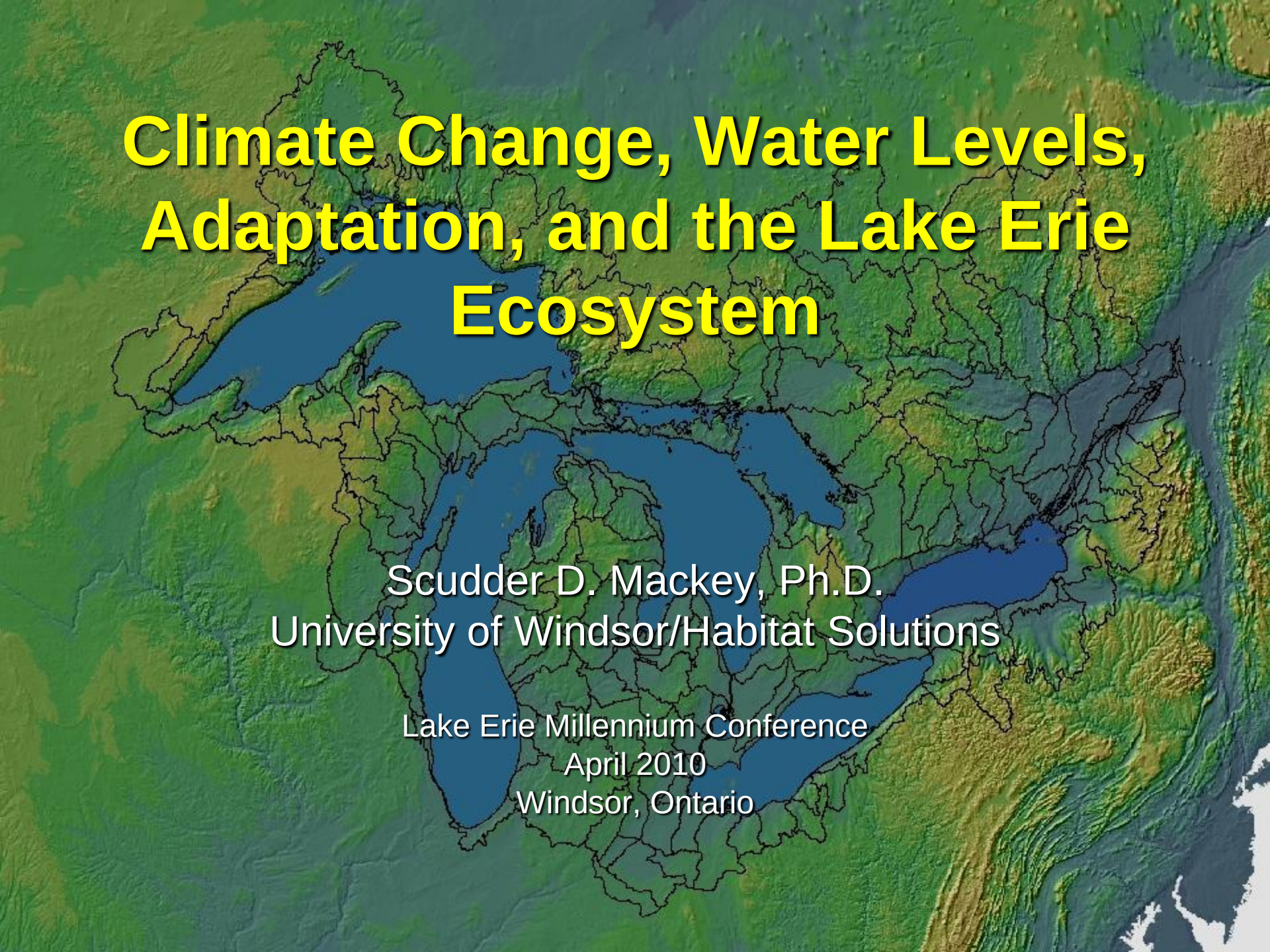
Climate Change, Water Levels, Adaptation, and the Lake Erie Ecosystem



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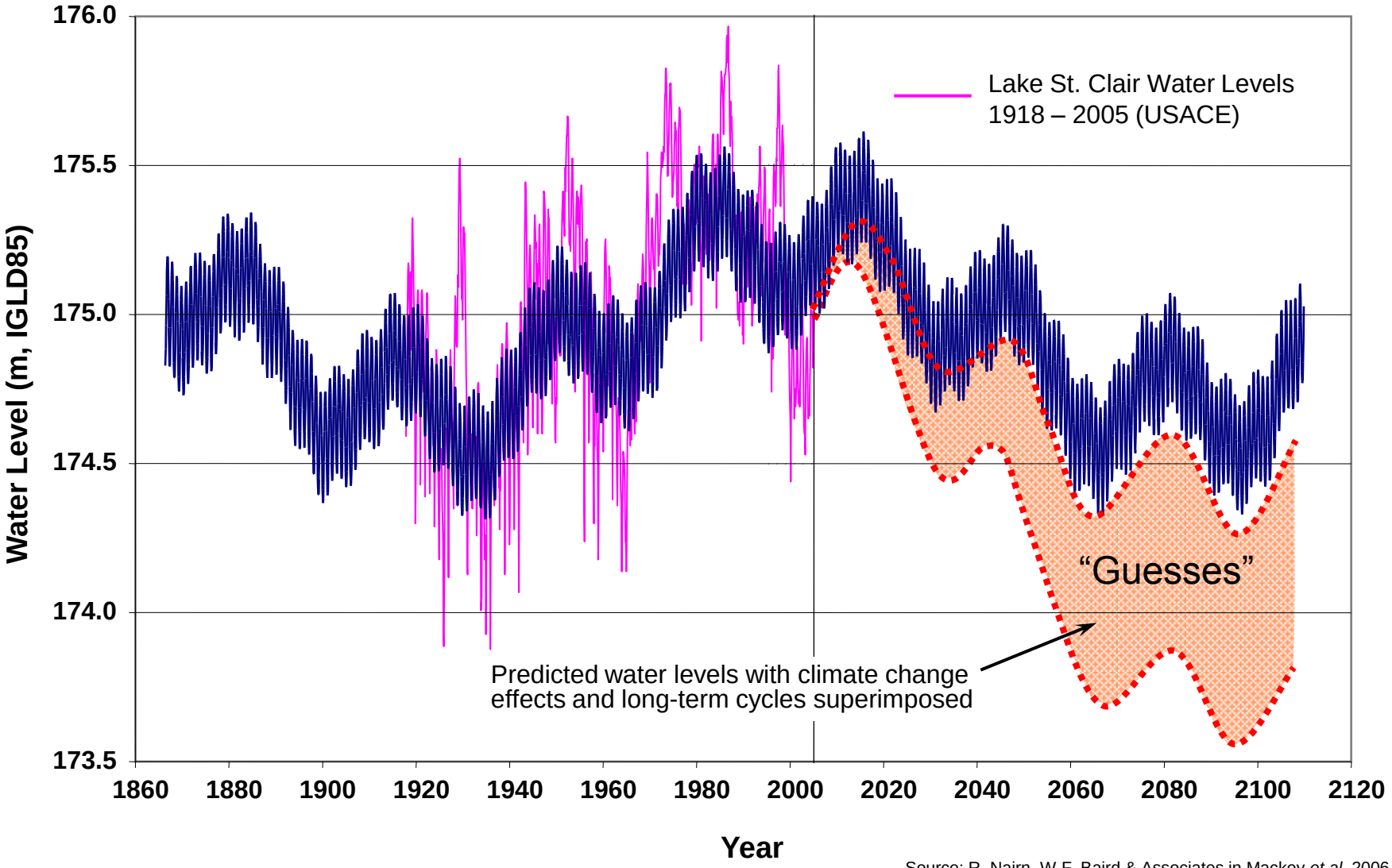
Today's Presentation

- Adopt a different paradigm - focus on ecosystem needs and thresholds, not climate change guesses
- Climate change impacts will alter Lake Erie water level regimes, temperatures, and shorelines
- Biological communities will respond to changes in water level and temperature regime
- Existing stressors will be compounded by effects of climate change
- Research needs
  - Thresholds and "tipping points"
  - What do we need to monitor?
- Adaptation strategies/solutions

Different Paradigm

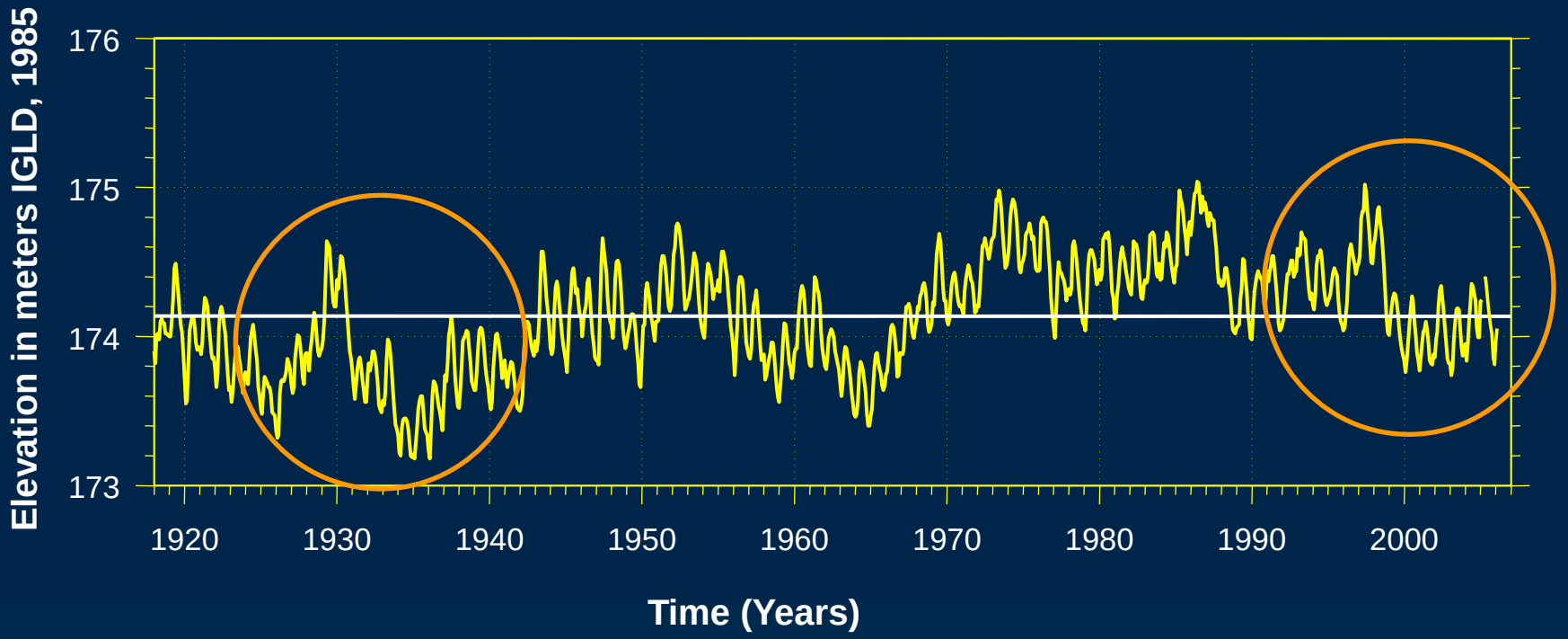
- Traditional approach is to generate climate change guesses (scenarios) and then predict responses based on those scenarios.
  - *High degree of uncertainty – and they are going to be wrong…*
- Instead, let's focus on the ecosystem and attempt to understand the vulnerability of various ecosystem components to water level regime changes.
  - *Water level regime – magnitude, frequency, timing, duration, and rate of change*
  - *Connectivity, water level range and duration, timing*
- Identify water-level regimes and thresholds that force us to re-evaluate policies and management plans
- Then ask the climate change scientists are these water level regimes plausible?

Long-Term Climatic Cycles (Lake St. Clair)



Source: R. Nairn, W.F. Baird & Associates in Mackey *et al*. 2006

Lake Erie Major Historical Declines



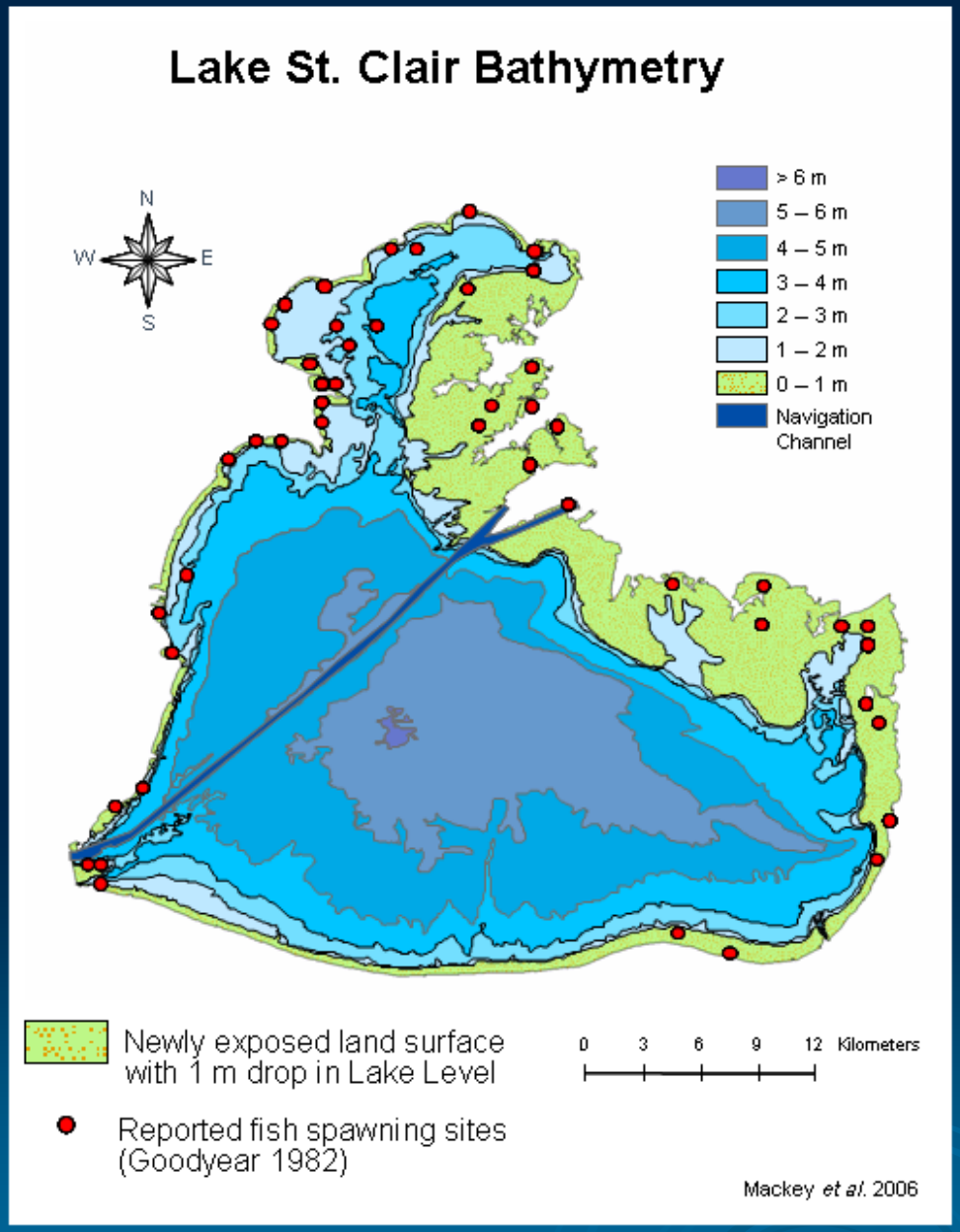
One Year	Two Year
-0.48 m (1998-1999)*	-0.74 m (1997-1999)*
-0.45 m (1987-1988)	-0.70 m (1986-1988)
-0.55 m (1930-1931)	-0.75 m (1929-1931)

* Second largest decline in 140 years.

Source: Great Lakes Environmental Research Laboratory

Water Level Regime

- Major shifts in shoreline position/location
- Loss of hydraulic connectivity
  - Wetlands
  - Small tributaries
  - Loss of wetlands and fish spawning/nursery habitat
- Changes in seasonal magnitude, timing and duration
  - Seasonal highs and lows
  - Intermittently exposed Western Basin reefs?
- Altered tributary flow regimes and Lake circulation patterns
  - Connectivity between spawning and nursery habitats
  - Nutrient and contaminant loadings



Lake St. Clair Connecting Channels

- Up to 1 m drop in lake level by 2050 (worst-case scenario)
- 22,000 ha (54,000 Ac) exposed

- Change in shoreline location
- Shallow-water areas will be exposed
- Littoral sand trapped onshore
- Wetland complexes will be hydraulically isolated and disconnected
- 43 spawning sites, 33 species
- 28 sites high and dry
- More than 60 % of shallow-water habit (< 1 meter) will be lost

Thermal Effects

- Higher surface water temperatures
  - Seasonal timing (many fish species spawn in response to thermal conditions)
- Deeper and stronger thermocline
  - Reduced Lake Erie hypolimnion volume (bottom waters)
  - Expansion of central basin hypoxia
  - Change in cold and warm water fish distributions
- Boundaries for up to 19 fish species (both cold and warm water fish) would shift northward
- Lower thermal constraints on invasive species
  - More rapid expansion of *dreissenid spp.* into Northern Lakes
- Reduced ice cover with potential changes in winter productivity

Descriptive Framework of Biological Condition

Pristine

Natural Variability

Critical Threshold

Degraded

Impact Score	Biological Condition
1	**Natural or native condition** Native structural, functional, and taxonomic integrity is preserved; ecosystem function is preserved within range of natural variability
2	**Minimal changes in structure of biotic community; minimal changes in ecosystem function** Virtually all native taxa are maintained with some changes in biomass and/or abundance; ecosystem functions are fully maintained within range of natural variability
3	**Evident changes in structure of biotic community; minimal changes in ecosystem function** Some changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but sensitive–ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system
4	**Moderate changes in structure of biotic community; minimal changes ecosystem function** Moderate changes in structure due to replacement of some sensitive–ubiquitous taxa by more tolerant taxa, but reproducing populations of some sensitive taxa are maintained; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes
5	**Major changes in structure of biotic community; moderate changes in ecosystem function** Sensitive taxa are markedly diminished; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased buildup or export of unused materials
6	**Severe changes in structure of biotic community; major loss of ecosystem function** Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism conditioning is often poor; ecosystem functions are severely altered

Jackson and Davies (2006), Bain (2007)

Summary/Research Needs

- Adopt a different paradigm - focus on ecosystem needs and thresholds, not climate change guesses.
- Identify critical ecological (and societal) thresholds or "tipping points" that will result in significant (i.e. unacceptable) detrimental changes to the Lake Erie ecosystem.
- What do we monitor that will tell us when we are approaching a threshold or "tipping point"?
  - Need to identify critical metrics or performance indicators
- What can we contribute toward more enlightened and adaptive resource management strategies to address potential climate change impacts?