ONTARIO'S LAKE CAPACITY MODEL
SCIENCE, CHALLENGES AND ALTERNATIVE APPROACHES

HESL

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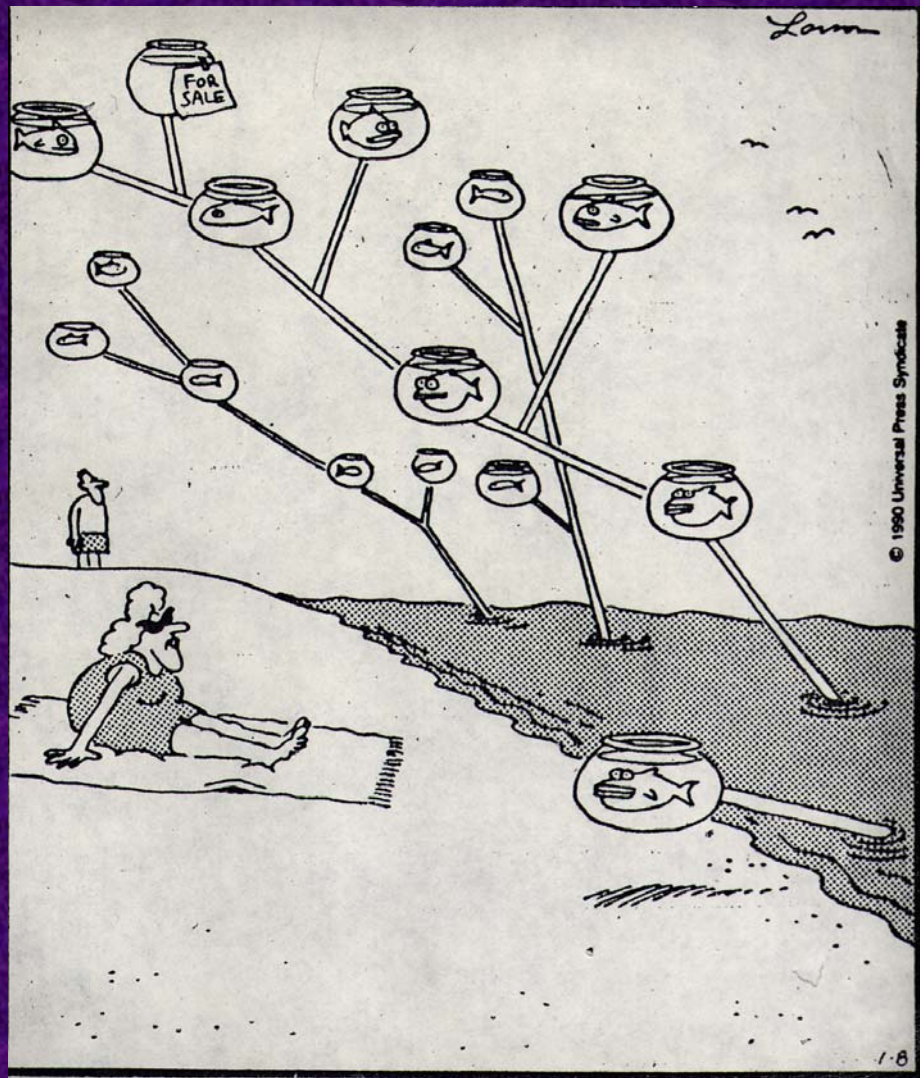
Why Manage Lakes ?

Why Plan for Lake Development ?

Why Set Development Capacities ?

It's a matter of perspective

- ⇒ Stability in **water quality**, to prevent observable changes by lake users and detrimental effects of lake use on aquatic life;
- ⇒ Stability in the **social environment** to maintain pleasant recreational opportunities; and
- ⇒ **Economic and planning** stability, to preserve property values, regulatory environment and employment opportunities.



Encroachment of the fish developers.

In Ontario
Lake Management = Development Capacity = Water Quality

We protect water quality in recreational lakes by:

- quantifying human sources of nutrients
- Setting acceptable levels of nutrients (water quality objectives)
- Setting “development capacities” to limit human nutrient impacts.

Muskoka Lake System Health Program

- Focus on recreational water quality
  - Phosphorus, chlorophyll “a”, water clarity
- Managed through Official Plan policies
  - First Canadian Municipality to place water quality protection in its Official Plan – early 1980s
  - Extensive revision in 2005 – review in 2011
- Technical Aspects
  - Whole watershed Dillon-Rigler mass balance phosphorus model
    - Proximity to MOE Dorset Environmental Science Centre
  - Pre-2005 – “Capacity” as allowable development intensity – absolute number of lots
  - Post 2005 – Moved to ”Sensitivity Based Planning Controls”
  - Explain how we got there
    - Major educational experience in municipal planning for a limnologist

Background
Ontario's "Lakeshore Capacity Study - 1986

- Ontario Lakeshore Capacity Simulation Model
- a "black box" model of acceptable limits to development on recreational lakes
  - Microbiology, Land Use, Fisheries, Wildlife, **Trophic Status** and Integration components
- Only the trophic status model was implemented by MOE
  - Formal acceptance in 2010.

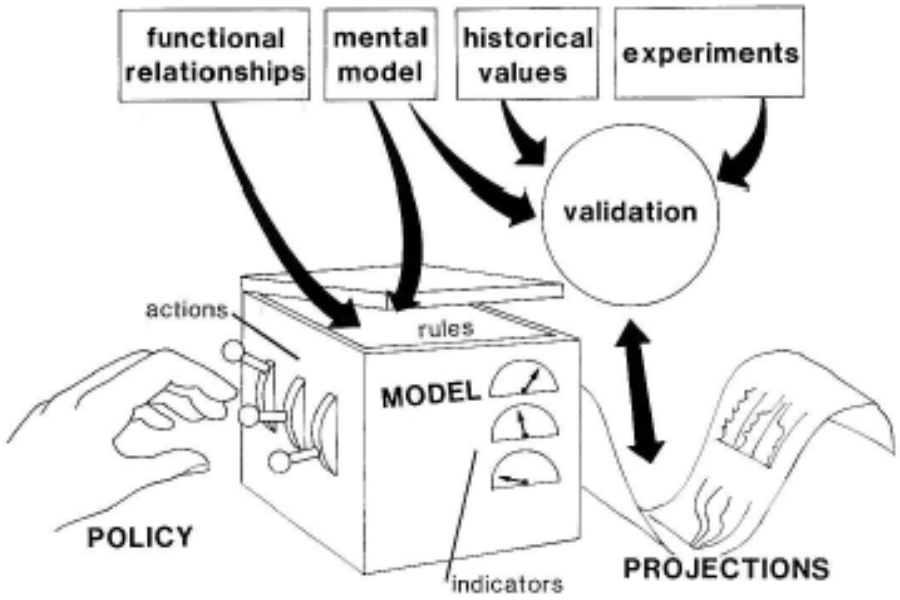
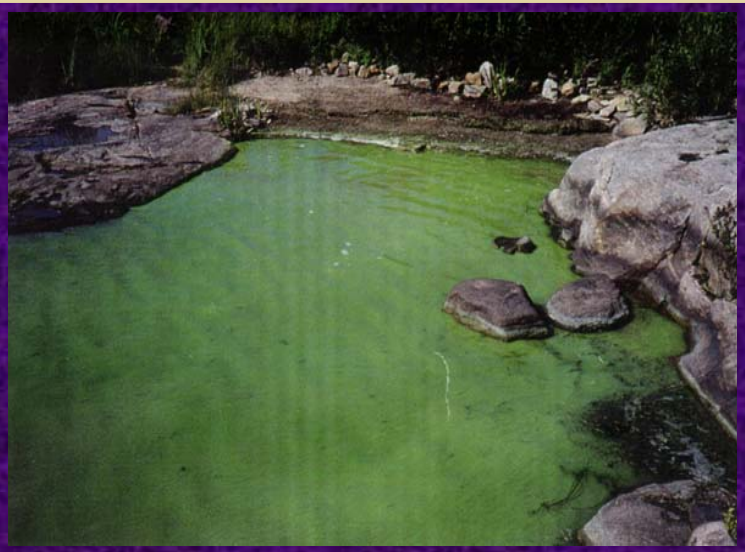
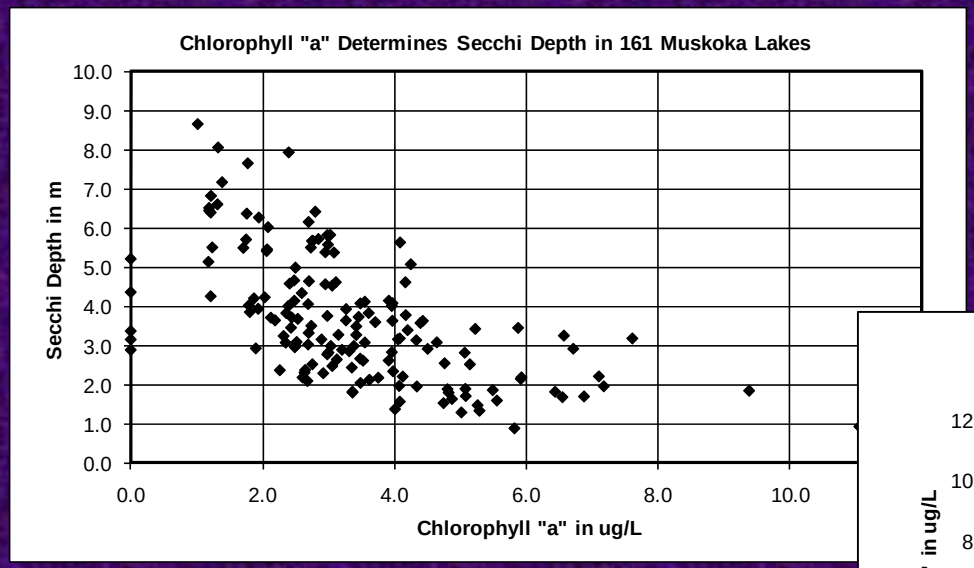


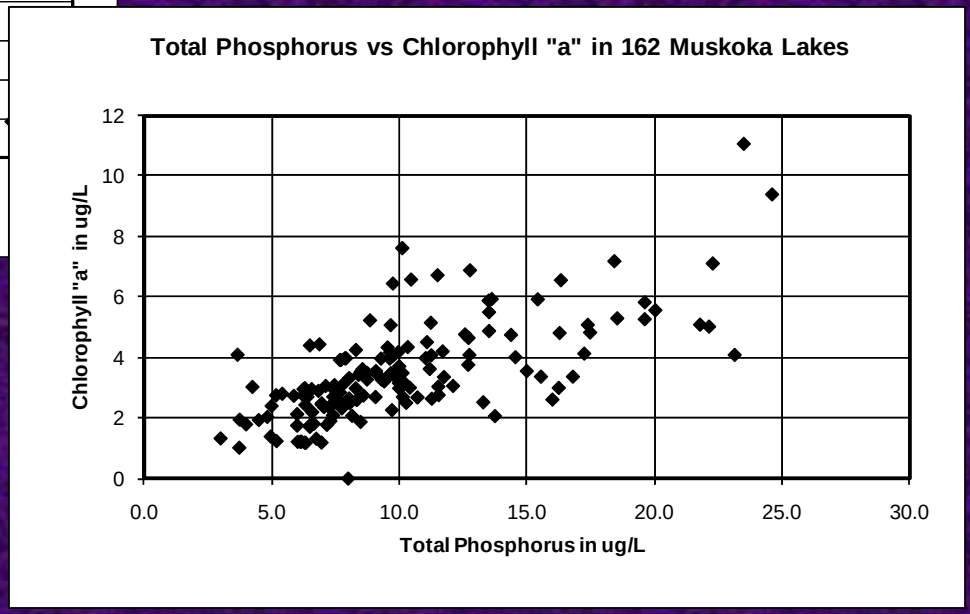
Figure 2. Modelling terminology

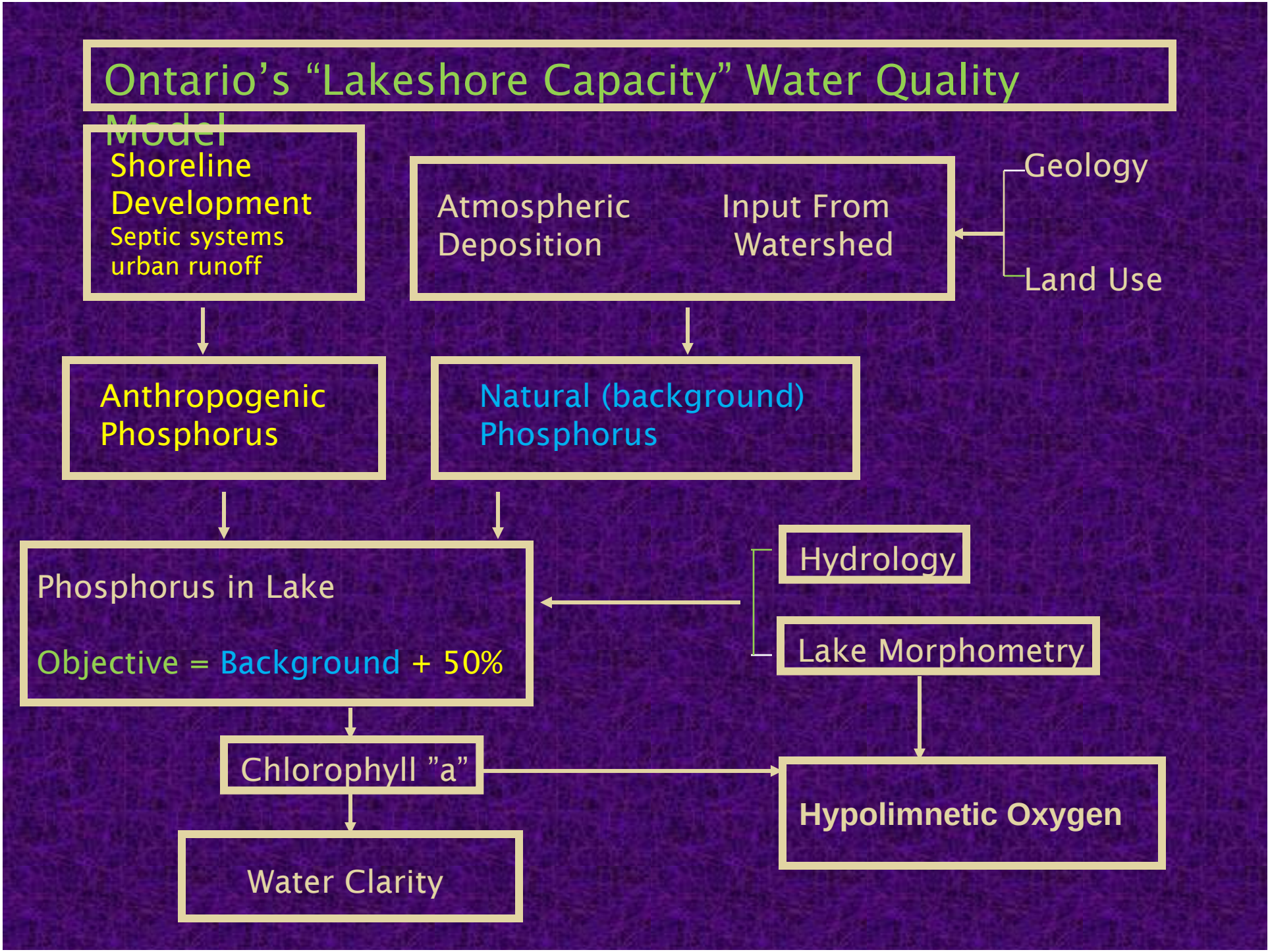
Ontario's "Lakeshore Capacity" Trophic Status Model

- Models "recreational" water quality
  - Water clarity via phosphorus
  - Visual aesthetics and algal blooms








Ontario's "Lakeshore Capacity" Water Quality Model
Shoreline Development
Septic systems
urban runoff
Atmospheric Deposition
Input From Watershed
Geology
Land Use
Anthropogenic Phosphorus
Natural (background) Phosphorus
Phosphorus in Lake
Objective = Background + 50%
Hydrology
Lake Morphometry
Chlorophyll "a"
Hypolimnetic Oxygen
Water Clarity

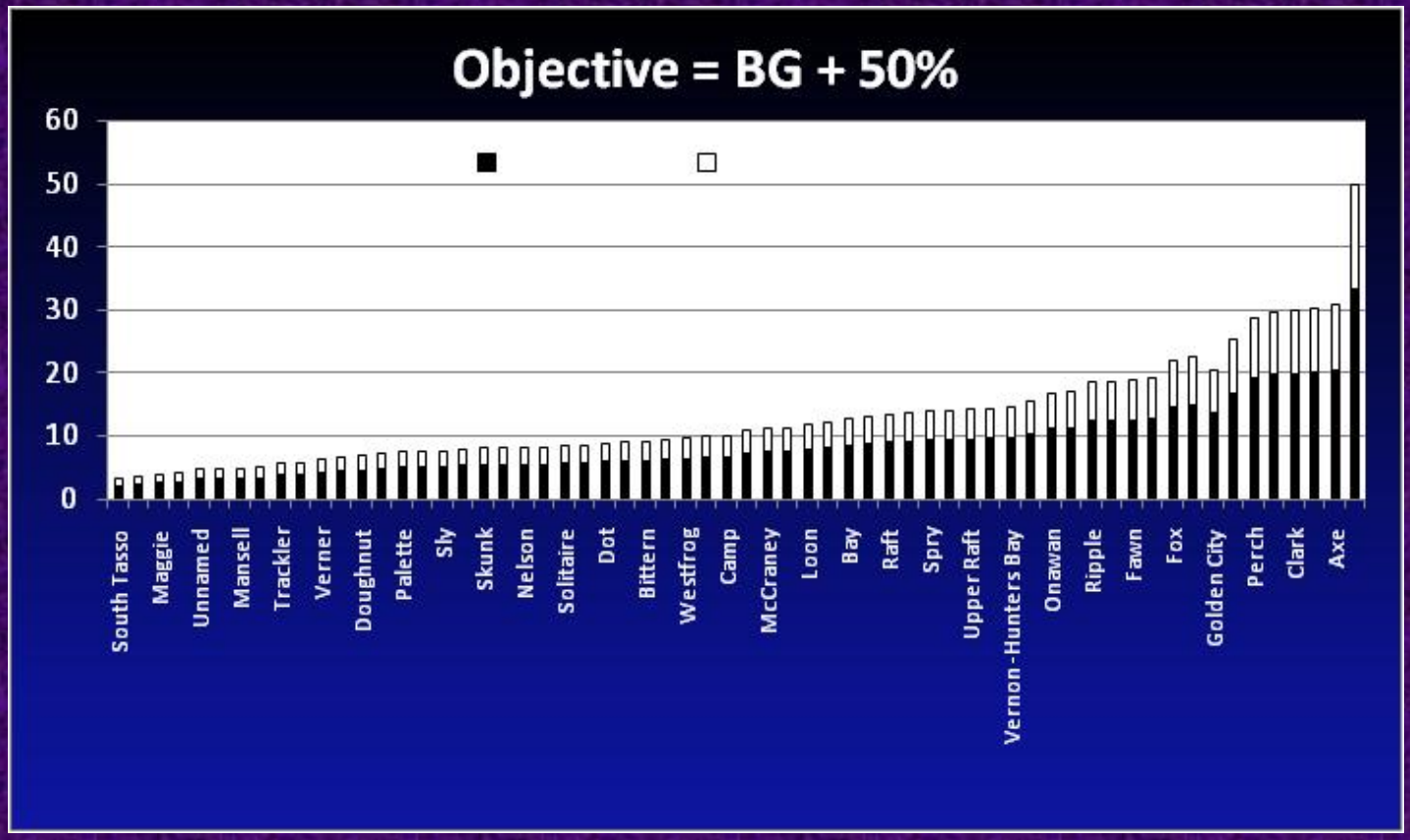
Ontario's "Lakecap" Approach

Manage phosphorus loading by

- -Modeling lake response to development
- -Setting nutrient limits based on septic system loading
- -Enforcing development capacities in the Official Plan
  - -a regulated limit to the number of shoreline septic systems

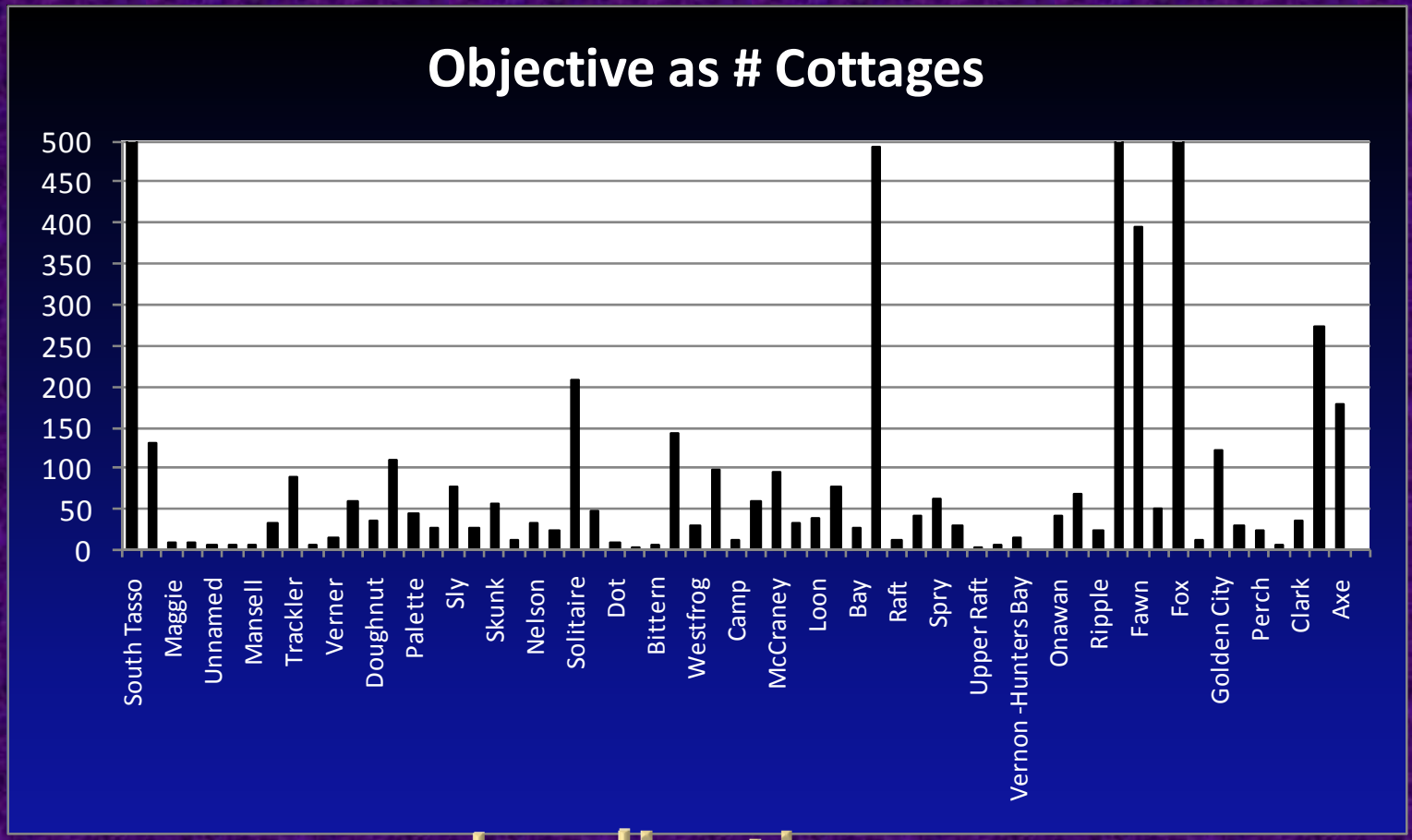
"Planning by Plumbing "

Translate Natural Phosphorus Concentration to a Water Quality Objective or Target
Maintain diversity of lake types



Hutchinson, N.J., B.P. Neary and P.J. Dillon. 1991. Validation and use of Ontario's Trophic Status Model for establishing lake development guidelines. Lake and Reserv. Manage.7(1):13-23.

Translate Objective to Cottages



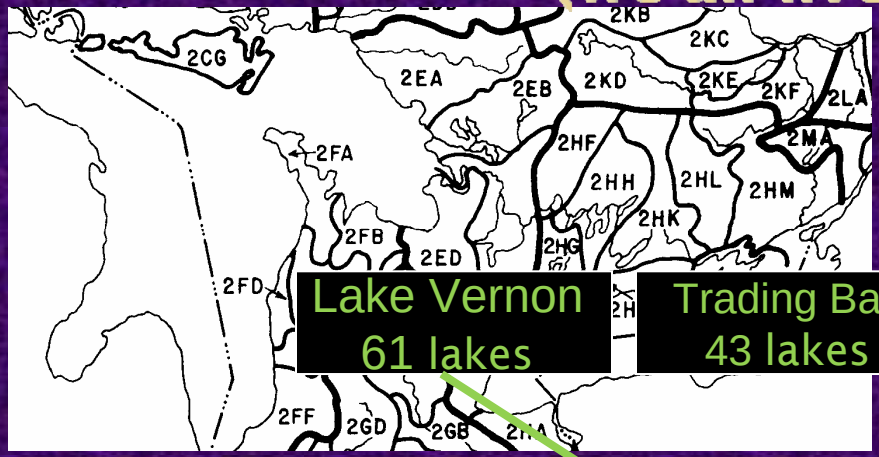
Implications

124 cottages is "acceptable"

125 cottages is "over capacity"

Does the model/approach support this precision ?

The model is complex – whole watershed orientation (we all live downstream)



Muskoka Watershed Model
17 sub watersheds
525 modeled lakes
161 managed lakes

Lake Vernon
61 lakes

Trading Bay
43 lakes

Dwight Bay
37 lakes

Black River
39 lakes

Sparrow Lake
19 lakes

Morrison Lake
9 lakes

Mary Lake
32 lakes

Lake of Bays
25 lakes

N Muskoka River
22 lakes

S. Muskoka River
31 lakes

Lake Rosseau
39 lakes

Lake Joseph
32 lakes

Lake Muskoka
32 lakes

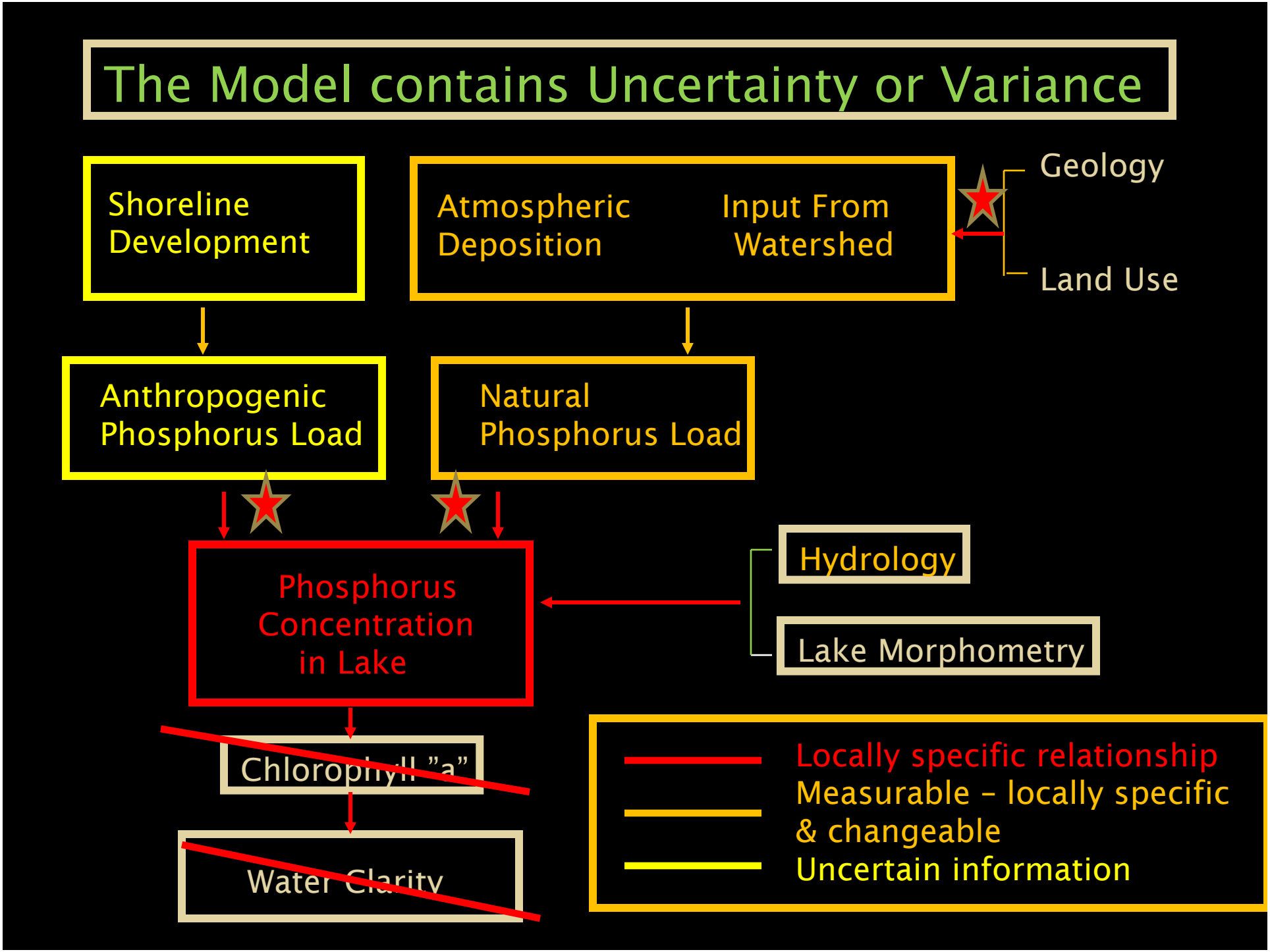
West
25 lakes

Moon River
43 lakes

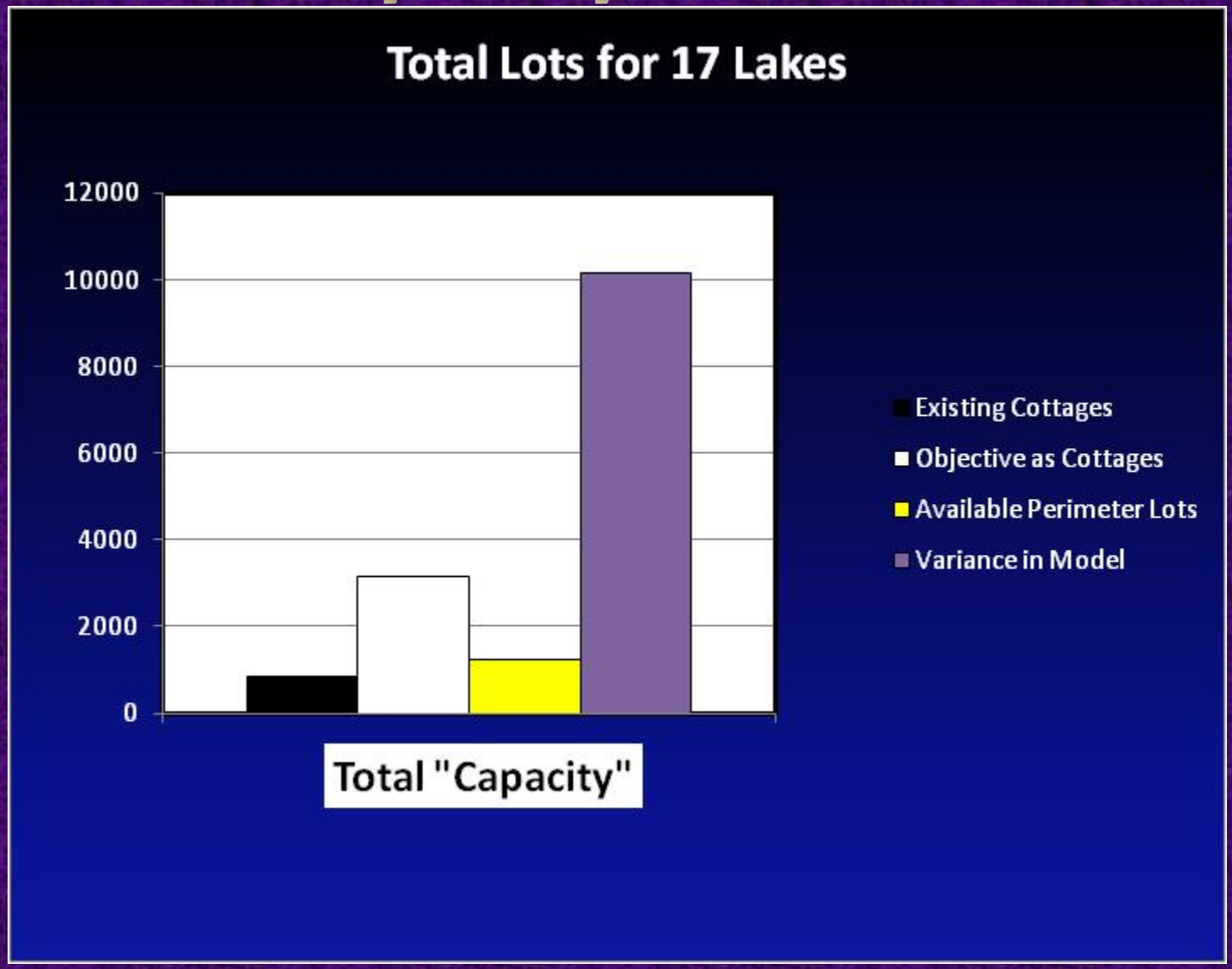
Musquash River
43 lakes

Georgian Bay

The Model contains Uncertainty or Variance



Several Capacity Determinants



Problem

"Lakeshore Capacity" assumes a finite limit
Add cottages to modeled BG + 50 %

Assumes a "line in the sand"

Reality is a "broad ribbon in the sand"

BG + 50% is a trigger for management
not an absolute threshold or capacity
Ontario uses BG+50% as "capacity"

Environment Canada uses BG + 50% as a trigger for detailed investigation

Problem

"Lakeshore Capacity" assumes phosphorus is mobile – all phosphorus moves from septic system to the lake

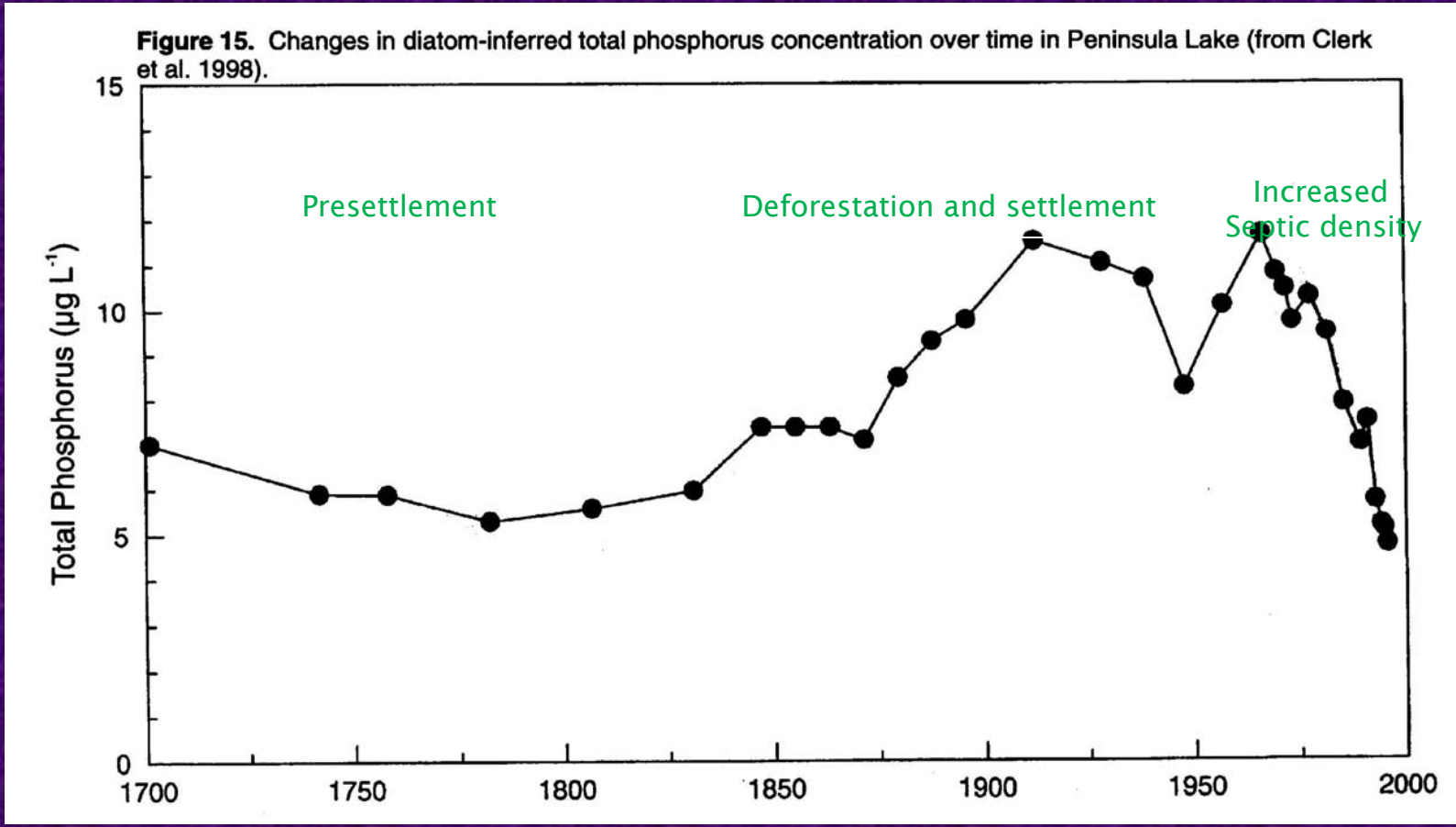
Harp Lake (MOE study lake) – 74% of development P is not evident in the lake (likely tied up in catchment soils)

Prof. W. Robertson (Univ. of Waterloo)

- septic P is immobilized by adsorption onto soil particles and mineralization with Al and Fe
- is retained within the tile field (often within 0.5m) even after decades

Example - Lake history from historic sediments

Fairy-Peninsula lakes in Huntsville ON. – no signal from shoreline development in lake sediments



So What ?

- Ask the right questions
- Lakeshore Capacity Asks
  - How much phosphorus is acceptable ?
  - How green can my lake become ?
  - How many users are acceptable ?
- Is growth the question ?
  - Or is better management of growth the question?

These lakes have lots of “capacity”

So What ?

- Recognize that development alters trophic status
- Recognize that variance >> specific capacity estimates
- Acknowledge where assumptions are not supported
- Model sensitivity vs capacity
- Manage nature of development vs “capacity”

Sensitivity = Responsiveness + Mobility

Responsiveness
Add standard areal load (1 cottage / 1.62 ha)
Model lake response

Responsiveness	
High	>80%
Medium	40-80%
Low	<40%

Mobility
Compare modeled [TP] to measured [TP]
Does lake response suggest anthropogenic response ?

Mobility	
High	Low
>80%	<80%

Sensitivity Assessment – 18 lakes in Muskoka

	Mobility	
Responsiveness	High	Low
High	1	
Medium	5	3
Low	7	2

- Management requirements (development controls) scaled to sensitivity score

Management vs Capacity

	Sensitivity		
Management Techniques	High	Medium	Low
Vegetated Buffers	X	X	X
Shoreline Naturalization	X	X	X
Soil Protection	X	X	X
On-Site SW Control	X	X	
Limit Impervious Surfaces	X	X	
Enhanced Septic Setback	XX	X	X
Septic Abatement Technologies	X		
Full Servicing	X		
Site Specific Soils Investigation	X		
Enhanced Lot Sizes	X		
Limit Lot Creation	X		
Compliance Monitoring/Securities	X		
Monitoring Intensity	Annual	Annual	BiAnnual

Conclusions

- Trophic status models are useful to scale / estimate lake response to development
- Modeled phosphorus concentrations have many variance elements
- Modeled phosphorus estimates do not support fine estimates of development capacity
- Use trophic status model to scale lake sensitivity
- Sensitivity =
  - Will lake respond if phosphorus is added ?
  - Does measured data suggest lake has responded to human impacts ?
- Scale lot-specific management to lake sensitivity
- Add assessment and development controls to Official Plan