

Regional Scale Modeling for Multiple Stressors of Lake Erie

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State of Lake Erie Ecosystem

- Lake Erie is structurally and functionally unhealthy (i.e. impaired)
 - Limited resilience
 - Structural instability
- Prevailing stress complex is currently unmanageable
 - Fish community unstable with cascade of effects
 - Management uncertainty
 - Confusion about important regulatory mechanisms



Project Goals

- Develop a regional-scale, stressorresponse model for the management of the Lake Erie ecosystem
 - Stressors: land use changes, nutrients, habitat alteration, flow regime modification, exotic species, and fisheries exploitation
- Incorporate model into a multiobjective decision making tool for use by Lake Erie managers



Project Task Structure

- Linking changes in watershed habitat and nutrient loading to Lake Erie ecosystem health
- Quantifying uncertainties in model predictions and the effects of uncertainties on management decisions
- ♦ Evaluating cross-scale interaction of stressors
- Developing tools to evaluate ecological risk of land-use changes
- Identifying and evaluate critical break-points in ecosystem and management integrity



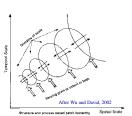
Users

- ◆ Fisheries managers
 - Lake Erie Committee (GLFC)
 - State and Provincial natural resource agencies
- ♦ Water quality managers
 - IJC (US EPA and Environment Canada)
 - EPA's TMDL process
- Planning and development agencies
 - Ohio Balanced Growth Initiative
 - Joyce Foundation funded initiative with watershed partnerships



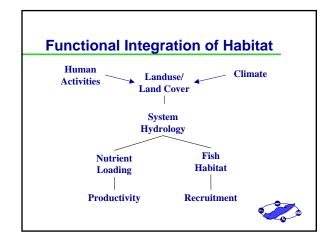
Current Challenges

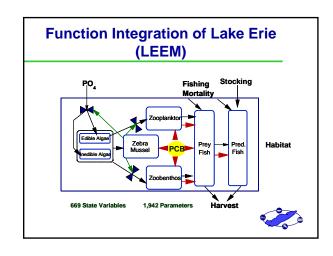
- Modeling
 - Explicit incorporation of scaling issues
 - Development of a hierarchical modeling architecture
- ◆ Database development
 - Coordinating geodatabases
 - Framework for upscaling and downscaling
 - Incorporation of dynamic land cover changes

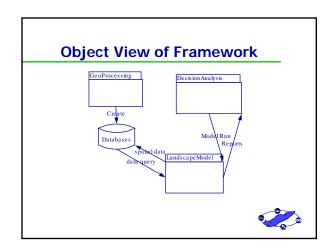


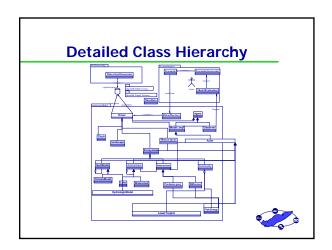


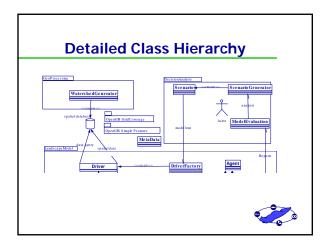
Unified Modeling Framework • Overall functional integration of habitat and Lake Erie ecosystem health • Linking landscape to whole lake processes • Determine cross-scale additivity of stressors • Database component • Fine scale classification of landscape • Biologically informed aggregation of landscape features • Ecological model • Hierarchical • Linked to management

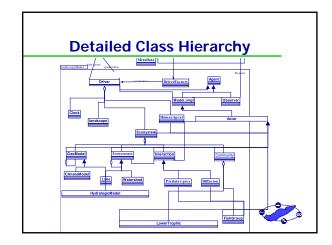


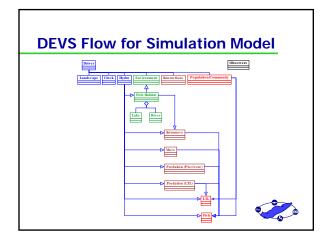












Implement XML Based Metadata Repository

- ◆ Metadata for spatial data
 - XML specification of data for models
 - XML specification of data for queries
- Metadata for model implementation
 - Model selection
 - Model assembly
- ◆ Model driven architecture
 - Platform Independent Model
 - Platform Specific Model
 - Transformation through code generators



Consequences for QA/QC

- **♦ Versioning control**
- ♦ Analyses of parameter space
- ♦ Documentation of parameter estimation procedures and data sources
- ◆ Model selection criteria through contest of models. Find levels of aggregation and the limits of their applicability
- Hypothesis generation and design of monitoring strategy

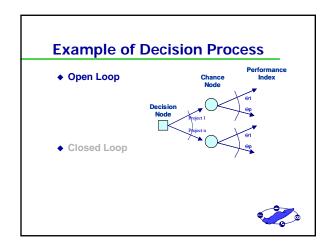


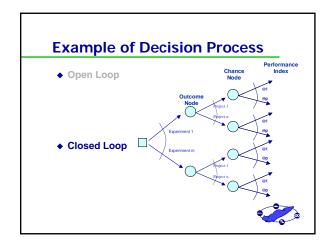
Management Domain

- ◆ Fisheries

 - Harvest quotasFish community objectives
 - Management of exotics
- ◆ Landuse change
 - Management of storm water runoff
 - Permitted changes
 - Mitigation priorities
- ♦ Instream habitat alteration
 - Riparian corridors
 - Stream bank stabilization



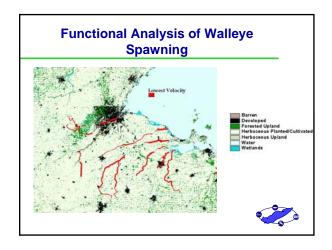


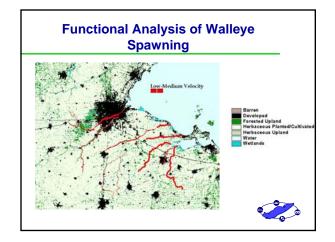


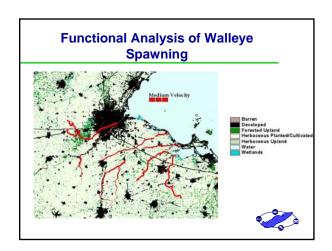
Walleye Spawning Example

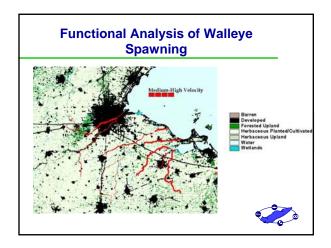
- ◆ Functional analysis of walleye spawning
 - Identification of habitat preferences for adults
 - Mapping of habitat supply
 - Prediction of larval mortality
- ◆ Linking landuse change to critical habitat features
- ◆ Prediction of consequences of alteration to reproductive success

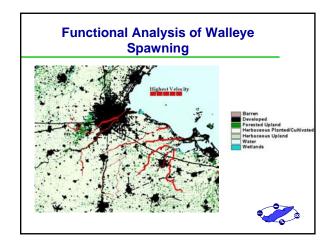












Short-term Outcome Issues

- Extrapolating from multiple scales of analysis
 Functional approaches to landscape hierarchies
- ♦ Interaction of multiple stressors
 Linking watershed hydrology to whole lake effects at a range of spatial and temporal scales
- Range of decision making alternatives
 Priorities for mitigation, functional identification of priority conservation areas, and decision support system for landuse planning
- ◆ Intermediate products Multi-modeling framework based on open DEVS standards



Long-term Outcome Issues

- ◆ Ways to reduce uncertainty Explicitly embracing uncertainty is the best way to reduce it
- ◆ Seminal contribution Assessment of cross-scale additivity of stressors
- ◆ Application of model to monitoring
 - Value of information
 - •Linking monitoring to expectations at various scales of resolution





