	6.14	5.83	5.87	6.00	5.73	5.88	6.02	6.42	6.67	7.00
18	2.93	3.94	4.99	5.29	5.58	5.44	5.59	5.73	5.84	5.72	6.16	6.49	6.62	7.18	7.72

Figure 1. Tamiami trail flow transects indicating modifications from SFWMM transects.

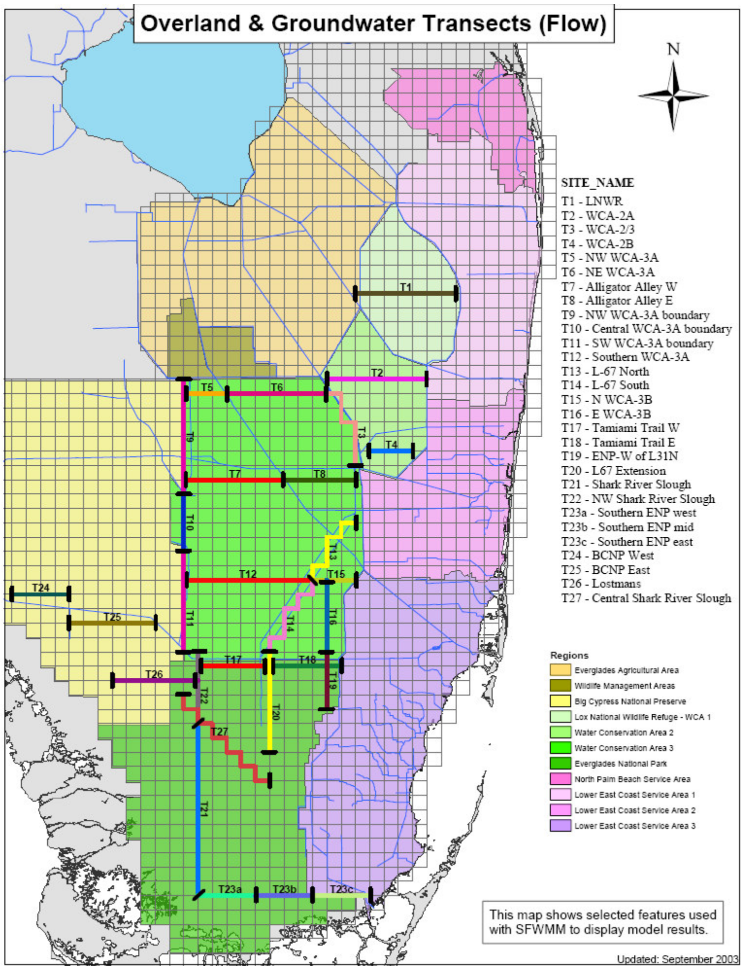


Figure 2. SFWMM transects.

1.1.2 Flow continuity:

Restore Natural System Model (NSM v4.62) continuity of flows (sheet flow) throughout the Greater Everglades Wetlands, except in areas where deviations from NSM have been deemed to be environmentally beneficial. The sheet flow component of this PM is currently applied at paired transects at Tamiami Trail. Additional paired transects may also be applied at the L-38, L-39, Miami, and L-67 canals. Removal of barriers to flow will be required to ultimately attain sheet flow. This component of the flow PM is directly applicable to project needs (particularly DECOMP). Coding of paired transects will be flexible. The flexible transect concept allows easy movement of transects to address specific project needs. RECOVER will coordinate with PDTs and support the development of additional transects to address specific spatial needs of the project teams. RECOVER will help

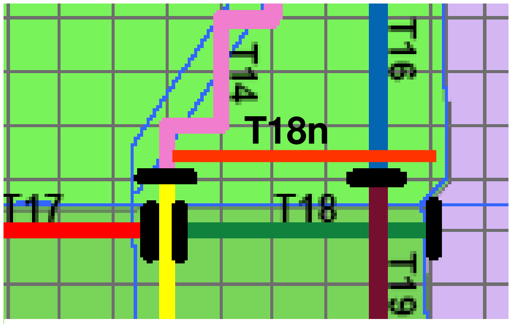


Figure 3. Tamiami Trail paired transects.

determine which components of the flow metric can be best applied (i.e., because of issues of flow directionality, it is likely that changes to sheet flow along the northern reaches of the Miami canal are best measured as change in distribution across transects. The canal is a constrained point of high flows creating less continuity in flow between 2*2 cells in this reach of the domain).

Given the complexity of the system, the SFWMM does a good job of simulating operations of the Central and Southern Florida Project for Flood Control and Other Purposes (C & SF Project). To ensure that a flow PM provides meaningful results, only transects that show a clear response to the operation of the structures should be used for alternative evaluation. The following graph demonstrates that flow in the western 8 miles of T17 (T17W4) clearly reflects operation of S12A, S12B, and S12C. Due to local rainfall, evapotranspiration, and other losses between the S12s and T17, the flow would not be expected to be identical at the two locations. Also, the total observed flow at S12A, S12B, and S12C is very similar to model results. (Generally, only output from calibration and verification model runs can be directly compared with observed data, however, the following graph demonstrates that flows from the S12s in the alt7r5e model run are very similar to actual operations. The alt7r5e represents simulated Interim Operational Plan (IOP) operations for the period of 1990 – 2000, while IOP in reality did not begin until after the year 2000. The alt7r5e has more S12 closures than actual operations during this time.)

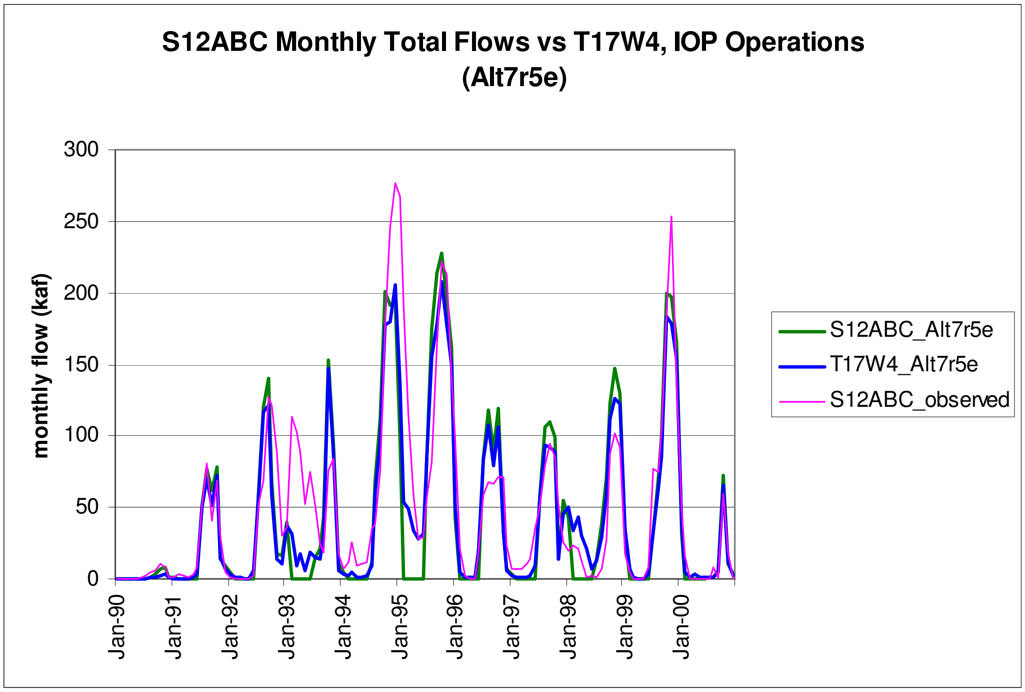


Figure 4. Temporal comparison of monthly total flow volumes.

1.2 Assessment Parameter and Target

The Everglades Depth Estimation Network (EDEN) is currently active and will be used for field assessments and comparisons to model projections. Estimates of flow timing, distribution, continuity, and volume can be compared to historic estimates and measures at inflow structures. EDEN can be applied further to help understand future refinement of this PM by potentially adding a directionality component if needed.

2.0 Justification

Historically the ridge and slough was the predominant landscape type of the central Everglades (present day WCAs), including Shark River Slough (NRC 2003). Rainfall and seasonal discharge from Lake Okeechobee into these spatially extensive, low topographic relief wetlands resulted in overland surface flows (sheet flow) in the pre-drainage system (RECOVER 2006a). It is sheet flow that helped shape the defining characteristics of the ridge and slough landscape. The landscape was a long-hydroperiod, hydrologically interconnected, fresh-water marsh with long-term storage capacity and shallow to very deep organic soils. In this system, parallel sawgrass ridges and tree islands were separated by more open-water slough communities aligned with historic flow directions (NRC 2003, SCT 2003). As a result, the vegetation patterns in this combined "wet prairie-sawgrass-slough-tree island mosaic" (Davis et al. 1994) largely reflected seasonal water depths, and the distribution and timing of surface water flows. The hydropatterns and vegetative communities in turn affected the distribution, abundance, seasonal movements, and reproductive dynamics of all aquatic and many terrestrial animal species in the Everglades (Ogden 2005).

Water management practices beginning in the early 20th century led to the construction of an extensive system of canals, levees, and pump stations crisscrossing the once free-flowing natural system, which in turn has led to human-dominated operations of that system. This channelization, compartmentalization, and physical manipulation of how water flows into the Everglades due to water management operational criteria (i.e., regulation schedules) has altered or eliminated sheet flow and related hydrologic characteristics throughout much of the Everglades. The loss of connectivity necessary for sheet flow has resulted in far-reaching effects on ecological processes and habitat (Ogden et al. 2005). The ridge and slough landscape has become severely degraded in a number of locations and is being replaced with a landscape more uniform in terms of topography and vegetation, with less directionality (NRC 2003, SCT 2003). The degradation of the ridge and slough landscape structure, particularly in association with levees and canals that inhibit flow, has been well documented (NRC 2003).

The Comprehensive Everglades Restoration Plan (CERP) proposes to restore more natural sheet flow patterns by eliminating unnatural barriers to flow. The Decompartmentalization project involves reconnecting significant portions of the Everglades ridge and slough landscape to restore sheet flow through:

- removal of the L-28, L-28 tieback, and L-29 levees;
- modification of the L-67A and L-67C levees;
- modifications to Tamiami Trail;
- backfilling the Miami Canal in WCA-3; and
- improvements to the North New River Canal to reroute water to the lower east coast that is now delivered by the Miami Canal.

In order to understand hydrologic effects of water deliveries, a complete suite of hydrologic metrics focusing on timing, distribution, continuity, and volume is needed. Each of the PM components is necessary so very different delivery mechanisms and related ecological implications (i.e., natural sheet flow and related hydrology and water quality benefits versus canal bypass deliveries) do not attain similar performance scores. The sheet flow metric provides a much needed addition to the suite of existing hydrologic PMs.

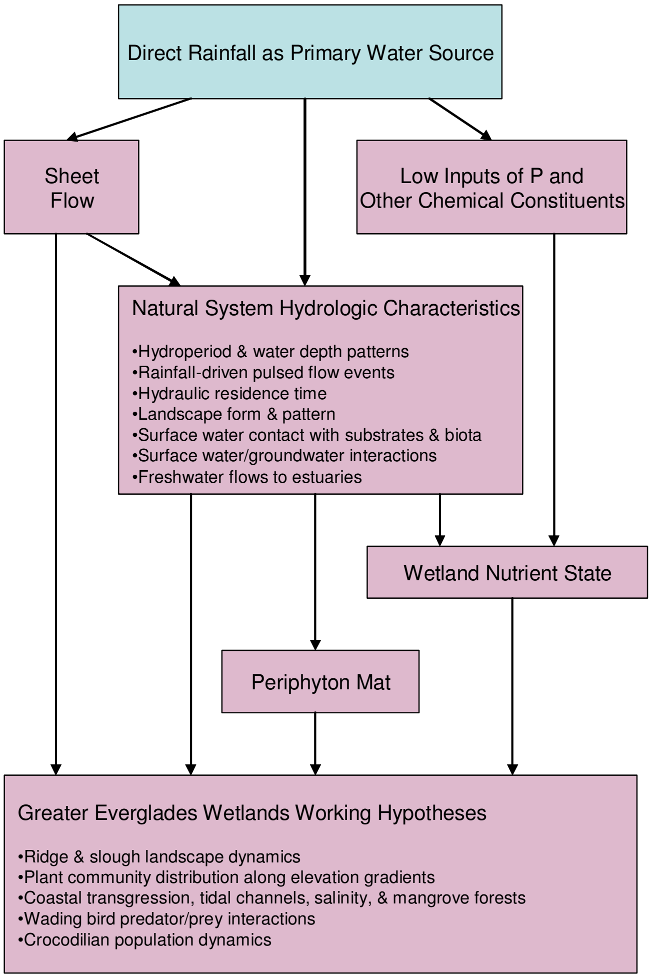
In addition to hydrologic effects, the historic sheet flow patterns in the Greater Everglades also had major water quality implications. Sheet flow, by its nature, increases the surface area of vegetation that contacts passing water, thereby providing increased opportunity for nutrient sequestration. Because of urban and agricultural development and the extensive canal delivery systems in the Greater Everglades, much of the natural treatment capacity that used to exist in the northern Everglades is bypassed. Water no longer slowly passes through the historic sawgrass plain south of Lake Okeechobee before entering the Greater Everglades, but actually is delivered into interior marshes or at a minimum into STAs and then into marshes below. Reestablishing sheet flow can help actualize both hydrologic and water quality benefits to the freshwater marsh system and potentially to the downstream estuaries.

3.0 Scientific Basis

3.1 Relationship to Conceptual Ecological Models

Sheet flow is identified as either a driver, stressor, or effect in the Total System Conceptual Ecological Model (CEM) (Ogden et al. 2005) (http://www.evergladesplan.org/pm/recover/recover_docs/cems/cem_total_system.pdf), the Integrated Hydrology and Water Quality CEM, the Everglades Ridge and Slough CEM, and the Everglades Mangrove Estuaries CEM. For detailed information regarding each of the hypotheses, including additional CEM diagrams, please see the MAP Part 2: 2006 Assessment Strategy for the MAP. A subset of figures and hypothesis descriptions are provided below for justification and general theory.

Integrated Hydrology and Water Quality Conceptual Ecological Model



3.2 Relationship to Adaptive Assessment Hypothesis Clusters

Sheet flow is an essential component in each of the four Greater Everglades hypothesis clusters within the MAP Part 2 (RECOVER 2006a) (http://www.evergladesplan.org/pm/recover/recover_docs/map_part2/section_9_app_of_guidance_ge.pdf).

Integrated Hydrology and Water Quality Hypothesis Cluster

Hypothesis 1: Rainfall and Sheet Flow as Determinants of Natural System Hydrologic Characteristics in the Everglades

Hypothesis 2: Nutrient Inputs and Sheet Flow as Determinants of Wetland Nutrient State in the Everglades

Coastal Transgression, Tidal Channel Characteristics, Salinity Gradients, and Mangrove Forest Productivity Hypothesis Cluster

Hypothesis 1: Sea Level and Freshwater Flow as Determinants of Coastal Transgression

Hypothesis 2: Sea Level and Freshwater Flow as Determinants of Tidal Channel Characteristics

Hypothesis 3: Sea Level and Freshwater Flow as Determinants of Coastal Salinity Gradients

Hypothesis 4: Sea Level, Freshwater Flow and Phosphorus Inputs as Determinants of Above and Belowground Production, Organic Soil Accretion, and Resilience of Coastal Mangrove Forests

Wetland Landscape and Plant Community Dynamics Hypothesis Cluster

Hypothesis 1: Everglades Ridge and Slough Micro-topography in Relation to Organic Soil Accretion and Loss (Sheet flow interacts with hydroperiod, water depth, fire, and nutrient dynamics to maintain organic soil accretion and loss in a state of dynamic equilibrium.)

Hypothesis 2: Everglades Ridge and Slough Landscape Pattern in Relation to Micro-topography

Hypothesis 3: Plant Community Dynamics along Elevation Gradients (The composition and distribution of plant communities along elevation gradients are determined by patterns of hydroperiod, water depth, nutrient dynamics, and fire patterns throughout freshwater wetlands of the Greater Everglades.)

Everglades Crocodilian Populations Hypothesis Cluster

Hypothesis 1: American Alligator Populations in Relation to Hydroperiod, Water Table, Water Depth, and Salinity in the Everglades (American alligator distribution, abundance, reproduction, and body condition in the Everglades are controlled by hydroperiod and water table in the Rocky Glades, salinity in the mangrove estuaries, and water depth patterns in the ridge and slough system, all of which were driven by direct rainfall and sheet flow prior to drainage.)

4.0 Evaluation Application

4.1 Evaluation Protocol

4.1.1 Timing:

The timing index scores provide information about how the timing of discharges across transects (and each transect's sub-transects) are altered by alternative project configurations. The magnitudes of the index scores are proportional to the similarity between the timing of flows yielded by the project alternative, and the timing of flows in the pre-drained system. A perfect index score of 1.0 indicates that the timing of flows yielded by the project alternative matches perfectly the timing of flows associated with the pre-drainage condition. As the timing of flows associated with the project alternative becomes more dissimilar to the pre-drainage condition, the index score decreases to a minimum score of 0.0 (at which point, the timing of flows yield by the project alternative is considered to bear little to no resemblance to the "target" condition).

For each water year in the simulation period of record, monthly flow volumes are computed for each transect (and sub-transect), and then expressed as a percentage of the transect's annual total flow volume (F_m) as follows:

$T_m = V_m / (V_1 + V_2 + V_3 \ldots + V_{12})$ for the target condition
$T'_m = V'_m / (V'_1 + V'_2 + V'_3 \ldots + V'_{12})$ for the project alternative condition

where:
m = Ordinal value for month of water year (i.e., November = 1, December = 2 …October = 12);
T_m = Percentage of annual volume discharged across transect during month m;
V_m = Volume discharged across transect during month m; and
' = Notation indicating that the value is associated with the project alternative condition

It should be noted that for each water year,

$$\sum_{m=1}^{12} T_m = 1.00 \text{ , and } \sum_{m=1}^{12} T'_m = 1.00$$

The above computation is performed for the target condition and the project alternative condition. Year by year and month by month, the absolute value of the difference between T_m for the target condition and T'_m for the project alternative condition is computed to yield a monthly deviation from target as follows:

$DEV_m = T'_m - T_m$

where:
DEV_m = Distance between the target value and that yielded by the project alternative for month m.

For each water year in the simulation period of record, the monthly distances between the target values and those yielded by the project alternatives are summed to yield an annual deviation from target as follows:

$$\text{DEV}_\text{A} = \sum_{m=1}^{12} \text{ABS}(\text{DEV}_\text{m})$$

where:
A = Ordinal value for water year within the simulated period of record
DEV_A = Cumulative annual deviation from target for water year A

A timing index score is then computed for each water year as follows:

$$\text{Timing Index}_\text{A} = \frac{\left(\sum_{m=1}^{12} \text{T}_\text{m}\right)_\text{A} - \text{DEV}_\text{A}}{\left(\sum_{m=1}^{12} \text{T}_\text{m}\right)_\text{A}} = \frac{1.00 - \text{DEV}_\text{A}}{1.00} = 1.00 - \text{DEV}_\text{A}$$

When $\text{DEV}_\text{A} > 1.00$, $\text{Timing Index}_\text{A}$ defaults to 0.00

These calculations are conducted for each year in the period of record for each project alternative as well as the Natural Systems Model (NSM) target.

4.1.2 Distribution:

The distribution index score provides information about how flow distribution across individual transects is altered by alternative project designs/operations. The index score is proportional to the similarity between the proposed project alternative and the natural system water flow distribution across a transect. A large index score number indicates that the spatial distribution of water movement is similar to that of the target condition, and visa-versa. Ideal configurations will produce no deviation from the target condition and will result in a distribution index score equal to 1.

Flow volumes for each month at each sub-transect are calculated, and then expressed as a percentage of the total monthly flow volume across the entire transect.

$\text{D}_{\text{m,i}} = \text{V}_{\text{m,i}} / (\text{V}_{\text{m,1}} + \text{V}_{\text{m,2}} + \text{V}_{\text{m,3}} + \ldots + \text{V}_{\text{m,n}})_\text{i}$ for the target condition
$\text{D'}_{\text{m,i}} = \text{V'}_{\text{m,i}} / (\text{V'}_{\text{m,1}} + \text{V'}_{\text{m,2}} + \text{V'}_{\text{m,3}} \ldots + \text{V'}_{\text{m,n}})_\text{i}$ for the project alternative condition

where:
m = Ordinal value for month of water year (i.e., November = 1, December = 2 …October = 12);
i = Ordinal value of the sub-transect whose proportion of total monthly flow is being calculated;
n = Number of sub-transects within a transect;
D_{mi} = Percentage of monthly volume discharged across transect that went across sub-transect i;

V_{mi} = Volume discharged across sub-transect i during month m; and
’ = Notation indicating that the value is associated with the project alternative condition

The above computation is performed for the target condition and the project alternative condition.

It should be noted that for each month,

$$\sum_{i=1}^{n} D_{m,i} = 1.00 \text{ , and } \sum_{i=1}^{n} D'_{m,i} = 1.00;$$

and for each year,

$$\left(\sum_{m=1}^{12}\left[\sum_{i=1}^{n} D_i\right]_m\right) = 12.00 \text{ , and } \left(\sum_{m=1}^{12}\left[\sum_{i=1}^{n} D'_i\right]_m\right) = 12.00$$

The absolute value of the difference between D_{mi} for the target condition and D'_{mi} for the project alternative condition is computed to yield a monthly deviation from target as follows:

$$DEV_{mi} = D'_{mi} - D_{mi}$$

where:
DEV_{mi} = Distance between the target proportion of flow crossing a sub-transect and the proportion of flow crossing a sub-transect demonstrated by a project alternative for month m at sub-transect i.

For each month in the simulation period of record, the monthly distances between the target values and those yielded by the project alternatives are summed to yield an annual deviation from target as follows:

$$DEV_A = \sum_{m=1}^{12} ABS(DEV_m)$$

where:
A = Ordinal value for water year within the simulated period of record
DEV_A = Cumulative annual deviation from target for water year A

A distribution index score is then computed for each water year as follows:

$$\text{Distribution Index}_A = \frac{\left(\sum_{m=1}^{12}\left[\sum_{i=1}^{n} D_i\right]_m\right)_A - DEV_A}{\left(\sum_{m=1}^{12}\left[\sum_{i=1}^{n} D_i\right]_m\right)_A} = \frac{12.00 - DEV_A}{12.00} = 1.00 - (DEV_A/12.00)$$

When $DEV_A > 12.00$, Distribution Index_A defaults to 0.00.

These calculations are conducted for each year in the period of record for each project alternative as well as the Natural Systems Model (NSM) target.

The annual timing indexes at each sub-transect are averaged to provide a single annual summary score for each transect.

Each time series of timing and distribution scores is then averaged to yield a 35-year average score for each of the two metrics.

4.1.3 Continuity (i.e., Sheet Flow)**:**

In order to measure sheet flow, the Coefficient of Variation (σ/μ) statistic is utilized. Transect pairs on either side of barriers are used to measure uniformity of flow within and between transects. A low score is an indicator of pre-drainage sheet flow and uniformity of flow.

The Coefficient of Variation (Cv) is a measure of dispersion. Coefficient of Variation is defined as the ratio of the standard deviation (σ) to the mean (μ).

$$Cv = {}^{\sigma}/_{\mu}$$

The Cv is a dimensionless number that allows for comparison of the variation of populations that have significantly different mean values, as is the case when comparing NSM flows with restoration alternatives. An alternative to Cv is the Squared Coefficient of Variation (SCv).

Further guidance associated with interpretation of the use of the coefficient of variation summary statistic is available in *Documentum* (Documentum\Docbases\CERPDoc_saj\Project Teams\RECOVER\ET\GE\Proposed PM documentation- related docs \Flow PM\Guidance Language for Flow Timing, Distribution and Continuity PM.doc).

1. For SFWMM cells in each transect pair, compute coefficient of variation at each timestep (monthly).

Note: The Coefficient of Variation statistic breaks down when the mean value is near zero, therefore all values from months with flow (in either paired transect) is < 1.0 kaf are discarded.

2. For NSM cells in each transect pair, compute coefficient of variation at each time step (monthly).

3. Compute absolute value of deviation from NSM at each timestep.

4. Score is sum of the deviations over POR (period of record).

5. Target is zero deviation from NSM.

	Alternative Coef_of_Var	NSM Coef_of_Var	Deviation
1/31/1965	0.77	0.41	**0.36**
2/28/1965	0.44	0.51	**0.07**
3/31/1965	0.28	0.45	**0.17**
4/30/1965	0.98	0.58	**0.40**
:	:	:	:
12/31/2000	0.81	0.40	**0.41**
	Score =	?	**Total of above**

4.1.4 Volume:

The working group recognizes the needed for a volume PM and emphasizes that valid interpretation of a complete flow PM would include a volume component.

4.1.5 Calculation details:

The calculations for timing, distribution, continuity, and volume of flows 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

4.2 Normalized Performance Output

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

4.3 Model Output

4.3.1 Timing and Distribution:

Standard PM graphics are box and whisker charts illustrated below. The intermediate tabular data that are used to synthesize the charts will be stored as tab-delimited text files so that they can be referenced at a later time by reviewers seeking a better understanding of PM time series. This will enable reviewers to provide more precise feedback/recommendations for improving regional performance to the modelers.

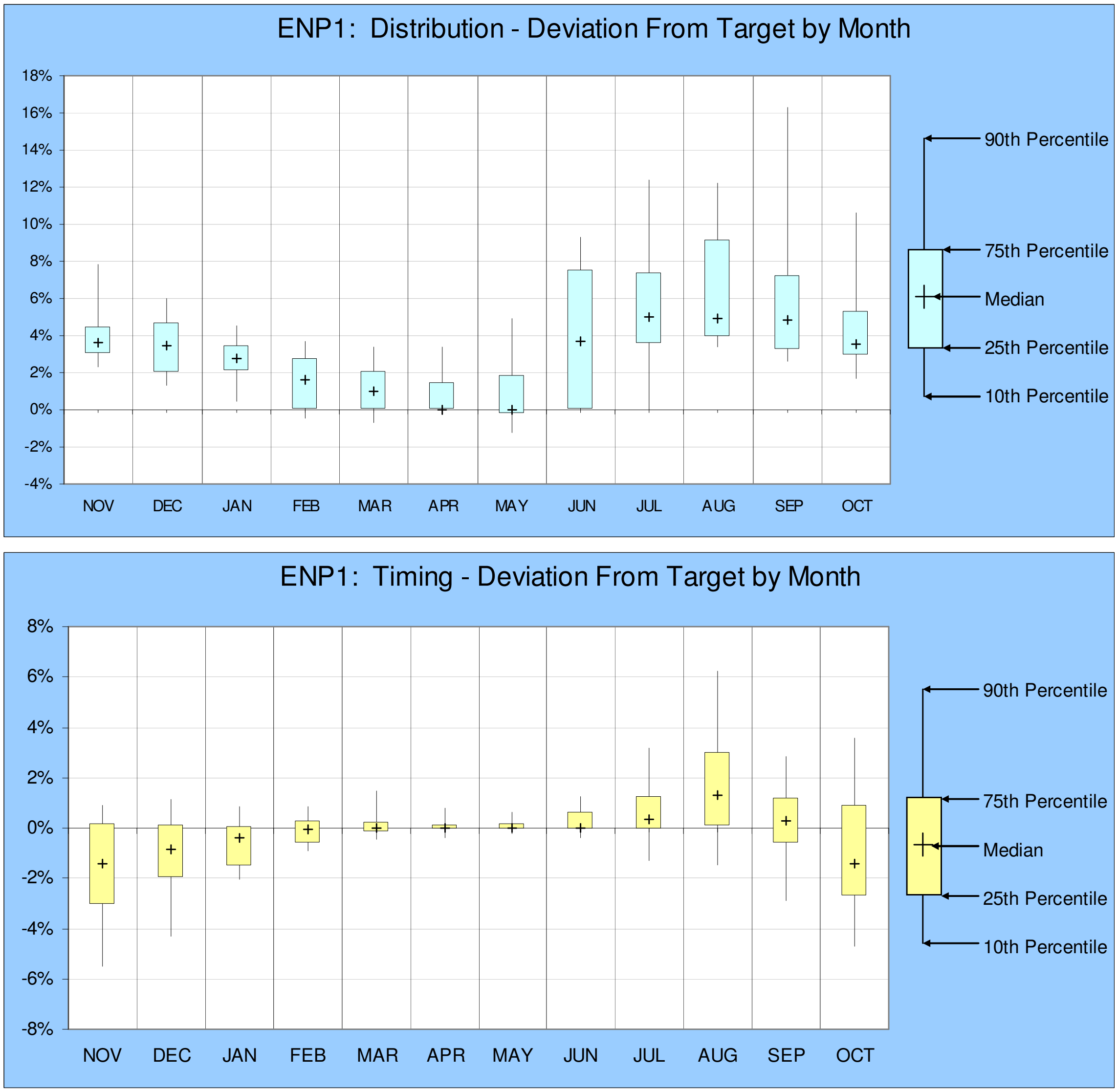
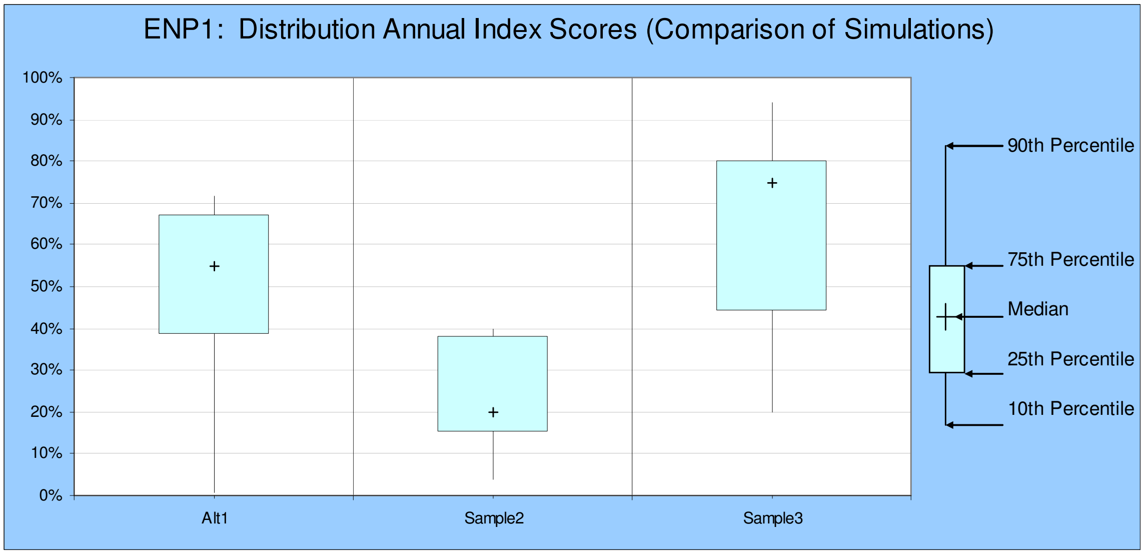


Figure 5. Box and whisker plots indicating the monthly deviation from the target for timing and distribution for an individual transect over a 36 year period of record.



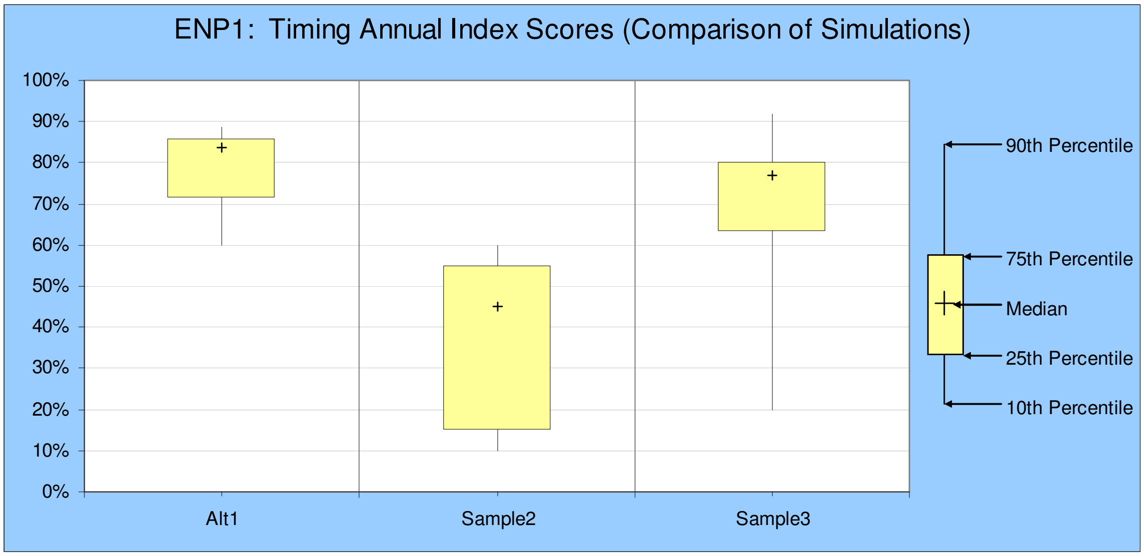


Figure 6. Box and whisker plots indicating the annual deviation from the target for timing and distribution for an individual transect over a 36 year period of record.

4.3.2 Continuity:

Alternative (Alt5r)

		Monthly Flow (kaf)												
#Date	T18	T18n	C22_R22	C23_R22	C23_R24	C24_R22	C24_R24	C25_R22	C25_R24	C26_R22	C26_R24	std (σ) (cells in transects)	mean (μ) (cells in transects)	coef of variation	(σ / μ) * 100
1/31/1965	9.14	30.45	1.6	1.48	10.03	1.43	8.4	2.35	5.96	2.28	6.06	3.11	4.40	0.71	70.59
2/28/1965	20.63	33.46	4.09	3.52	9.07	3.31	8.08	4.42	6.64	5.29	9.67	2.30	6.01	0.38	38.29
3/31/1965	21.8	25.3	4.24	3.59	7.2	3.41	6.25	4.52	4.89	6.04	6.96	1.34	5.23	0.26	25.61
4/30/1965	0.67	6.85	0.1	0.01	2.36	0.04	1.87	0.03	1.24	0.49	1.38	0.85	0.84	na	na
5/31/1965	0.03	1.47	0	0	1.02	0	0.37	0	0.08	0.03	0	0.32	0.17	na	na
6/30/1965	0	2.26	0	0	1.6	0	0.66	0	0	0	0	0.52	0.25	na	na
7/31/1965	0.36	4.06	0.06	0.03	2.41	0.02	1.46	0.07	0.19	0.18	0	0.81	0.49	na	na
8/31/1965	0.71	9.34	-0.13	-0.09	3.87	0.09	3.38	0.32	2.01	0.52	0.08	1.48	1.12	na	na
9/30/1965	11.15	28.85	1.13	1.39	8.26	1.76	7.38	2.89	6.05	3.98	7.16	2.65	4.44	0.60	59.66
10/31/1965	56.92	43.83	11.2	10	14.12	9.72	11.92	12.01	7.47	13.99	10.32	1.99	11.19	0.18	17.82
11/30/1965	67.36	37.3	12.47	13.59	15.02	12.93	10.99	13.91	3.95	14.46	7.34	3.48	11.63	0.30	29.89
12/31/1965	59.3	52.83	12.41	10.88	17.78	10.42	15.22	12.27	8.47	13.32	11.36	2.59	12.46	0.21	20.81
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
2/28/1971	12.54	29.87	2.65	2.15	7.82	1.94	6.9	2.55	5.93	3.25	9.22	2.62	4.71	0.56	55.50
3/31/1971	3.15	13.67	0.68	0.45	3.93	0.41	3.38	0.54	2.65	1.07	3.71	1.43	1.87	0.77	76.70
4/30/1971	0.16	2.72	0.01	-0.01	1.45	0	0.89	0.01	0.37	0.15	0.01	0.49	0.32	na	na
5/31/1971	0.04	4	0	0	2	0	1.46	0	0.52	0.04	0.02	0.71	0.45	na	na
6/30/1971	1.1	5.42	0.14	0.1	2.57	0.08	1.88	0.25	0.97	0.53	0	0.87	0.72	1.19	119.42
7/31/1971	1.16	6.28	0.09	0.04	2.86	0.09	2.18	0.28	1.23	0.66	0.01	0.99	0.83	1.20	119.80
8/31/1971	2.49	8.73	0.18	0.22	3.47	0.22	3.22	0.64	2.13	1.23	-0.09	1.29	1.25	1.04	103.62
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
4/30/2000	35.27	39.35	7.25	6.43	12.02	6.11	10.55	7.45	6.81	8.03	9.97	1.95	8.29	0.23	23.48
5/31/2000	16.45	34.18	3.41	2.86	9.21	2.64	8.17	3.4	6.62	4.14	10.18	2.78	5.63	0.49	49.46
6/30/2000	17.07	22.77	2.61	2.68	7.69	2.71	6.03	3.83	4.1	5.24	4.95	1.63	4.43	0.37	36.83
7/31/2000	32.26	28.76	6.05	5.43	9.19	5.28	7.78	6.84	5.41	8.66	6.38	1.37	6.78	0.20	20.26
8/31/2000	41.45	27.48	8.17	7.18	8.95	6.9	7.77	8.67	4.64	10.53	6.12	1.62	7.66	0.21	21.10
9/30/2000	48.01	21.46	9.28	8.49	8.51	8.29	6.67	10.25	2.37	11.7	3.91	2.80	7.72	0.36	36.25
10/31/2000	76.38	11.99	17.13	15.66	7.09	14.45	3.87	15.24	-0.58	13.9	1.61	6.44	9.82	0.66	65.60
11/30/2000	57.45	36.76	11.87	10.52	13.08	10.17	10.48	11.96	5.29	12.93	7.91	2.37	10.47	0.23	22.63
12/31/2000	42.1	40.77	8.66	7.48	12.17	7.13	10.94	8.82	8.01	10.01	9.65	1.56	9.21	0.17	16.90

Graphical summaries for coefficient of variation:

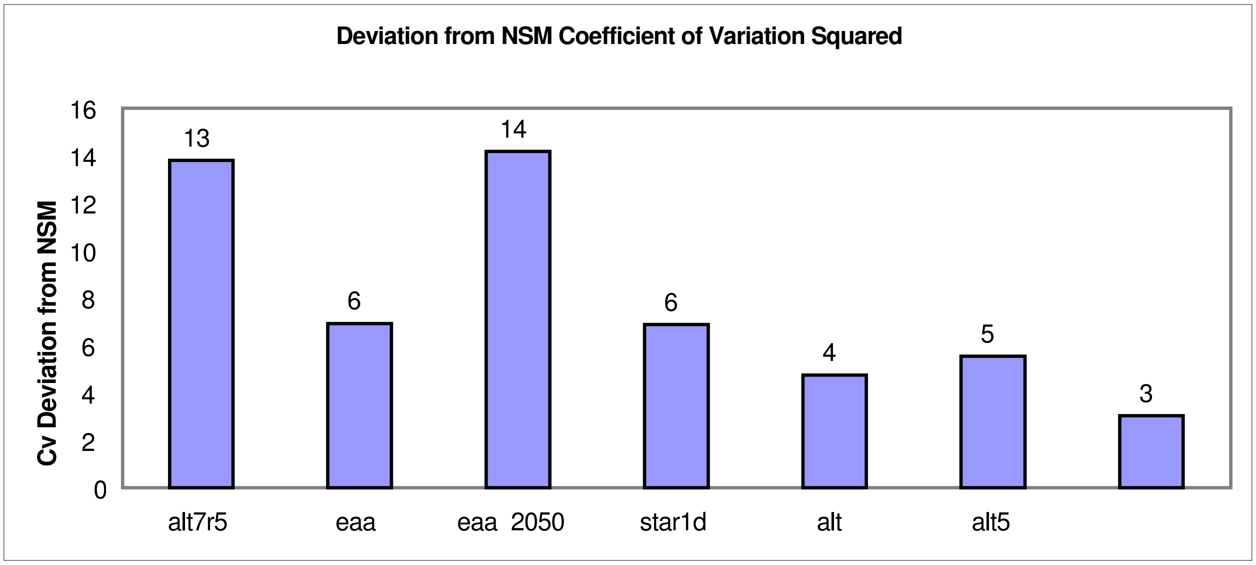


Figure 7. Monthly average coefficient of variation by project alternative.

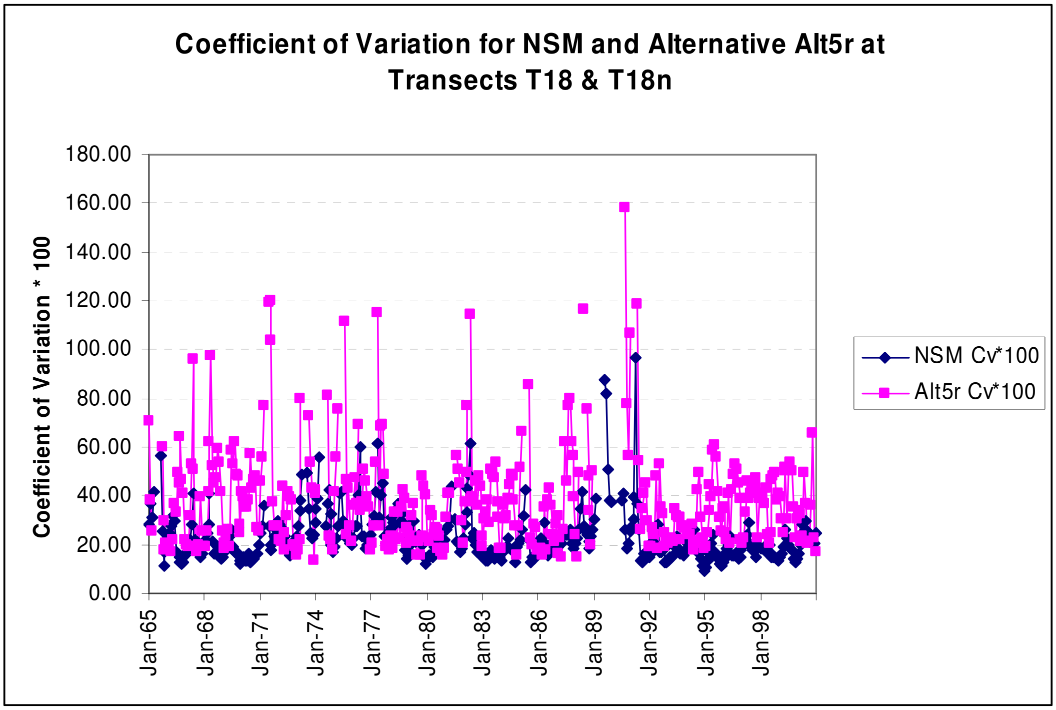


Figure 8. Comparison of coefficient of variation scores of Natural System Model and model run with Project.

4.4 Uncertainty

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 2004a)

5.2 Assessment Approach

NA

6.0 Future Tool Development Needed to Support Performance Measure

6.1 Evaluation Tools Needed

Further work to evaluate flow volume is needed. Currently this PM addresses timing, distribution, and continuity (sheet flow) but it is the intent of the working group to complete development of the flow volume metrics as a next step. Flow volume targets based on linkages to Florida Bay salinities and understanding of historical flows (using NSM) will allow for greater continuity between regional targets within the CERP domain. Flow volume targets will also be developed such that they are consistent with depth targets in free flowing, decompartmentalized areas. The working group will incorporate volumes associated with seepage loss and discharges, and document seasonal and inter-annual variability in order to develop the flow volume targets. The working group has identified the needed inputs to develop the volume component of the PM. Additionally, an evaluation protocol similar to that used for timing and distribution can be applied for the volume component.

6.2 Assessment Tools Needed

Identification of specific flow targets in areas not identified in this documentation will allow application of this PM at a larger scale or at the project level. This includes measures of flow timing, distribution, continuity, and volume.

7.0 Notes

Under the current formulation of the PM, it is possible to meet timing and distribution goals while still performing poorly due to lack of volume. All interpretation of timing, distribution, and continuity should be done with the recognition that the volume metric is still missing from the PM.

Special Considerations: The Western Tamiami Trail transect (Transect 17) and implications to the Cape Sable Seaside Sparrow (CSSS) Population A and Wet Prairie Performance Measures.

While evaluating flows across Transect 17, it is necessary to consider potential impacts to the marl prairie communities and CSSS sub-population A. By observing the detailed monthly data/output (IV) one can observe potential time frames where these two attributes of Everglades National Park may be negatively impacted. By looking at the continuity and distribution components of the metric, evaluators will gain further insight into potential impacts to marl habitats within which CSSS wet prairie habitat is one of the vegetation types present.

8.0 Working Group Members

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