

1 **Appendix C: Use of NSM as targets for System-wide**
2 **Performance Measures**

3 **1.0 Introduction**

4 Midway during the ICU process several future with-CERP SFWMM sensitivity runs
5 were conducted. The results of those sensitivity runs led to concerns that problems with
6 NSM ground surface topography estimates south of Tamiami Trail might be contributing
7 to counter-intuitive SFWMM run results. The ICU team therefore established an
8 interagency sub-team that re-evaluated topography throughout the NSM domain. This
9 team created contours for the area within the pre-drainage Everglades boundary. The
10 contours were then used to update grid topography within the NSMv4.6.2. The team
11 evaluated several NSM sensitivity runs, gathering input from evaluators and scientists
12 familiar with the current Everglades landscape and pre-drainage Everglades
13 characteristics. The final sensitivity run conducted by this sub team was the NSM Sens4.
14

15 Agreement could not be reached about whether the Sens4 run was a better predictor of
16 natural system response than NSMv.4.6.2, and about whether the Sens4 run should
17 replace NSM v.4.6.2 for use in ICU modeling comparisons and evaluations. The ICU
18 team and Evaluation Team members determined that NSM Sens4 provided the best
19 topographic contours based on available scientific information and that those contours are
20 better documented than contours in previous model versions or other sensitivity runs.
21 There was also general agreement that the much more consistent predictions across the
22 ridge and slough landscape in this run make better ecological sense and are more
23 consistent with scientific and historical evidence. NSM Sens4 predictions in the marl
24 marshes are also closer to best professional judgment and provide a better hydrological
25 match to historical soil type information than those in the other runs. After consideration
26 of all team members' thoughts and points of view, the RECOVER Planning and
27 Evaluation Teams decided to use both the NSM Sens4 run and the NSMv.4.6.2 run to
28 perform modeling evaluations and comparisons for the Initial CERP Update.

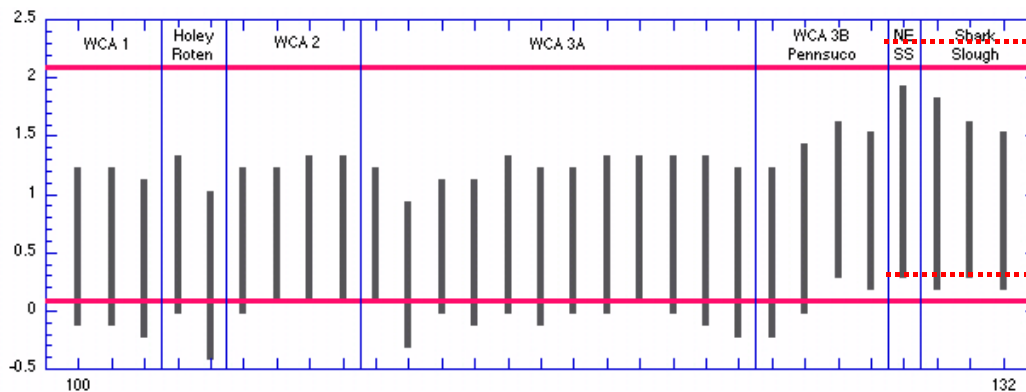
29 **2.0 Comparison of NSM Sens4 to Historical Information by**
30 **RECOVER Members**

31 Despite the improved scientific information used to create NSM Sens4, ICU and
32 Evaluation Team members felt that the sensitivity exercises highlighted outstanding
33 concerns regarding the ability of any of the recent NSM runs to serve as the basis for
34 setting natural system restoration targets. Following is a summary discussion of the
35 conclusions reached by several RECOVER scientists regarding evaluation and
36 comparison of NSMv.4.6.2 and NSM Sens4 model runs. Though specific authors are
37 mentioned, their analysis, thoughts and conclusions represent the range of thinking on the
38 part of RECOVER Planning and Evaluation team members who expressed thoughts or
39 opinions on this issue.
40

1 Christopher McVoy, SFWMD

2 Christopher McVoy’s examination of the differences between the two runs concluded
3 that simulations using the two different topographies produced, with some exceptions,
4 very similar water depths throughout the remaining ridge and slough landscape (McVoy,
5 2005). Exceptions were concentrated in four IRs in WCA 3A and Northeast Shark Slough
6 (See Figure 27). McVoy determined that the differences in water depths for IRs in this
7 area are due to an artifact of the estimated NSMv. 4.6.2 topography, namely a “pseudo
8 trough,” whose existence is not supported by historical evidence. In summary, he
9 concluded there was no significant difference in water depths resulting from the different
10 topographic estimates.

11
12 McVoy did find, however, that model-simulated water depths for both NSMv.4.6.2 and
13 Sens4 were “substantially shallower” than pre-drainage water depths estimated from
14 historic observations. The shortfall in depths simulated was stronger in the wet season (-
15 0.9 feet), compared to the dry season (-0.15 feet). Comparison of simulated (NSM
16 Sens4) and historically estimated seasonal amplitude in water depths for 29 ridge and
17 slough landscape IRs showed that simulated minima are similar to historical
18 observations, but simulated maxima and seasonal amplitude are much lower than
19 historical observations. He concluded that the shortfall is significant and would
20 substantially reduce simulated flows. The similarity of simulated water depths in NSMv.
21 4.6.2 and NSM Sens4 suggests that the shortfall is due not to the difference in topography
22 between the two runs, but to other (unidentified) model inputs. McVoy recommended
23 that further sensitivity analysis of the model be conducted and cautioned model users to
24 recognize that both NSMv.4.6.2 and NSM Sens4 substantially underestimate pre-
25 drainage water depths and, as a result, very likely underestimate flows as well.



27
The bottom of each black vertical bar is model-simulated “typical annual minimum;” top of bar is
“typical annual maximum.” For NSM Sens4, the red horizontal lines, 0.1 feet and 2.1 feet, show
typical annual minimum and maximum estimated from historical data. (Note same values assumed
across whole landscape, with possible exception of Shark Slough where dashed red indicates possibly
deeper depths due to narrowing.) Simulated minima are similar to historical observations, but the
simulated maxima and seasonal amplitude are much lower than historical observations.

28 **Figure 27. Comparison of Simulated and Historically Estimated Seasonal**
29 **Amplitude in Water Depths for 29 Ridge and Slough Landscape Indicator**
30 **Regions**

1 Tim Towles, biologist, Florida Fish and Wildlife Conservation Commission

2 Florida Fish and Wildlife Conservation Commission (FFWCC) biologist Tim Towles
3 evaluated and compared NSMv.4.6.2 and NSM Sens4 simulation results as well (Towles,
4 2005). Towles concluded that the updated topography, improved corrections for
5 subsidence in areas where there is evidence subsidence has indeed occurred, the
6 smoothing out of topographic countours, the more realistic flows across the coastal ridge
7 through the transverse glades and other model improvements in NSM Sens4, based on
8 historical data, resulted in a representation of the Everglades landscape that is more
9 consistent across broad eco-regions. Greater consistency in predicted inundation
10 characteristics across IRs of similar ecosystem types in NSM Sens4 was seen as an
11 improvement over NSMv.4.6.2. Towles pointed out that certain ridge and slough areas,
12 which were predicted to have extreme high water conditions in NSMv.4.6.2, were
13 predicted to have water levels more consistent with other areas of similar ecosystem
14 types in NSM Sens4. In addition, predicted hydroperiods in areas known to have been
15 marl prairies historically are closer to hydroperiods deemed desirable for formation and
16 maintenance of that ecosystem, based on best professional judgment. Hydroperiod
17 predictions for Rotenberger and Holeyland WMAs changed significantly in NSM Sens4,
18 compared to NSMv.4.6.2. Predicted hydroperiods in Rotenberg have increased,
19 suggesting much wetter conditions, while hydroperiods in Holeyland are predicted to
20 decrease. Although a greater number of extreme low water conditions in Holeyland
21 would raise concern, Towles concluded in general the change in predicted hydroperiods
22 made sense based on landscape differences between the two areas.

23
24 In summary, Towles supported use of NSM Sens4 for evaluation and comparison of ICU
25 model run performance because it incorporated the best available scientific data and
26 understanding of the natural system. He advocated refraining from further changes or
27 incorporating “offsets” to NSM Sens4 unless there is credible scientific or historical
28 information to justify such changes. He also concluded that because there is a high level
29 of uncertainty associated with flow measurements in NSM, evaluation of effects to
30 ecosystems should instead be based on stage values at indicator gauges, which have a
31 much lower degree of uncertainty. It could be the case that timing and distribution of
32 flows is more important to ecosystem development or maintenance than the actual flow
33 volume, in which case over-focus on flow volumes would be misplaced.

34 Vic Engel, hydrologist, Everglades National Park

35 Vic Engel, in a paper titled “Comments on NSM Sens3.1,” evaluated and compared an
36 earlier sensitivity run (NSM Sens3.1) to NSMv.4.6.2 and continued his evaluation of
37 NSM Sens4 in a later paper (Engel, 2005 a and b). Many of his concerns are applicable
38 to both sensitivity runs. Generally, Engel, a hydrologist atENP, supported the effort to
39 update topography estimates and concluded they appear “plausible,” but determined in
40 his analysis that modeled water levels using the updated topography are too low. Like
41 Towles, he was encouraged by the consistency of hydrologic characteristics modeled for
42 ridge and slough habitat throughout the GE, and the fact that modeled flow directions
43 generally matched the current ridge and slough orientation.

1
2 His analysis did highlight, however, several areas of concern regarding sensitivity run
3 performance. First, he pointed out that NSM Sens3.1 results in the southern Everglades
4 would suggest current salinities in Florida Bay are similar to historic values, but that
5 result is not consistent with paleoecological studies of Florida Bay, or with direct
6 observations of the landward migration of red mangroves in the area over the past several
7 decades. Paleo data indicate convincingly that these systems were essentially fresh water
8 systems. Second, he compared NSM Sens3.1 and NSM Sens4 topographic adjustments
9 to measured subsidence rates for IRs in WCA 3A and ENP. A qualitative comparison
10 showed general agreement in both areas for the two estimates of subsidence rates, but
11 indicated potentially significant differences in the southern portions of ENP and central
12 WCA 3A. Finally, there were several areas in which he concluded simulated water levels
13 in the sensitivity runs may be too low. An analysis of transverse glades inundation
14 periods led to the conclusion that water levels at the headwaters of the transverse glades
15 may be too low and that groundwater and surface water flows in that area are not
16 modeled accurately. An analysis of depth exceedence curves for IRs in WCA 3A implied
17 that the simulated shallow depths for those areas do not agree with current
18 understandings of hydrologic requirements for ridge and slough communities. This
19 conclusion is supported by the fact that water depths in an area of well-preserved ridge
20 and slough community are greater in the 2000B2 model run than in the NSM Sens3.1 and
21 NSM Sens4 runs. Engel also evaluated NSM Sens3.1 and NSM Sens4 results using
22 stages, rather than water depths. This analysis led to the same conclusion, namely, that
23 historic water levels in several areas are underestimated in NSM Sens3.1 and NSM
24 Sens4.

25
26 Engel pointed out a weakness in comparing NSM Sens3.1 and NSM Sens4 simulated
27 water depths with observations from historic, long term gauge data. Because stage, not
28 depth, was recorded at each station, and because subsidence of the land surface
29 throughout the ridge and slough community is likely to have occurred over the POR, the
30 depths associated with a particular stage at the long term gauge stations are likely to have
31 changed over time. Historic depth estimates based on gauge data and the current ground
32 surface elevations may therefore be in error.

33
34 Engel also voiced concerns regarding the application of NSM modeling runs to
35 establishment of Everglades restoration targets and measurement of project performance
36 with respect to those targets. He noted that a comprehensive validation of NSM results is
37 a pre-requisite to the adoption of restoration targets based on NSM. Information on the
38 distribution of soil types, vegetation communities, salinity gradients, flow volumes and
39 seasonal water depths and necessary assumptions should be used to accomplish the
40 validation. Support for use of NSM Sens4 runs in ICU evaluations relies too heavily, in
41 Engel's opinion, on the consistency of hydrologic conditions throughout the ridge and
42 slough landscape. In addition, the ability of the SFWMM (and thus NSM, both
43 hydrological models) to simulate ecological performance measures should be determined.
44 Until this is done, use of performance measures to evaluate the NSM results with respect
45 to any validation data is problematic. Finally, the team should document the model
46 elements to which results are most sensitive. Until further sensitivity analyses are

1 conducted and more results validated, NSM, regardless of which run, should be used as
2 reference only, rather than a fixed target or a thorough representation of the natural
3 system.

4 Heather McSharry, biologist, U.S. Fish and Wildlife Service

5 Heather McSharry, a biologist for U.S. Fish and Wildlife Service (FWS) concluded after
6 analysis of the calibration and verification data for the NSM sensitivity runs that Sens4
7 simulates conditions that would provide greater flows to Florida and Whitewater Bays
8 than have actually occurred over the past 20 years and questioned whether concerns
9 regarding flows being too low should be re-evaluated. She recognized that the question
10 of how much additional flow is “enough” compared to recent decades is a different
11 question, and one she did not address. Additional analysis of the calibration/verification
12 data led her to conclude that NSM Sens4 would increase hydroperiods and alleviate the
13 extreme lows that promote peat fires and other symptoms of overdrainage without having
14 stage or depth duration curves showing water levels consistently higher than the CalVer
15 run. McSharry noted, however, there remains an apparent conflict between conclusions
16 based on depths versus hydroperiods. Because NSM Sens4 is based on better topographic
17 information and analysis of the calibration/verification run appeared to have eliminated a
18 major concern of less flow to Florida Bay compared to current conditions, McSharry
19 supported use of NSM Sens4 in ICU evaluations and comparisons. While not perfect,
20 she concluded, it does represent a “step forward.” Finally, though recommending use of
21 NSM Sens4 for model run evaluations and comparisons, McSharry agreed that there are
22 important outstanding concerns regarding use of any NSM run for restoration targets.

23 RECOVER Evaluation Team–Southern Estuaries Sub-team

24 The Southern Estuaries Sub-team of the RECOVER Evaluation Team performed a
25 literature search to document appropriate salinity targets for Florida Bay, Biscayne Bay,
26 and Whitewater Bay. During the course of their analysis, the sub-team addressed NSM
27 predicted salinities compared to paleoecological data and historical accounts for the areas
28 of interest. For Manatee Bay, NSM Sens3.1 consistently predicts salinities that are 3-14
29 ppt higher than those estimated from sediment core data. For Middle Key (in Barnes
30 Sound), this disparity increases, with NSM Sens3.1 predicting salinities 24-34 ppt higher
31 than paleosalinity estimates. Within Florida Bay, NSM Sens3.1 generally predicts
32 salinities ten ppt higher in Whipray basin and five to seven ppt higher in Joe Bay. The
33 Southern Estuaries sub-team’s analysis generally pointed toward anthropogenic changes
34 and changes in climate to account for changes in salinities from pre-drainage conditions.
35 The climactic influence is particularly relevant to the NSM discussion, since NSM
36 predictions are based on a period of record from 1965 to 2000. Given that this time
37 period is drier than average, NSM predictions for may be based on rainfall information
38 that is different from the pre-drainage period, thereby predicting salinities higher than
39 those substantiated by historical accounts. Efforts to compare NSM output with
40 paleoecological reconstructions and to develop targets for ecosystem restoration will be
41 further pursued by the Southern Estuaries Sub-team.

1 **3.0 Conclusions**

2 Despite the improved scientific information used to create NSM Sens4, ICU and
3 Evaluation Team members felt that the sensitivity exercises highlighted outstanding
4 concerns regarding the ability of any of the recent NSM runs to serve as the basis for
5 setting natural system restoration targets. The NSM Sens4 run represents the best
6 topographic contours based on available scientific information and that those contours are
7 better documented than contours in previous model versions or other sensitivity runs;
8 however, NSM Sens4, has known weaknesses that must be described and understood.
9 While the NSM Sens4 run is generally seen as an improvement over NSMv.4.6.2, further
10 improvements in the model are necessary in order for many scientists to support use of
11 NSM predictions as restoration targets in all ecosystems and geographic areas throughout
12 the model domain.