Performance Indicators (PI): Decomp Phase 1, ELMreg500, v2.8.4 *version: Sep 1, 2011*

Brief description, and basis for use in evaluating hydro-ecology and eutrophication risk of simulated Alternatives relative to FWO Base.

For each Performance Indicator:

-- A) To assess the landscape area exceeding defined eutrophication thresholds for the Alternative X and the FWO Base runs, for each run produce an output map showing two eutrophication threshold contours; for each run, produce entries in a summary table showing the total landscape area that exceeded each threshold.

-- B) To directly compare the Alternative X with the FWO base, produce an output difference map showing two difference threshold (± *value*) contours; produce entries in a summary table showing total landscape area of Alternative X that had results that were *"value"* less than, and *"value"* more than, the FWO base.

-- NOTE: The A) metrics of threshold exceedance provide direct measures of landscape area exceeding specific eutrophication thresholds. However, model grid cell values in one (Alternative or Base) run may be slightly below threshold, while another run may have values slightly above threshold (and thus may appear quite different). Therefore, the B) difference-map comparison provides the means to specfically determine whether the Alternative X had more landscape area with results greater than, and/or less than, the FWO Base, at difference-thresholds that are ecologically meaningful and that can be meaningfully discerned within the model performance capabilities. *The difference-thresholds are generally less than the eutrophication thresholds, and show whether Alternative X is trending towards less or more eutrophication risk relative to the FWO Base.*

PI Family	Performance Indicator Name	Performance Indicator Target	Ecological time scales	Performance Indicator "Pros"	Performance Indicator "Cons"	Performance Indicator Thresholds
Total Phosphorus (TP) concentration in marsh surface water			P uptake by microbial/plant communities occurs on order of minutes/days; thus most high P concentrations in surface water tend to reflect uptake & release mechanisms associated with a ecosystem that is eutrophic, or becoming eutrophic, over annual/decadal time scales.	-- Compared to other metrics, water column P is easily/quickly sampled in the field, and has been used as a primary metric to evaluate *in situ* eutrophication for permitting etc. -- Due to the extensive temporal and spatial availability of observed data, is widely used to evaluate performance of water quality models. -- Well known and easily interpreted by range of audiences	-- Because of extremely rapid loss rates upon introduction to a (modeled or real-world) marsh, may underestimate level of eutrophication. -- After long-term water column loading, surface water concentrations increase in marsh and reflect eutrophication, but the net results from the soil-plant-water gain-loss dynamics may not fully reflect "true" level of ecosystem eutrophication.	-- Fast response time of P uptake by microbial and plant communities lead to need to evaluate water column P concentration Performance Indicators with a variety of methods. NOTE: these metrics of TP concentration in surface water exclude all values when surface water depth is <10 cm, at request of Decomp PDT members (to be consistent with field monitoring protocols).
1a	TP surface water, Dry season of Dry year snapshot	Minimize area of marsh with concentration > 10 ppb	-- Temporal snapshot reflective of P availability in water column at one point (ca. month) in time.	-- May capture relatively short-term events due to hydrologic conditions at time of snapshot, thus this snapshot is intended to be approximately representative of the chosen season and rainfall-year.	-- Snapshot in time must be considered in conjunction with other snapshots in time, and professional judgement must be used to determine the appropriate number and timing of snapshots. -- Significant inter-annual and among-season variability in antecedent conditions and water management responses make it necessary to consider any temporal snapshot to be a general guideline, and should not be used without considering other metrics (including other temporal snapshots).	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
1b	TP surface water, Dry season of Average year snapshot	Minimize area of marsh with concentration > 10 ppb	"	"	"	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
1c	TP surface water, Dry season of Wet year snapshot	Minimize area of marsh with concentration > 10 ppb	"	"	"	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
1d	TP surface water, Wet season of Dry year snapshot	Minimize area of marsh with concentration > 10 ppb	"	"	"	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
1e	TP surface water, Wet season of Average year snapshot	Minimize area of marsh with concentration > 10 ppb	"	"	"	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
1f	TP surface water, Wet season of Wet year snapshot	Minimize area of marsh with concentration > 10 ppb	"	"	"	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
1g	TP surface water, Period-of-Simulation mean	Minimize area of marsh with concentration > 10 ppb	-- Long-term, multi-decadal mean concentration tends to reflect level of eutrophication status of ecosystem.	-- Provides some degree of long term integrative understanding (due to soil-plant-water fluxes leading to higher concentration above eutrophic marsh system).	-- Does not generally reflect true magnitude of any ecosystem eutrophication, due to rapid uptake rates of P from surface water. -- Long-term mean value tends to mask short-term pulses that may have been assimilated by system (but model should primarily be used to consider long-term dynamics due to stochasticity of ecosystem). -- Needs to be considered in conjunction with temporal snapshots of P concentration in surface water.	-- A) Eutrophication thresholds at 10 and 20 ppb (ug/L). -- B) Difference thresholds at ± 5 ppb (ug/L).
Phosphorus accumulation rate in marsh ecosystem/soils	Phosphorus accumulation rate in marsh ecosystem/soils, Period-of-Simulation mean	Minimize area of marsh with excessive P accumulation rates, using two risk levels: 50 mg m^2 yr^{-1} and 100 mg m^2 yr^{-1}	-- Long-term, multi-decadal, P accumulation rate is a cumulative metric over duration of Period of Simulation, capturing the net effect of P that has been assimilated in ecosystem.	-- Of all nutrient-related Performance Indicators, provides the most sensitive, integrative measure of ecosystem eutrophication status (see CERP RECOVER documentation of Peformance Measure).	-- Long-term mean value tends to mask short-term pulses that may have been assimilated by system (but model should primarily be used to consider long-term dynamics due to stochasticity of ecosystem).	-- A) Eutrophication thresholds at 50 and 100 mg m^2 yr^{-1}. -- B) Difference thresholds at ± 10 mg m^2 yr^{-1}.
Peat accretion rate in marsh soils	Peat accretion rate in marsh soils, Period-of-Simulation mean	To be more formally established, but target range is to maintain accretion rates of at least 0.25 mm/yr, but no greater than 2 mm/yr	-- Long-term, multi-decadal, peat accumulation rate is a cumulative metric over duration of Period of Simulation, capturing the net effect of ecosystem responses to P loads and varying water depths.	-- Provides the most integrative metric of ecosystem response to hydrologic and nutrient drivers. -- Rates less than 0-1 mm/yr may reflect excessive dry-out (and thus organic oxidation), while rates exceeding 2-3 mm/yr may reflect eutrophication (and thus high plant turnover & associated organic accretion).	-- Because it integrates multiple processes (of biological responses to hydrologic and nutrient dynamics), high vs low peat accumulation/loss can not be attributed to be caused by single processes, such as nutrient loading. -- While the relatively broad range of targeted peat accumulation rate is accepted, more specific target rates have not been defined/accepted. -- Long-term mean value tends to mask short-term pulses that may have been assimilated by system (but model should primarily be used to consider long-term dynamics due to stochasticity of ecosystem).	-- A) Rate thresholds at 0.25 and 2.0 mm yr^{-1}. -- B) Difference thresholds at ± 0.25 mm y^{-1}. -- Note that peat accumulation rate is not a direct measure of eutrophication, and the results seen in the difference thresholds are not used in making judgements about the relative ecological performance of the simulations.
Phosphorus concentration in marsh soils	Phosphorus concentration in upper 0-10 cm of marsh soils, End-of-Simulation snapshot	Minimize area of marsh with soil P concentration exceeding 400 - 500 mg P / kg soil in the upper 0-10 cm layer (excluding floc)	-- The ending soil P concentration after long-term, multi-decadal period is a cumulative metric over duration of Period of Simulation, capturing the net effect of P that has been assimilated in the soils (and thus reflects ecosystem eutrophication status).	-- While field sampling is labor-intensive (and expensive), the metric has been used to evaluate long-term, *in situ* eutrophication status of marshes. -- Well known by range of audiences, and can be interpreted reasonably well. -- Somewhat analagous to the P accumulation metric, this tends to integrate long-term P eutrophication status.	-- Because the mass of any new input of P is averaged within a 10-cm depth of soil (which may take ca. 50 years or more to accumulate), changes in soil P concentration are somewhat masked ("diluted") by the overall mass of antecedent P and organic matter in that profile; i.e., metric not very sensitive to low/intermediate levels of P loading.	-- A) Eutrophication thresholds at 400 and 500 mg kg^{-1}. -- B) Difference thresholds at ± 100 mg kg^{-1}.