



Regional Scale Modeling for Multiple Stressors of Lake Erie

Joseph F. Koonce
Case Western Reserve University
Benjamin F. Hobbs
Johns Hopkins University

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, stressor-response 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 multi-objective 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



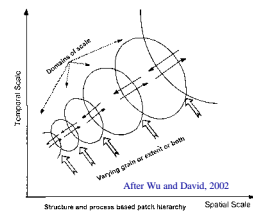
Users

- ◆ 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



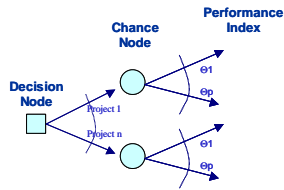
Current Challenges

- ◆ 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



Example of Decision Process

◆ Open Loop

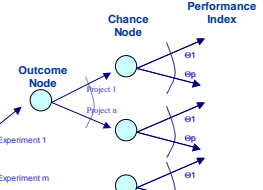


◆ Closed Loop



Example of Decision Process

◆ Open Loop



◆ Closed Loop

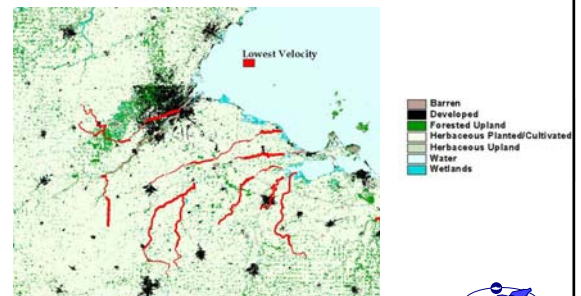


Walleye Spawning Example

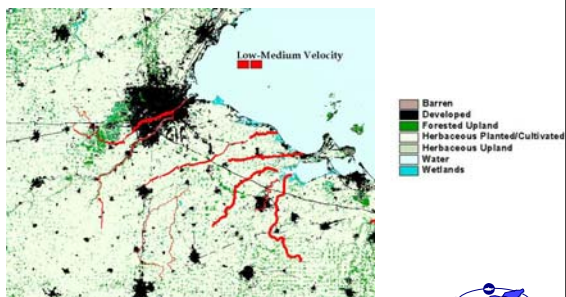
- ◆ Functional analysis of walleye spawning
 - Identification of habitat preferences for adults
 - Mapping of habitat supply
 - Prediction of larval mortality
- ◆ Linking landuse change to critical habitat features
- ◆ Prediction of consequences of alteration to reproductive success



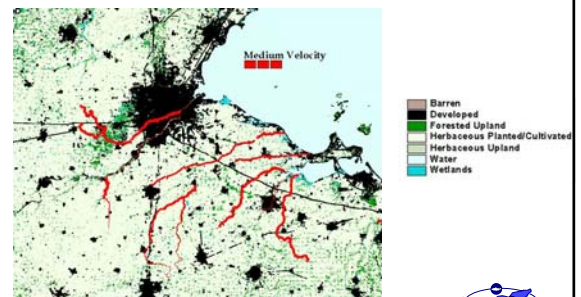
Functional Analysis of Walleye Spawning



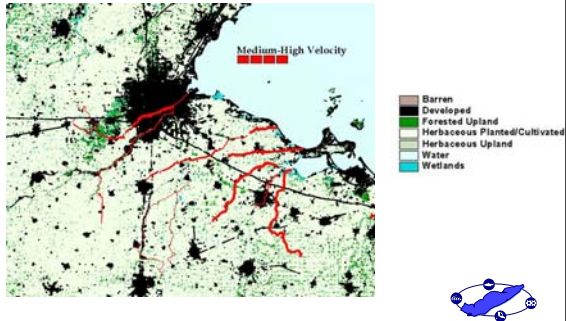
Functional Analysis of Walleye Spawning



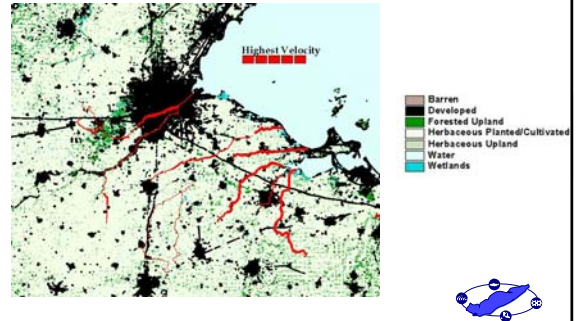
Functional Analysis of Walleye Spawning



Functional Analysis of Walleye Spawning



Functional Analysis of Walleye Spawning



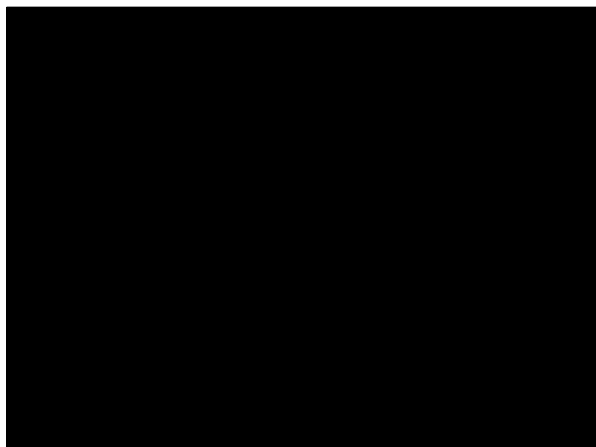
Short-term Outcome Issues

- ◆ **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 land-use planning
- ◆ **Intermediate products**
Multi-modeling framework based on open DEVS standards

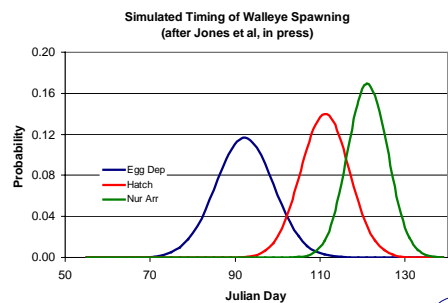


Long-term Outcome Issues

- ◆ **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

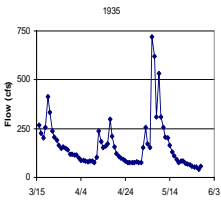


Functional Analysis of Walleye Spawning

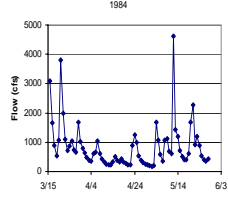


Functional Analysis of Walleye Spawning

Dry Year



Wet Year

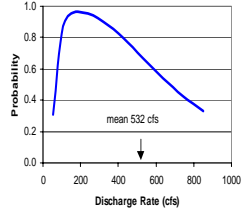


Chagrin River



Functional Analysis of Walleye Spawning

4.1 miles



18 miles

