

Shifting Baselines of Perception

Vulnerability of Reference Condition
to Climate and Land Use Change

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Reference Condition

- Assessment of biological condition is relative to a reference condition – what the water body would be like in the absence of modern human effects
- Requires us to reconstruct undisturbed conditions if they are unavailable
- The parable of the frog: slow (or unknown) change leads to undetected shifts in perception
- We have a history of change in perception

Asher Brown Durand
Forest in the Morning Light, c. 1855
National Gallery of Art



Original Perception: The Forest Primeval

- In the East: Undisturbed, “pristine” forest,
- BUT:
 - Original Native American population was sizable
 - Practiced agriculture
 - Managed forests for wildlife with fire
 - By the time of English settlement (after 1600), Native populations had been decimated by Eurasian diseases

Brief history of changes

- Our effects on waterbodies can be traced by out economic activity
- Colonial period
 - Extractive industry
 - Fur trade: remove beaver
 - Timber: export, construction, fuel
 - Clearing for agriculture

Early Industrial Era

- Widespread use of water power: many small dams
- Agriculture reached widest extent in East
- Extractive industry
 - Mining: small scale (coal, metals)
 - Timber: construction, fuel, charcoal for smelters
- Manufacturing
 - Tanning, smelting, textiles



George Inness

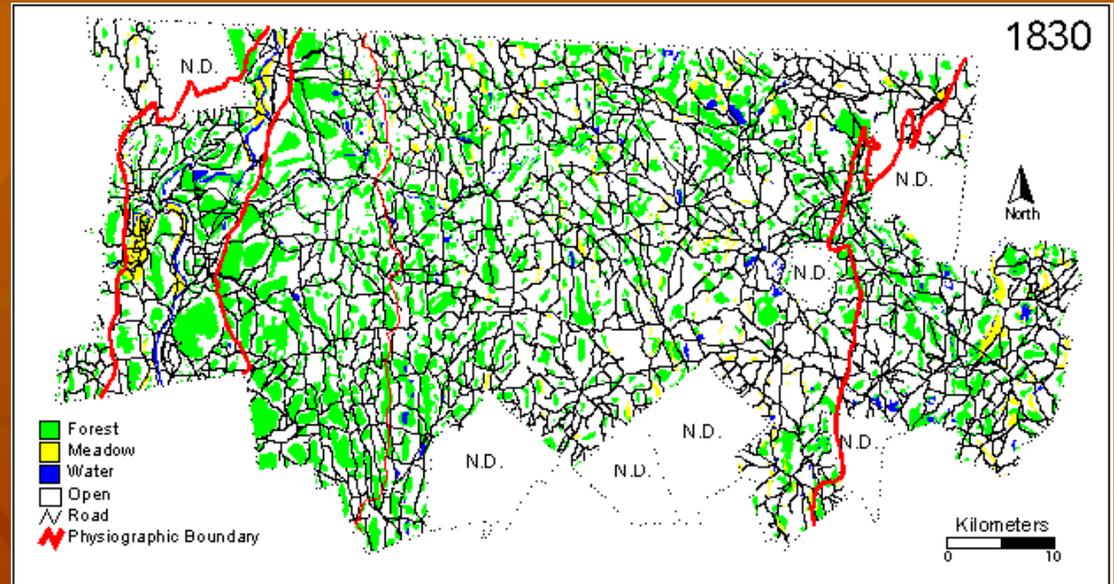
detail: *The Lackawanna Valley*, c. 1856

National Gallery of Art

Heavy Industrial Era: The Steel Age

- Coal and steel were king
- Extractive industry activity moved west
 - Coal – primarily Appalachian
 - Oil, minerals – now centered in the west
 - Timber – now centered in the west
- Agriculture
 - Midwest and West, increasing mechanization
 - Abandonment of Eastern agricultural land – reforestation
- Manufacturing: heavy industry

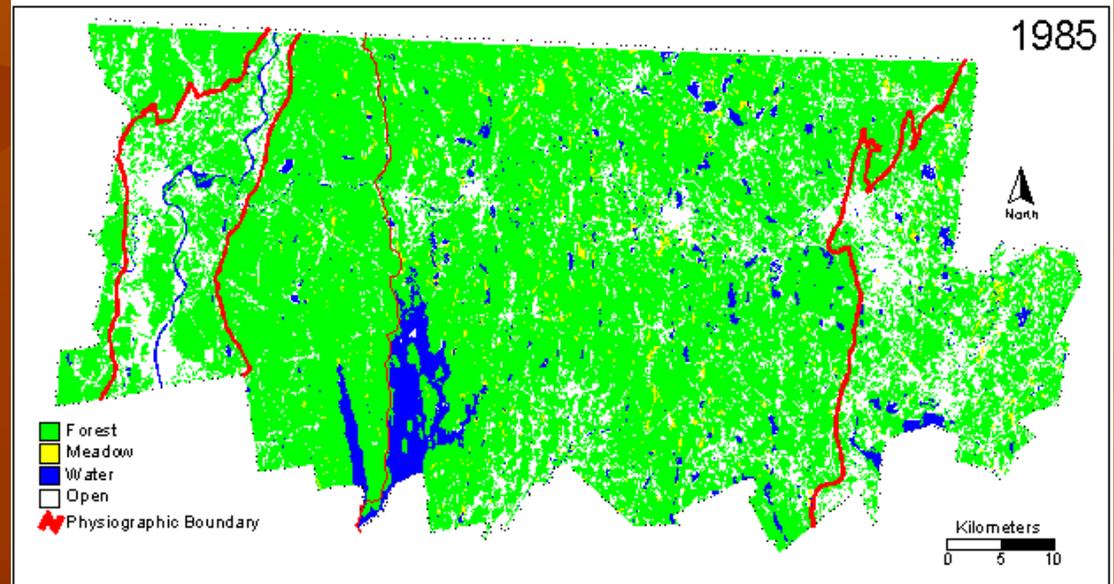
Land cover change in north central Massachusetts



Source:
D. Foster, G. Motzkin, J. Fuller, B. Slater. 1998
Land-use History as Long-term, Broad-scale Disturbance:
Regional Forest Dynamics in Central New England

Land Use History of North America (LUHNA)

<http://biology.usgs.gov/luhna/harvardforest.html>



Post WWII (Post-Industrial) Era

- Decline of heavy manufacturing; increase of high-tech and military industry
- Movement of military and tech industry to “sun belt”
- Increasing importance of construction industry as major component of economy

Urbanization

- Rapid population growth since 1945
- Growth in suburbs and exurbs - a slice of the suburban “dream”
 - Larger houses
 - Farther transportation; exclusively automobiles
 - Proportionally more land area devoted to pavement than in urban cores
 - use of fertilizers, energy, pesticides on lawns



Climate and Land Use

- Land use affects stream temperature, flow, and water chemistry
- Climate change will affect stream temperature and flow (see M. Paul presentation)
 - Happening over an ongoing dramatic change in land use
 - Effects of climate change will be felt to differing degrees relative to land use change

Shifting Reference Sites

- What is vulnerability of reference sites?
 - Climate change is universal
 - If reference sites become urbanized, how can we detect the effects of climate change? What happens to our ability to determine effects of stressors we do not measure (e.g., drugs)

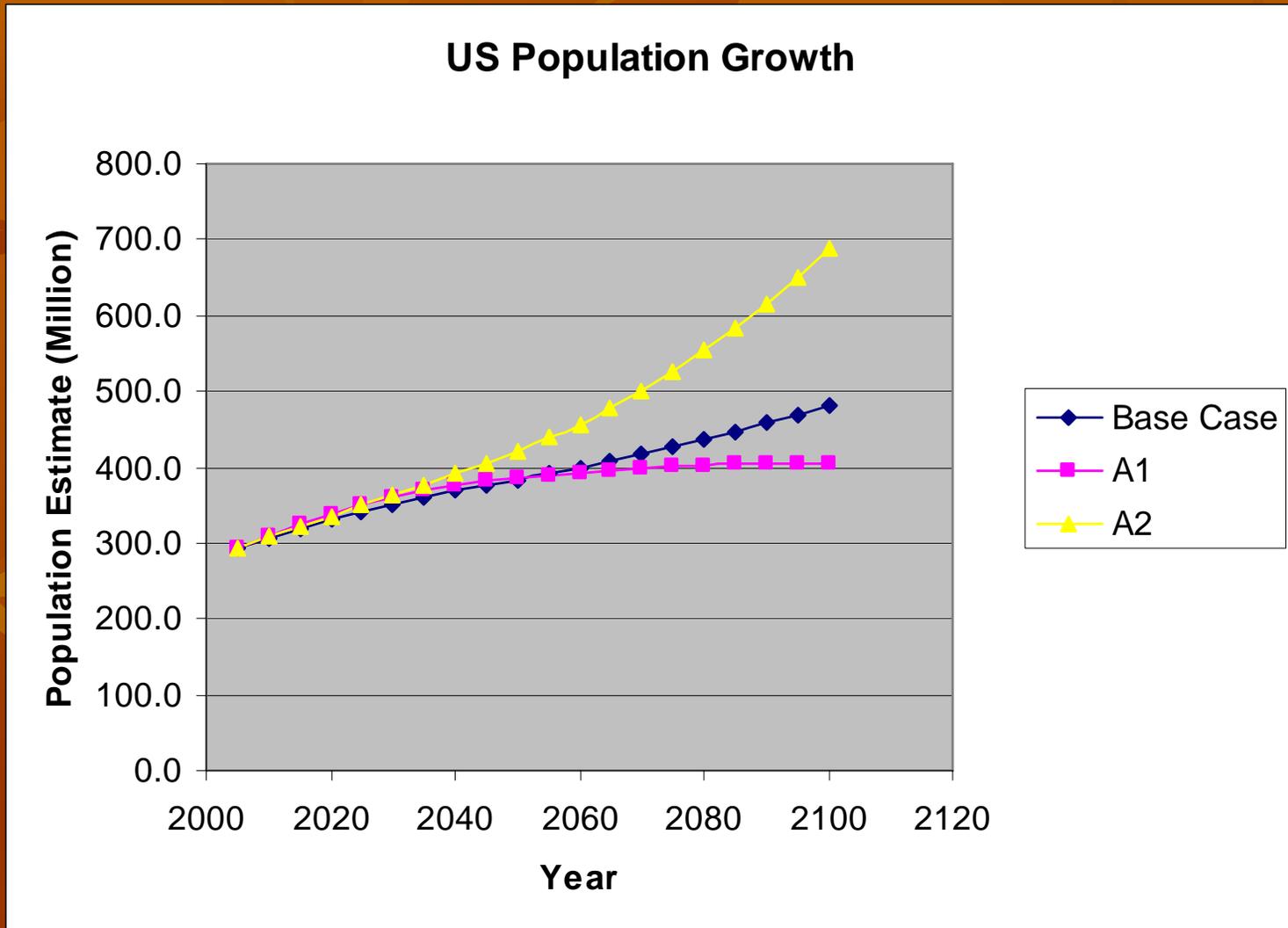
Vulnerability of reference

- Reference sites in Florida
 - Florida DEP has identified reference sites throughout state
 - “Legacy” pollution less in FL than other eastern states – not part of early industrial or heavy industrial eras
- Current era growth and urbanization has been extraordinary
- Examined reference sites in 3 future growth scenarios
 - Scenarios courtesy of David Theobald, Colo. State Univ., GCRP ICLUS (Integrated Climate and Land Use Scenarios)

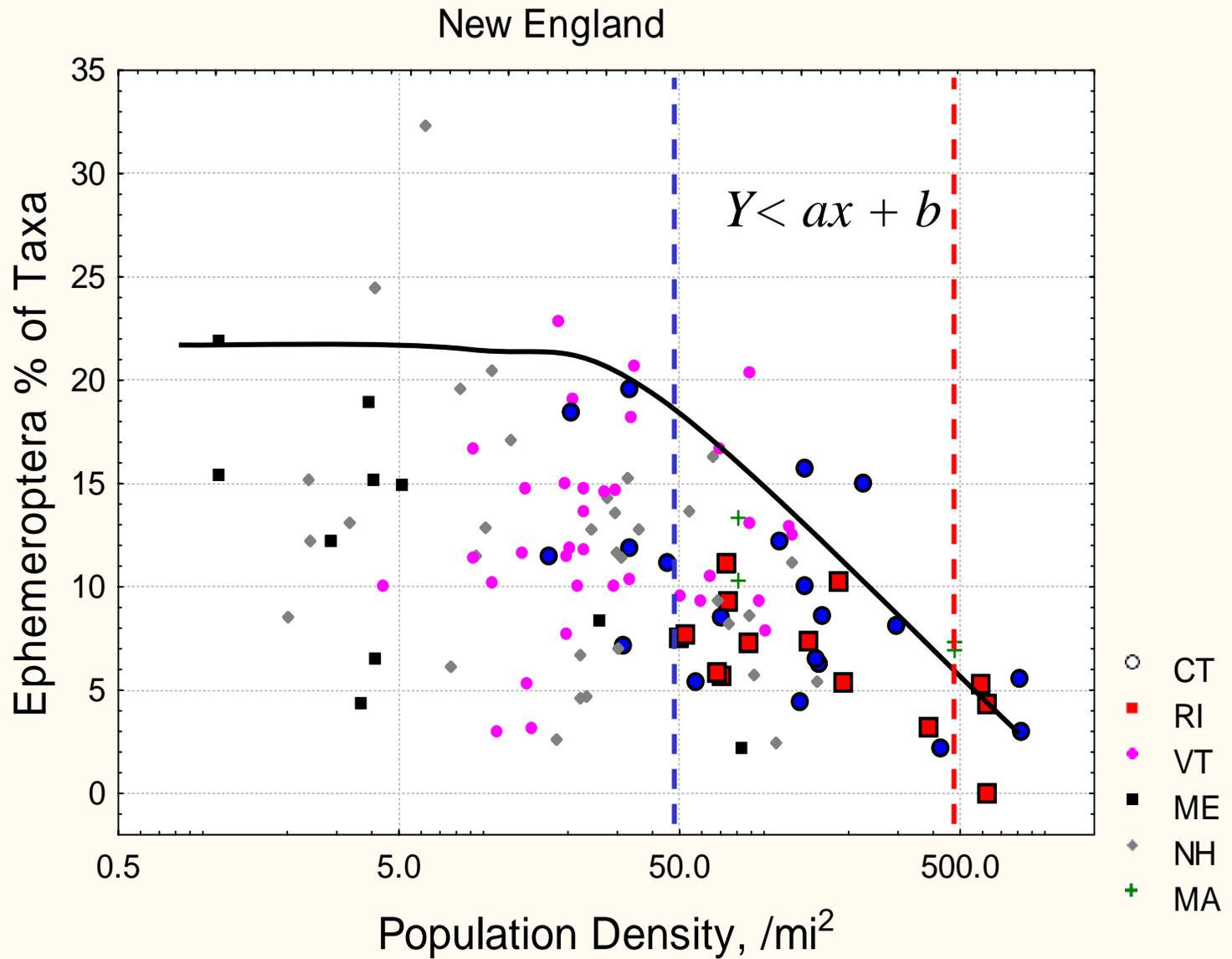
Scenarios

- A1 (IPCC)
 - Integrated, technological world, rapid economic growth, low population growth
- A2 (IPCC)
 - Slower technological change than A1, slower economic growth, higher population growth rate
- Base Case
 - “Middle” Census Bureau population growth projection
 - Closest to “current conditions”

Scenarios

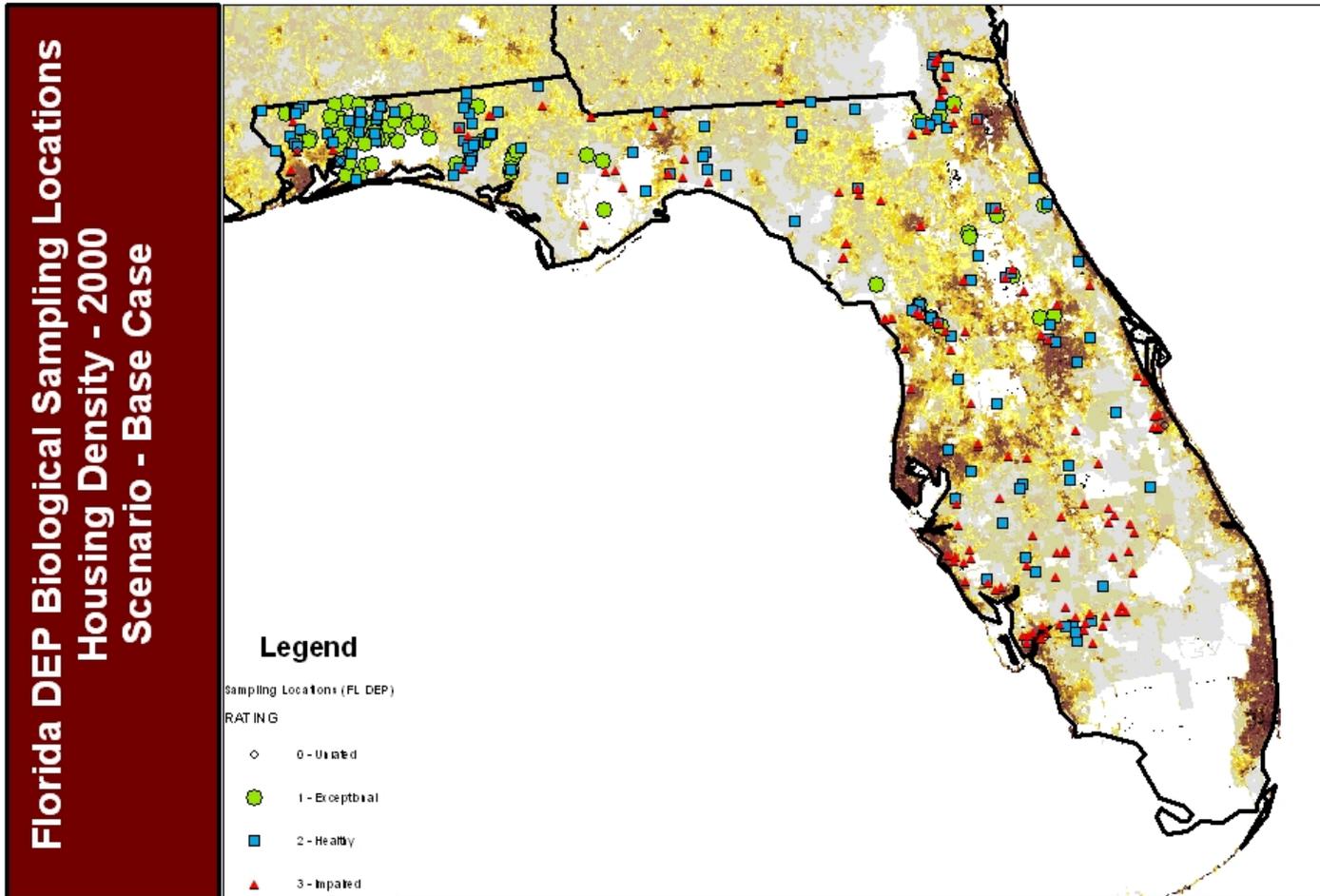


How does density affect aquatic biota?



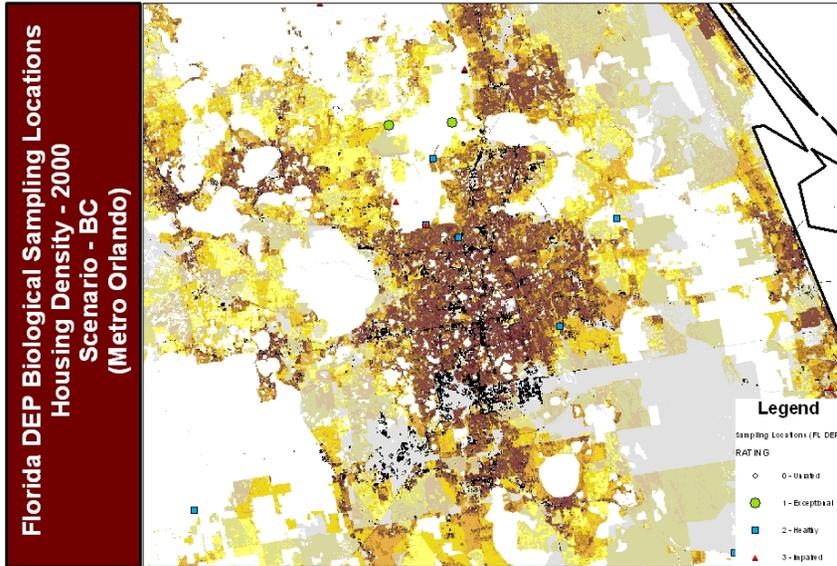
Current situation

54 reference sites



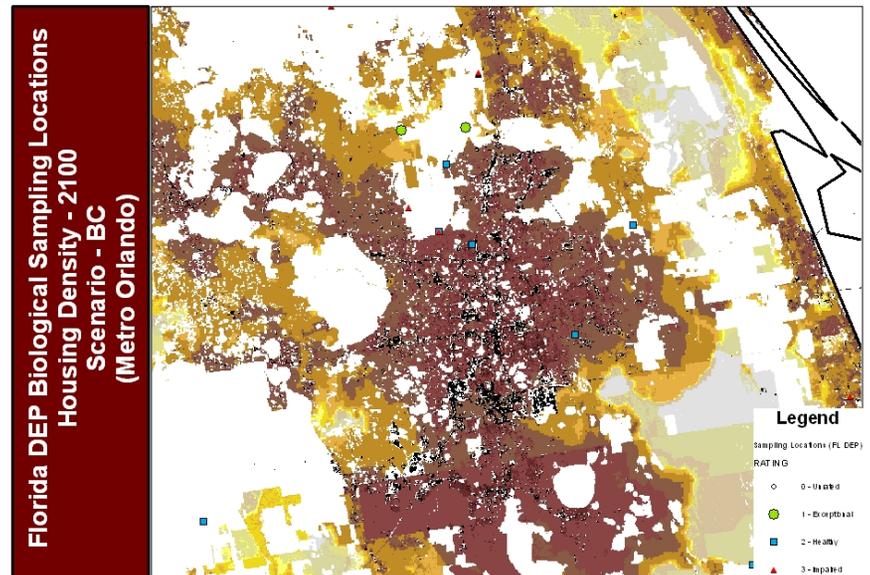
Example: Orlando area

2000



2100

Base Case



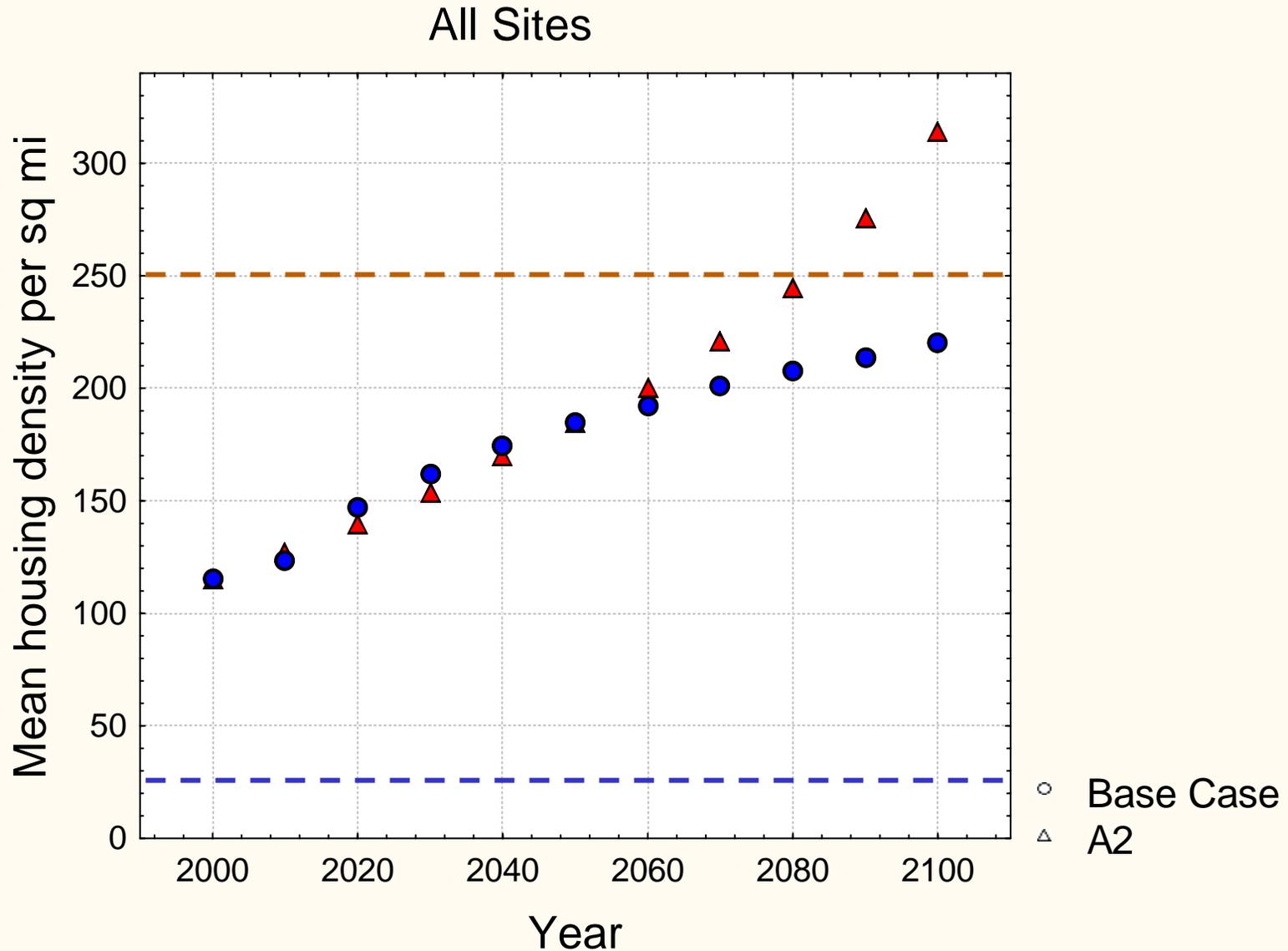
Assessing vulnerability

- 1 km circular buffer around each reference site, as estimate of land use
- Land use for each decade from scenario output
- Estimated fraction of buffer in categories of increasing housing density.
- Government land and open water:
 - Assumed “natural” for reference sites
 - 9 sites (17%) with $> 90\%$ govt land or water

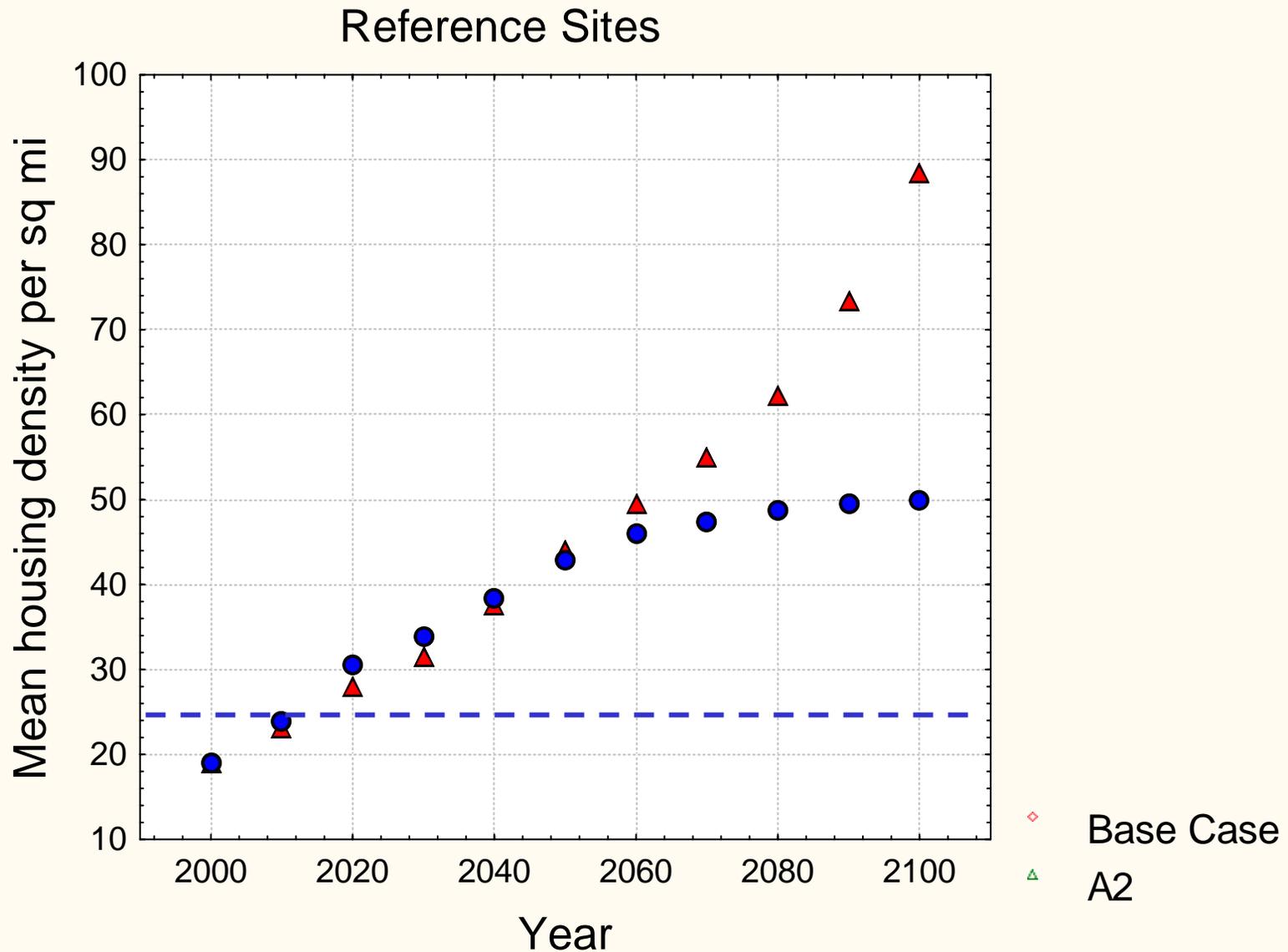
Effect of population

- Up to 50 persons per sq mi (25 houses), effects begin, but not universal or severe.
- 50-500 persons / sq mi (25 – 250 houses) corresponds to degradation gradient
- > 500 persons (250 houses), new England streams were degraded

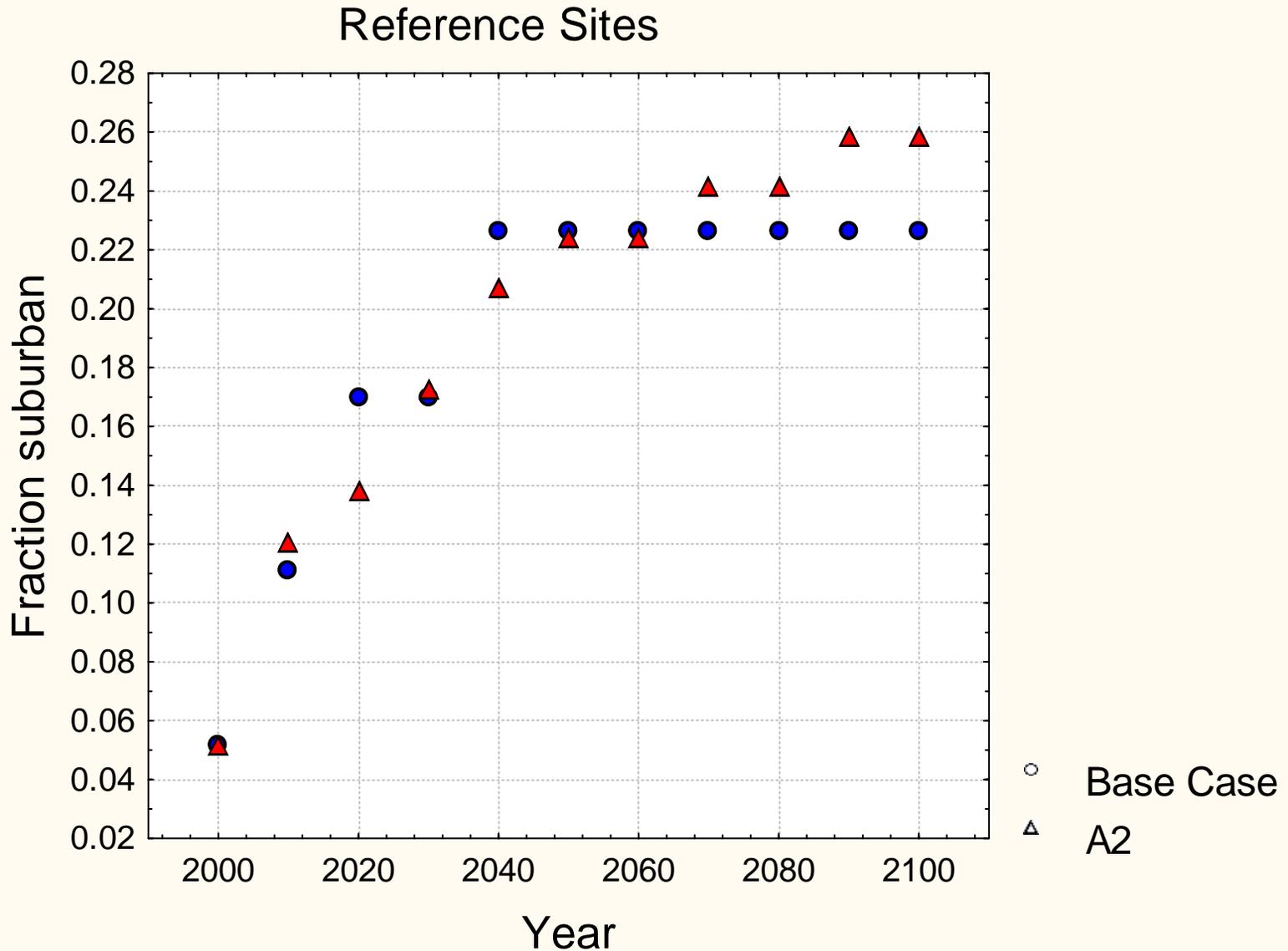
Residential density, statewide



Residential density, reference sites



> 50% suburban land use



Conclusions

- Statewide, average site will approach “complete degradation” point by 2100
- Average reference site will exceed effects threshold in approximately 2020, but will not reach “complete degradation” point
- 17% of reference sites appear to be protected
- Approximately 25% of reference sites appear to be unprotected from development

Conclusions

- Importance of protecting and preserving reference status
- How?
- If protected reference sites are too few, they will be unrepresentative