2007

A Watershed Analysis of Long Pond South: Implications for Water Quality and Land-Use Management [Presentation]

Colby Environmental Assessment Team, Colby College

Problems in Environmental Science course (Biology 493), Colby College

A Watershed Analysis of Long Pond South

Implications for Water Quality and Land-Use Management

Colby Environmental Assessment Team

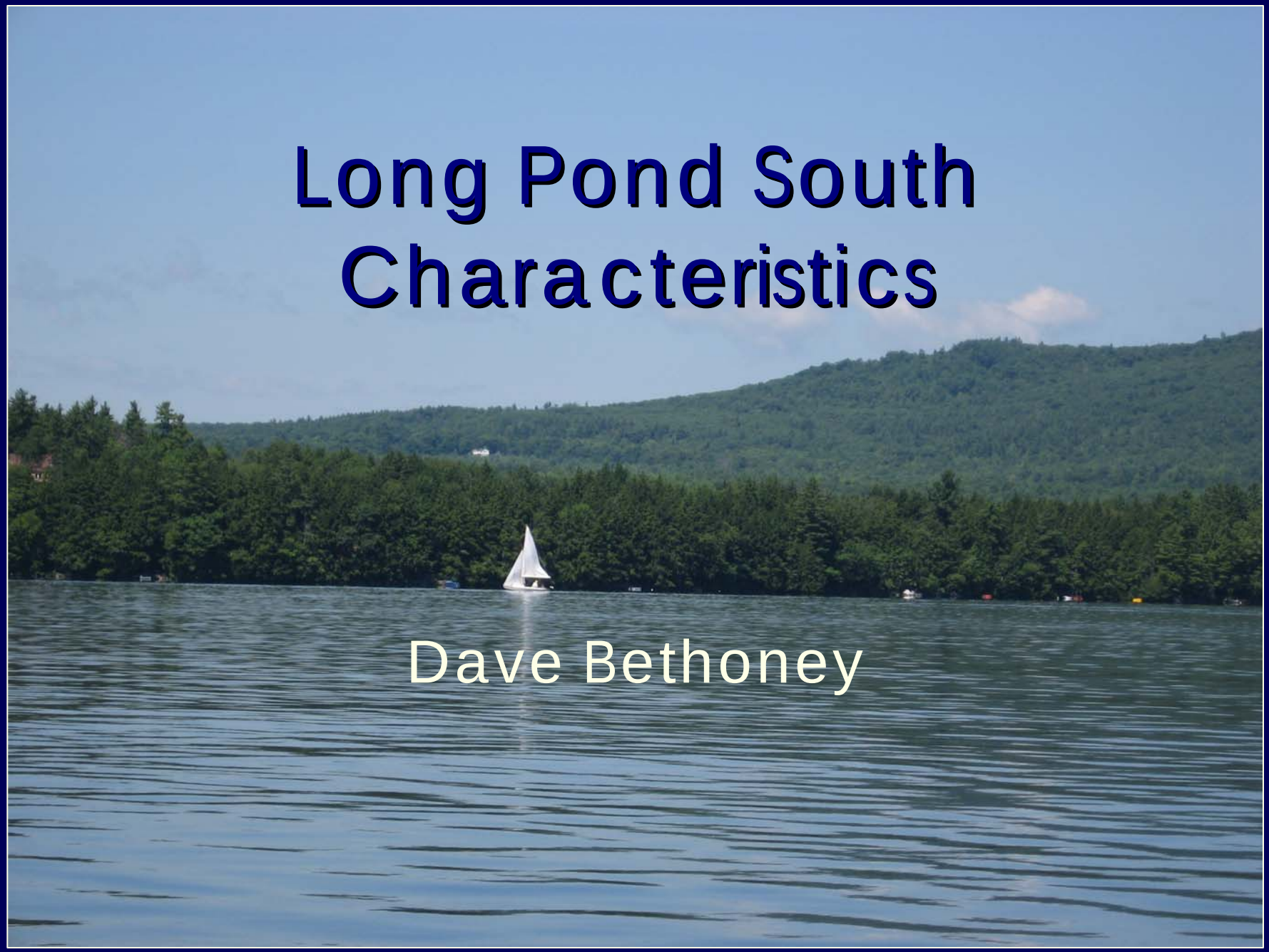
December 6th, 2007

Presentation Outline

- Introduction – Kristyn Loving
- Long Pond South Characteristics - Dave Bethoney
- GIS and Land-Use Analysis - Kerry Whittaker
- Water Chemistry - Jamie O'Connell
- Water Budget and Phosphorus Budget - Claire Thompson

INTERMISSION

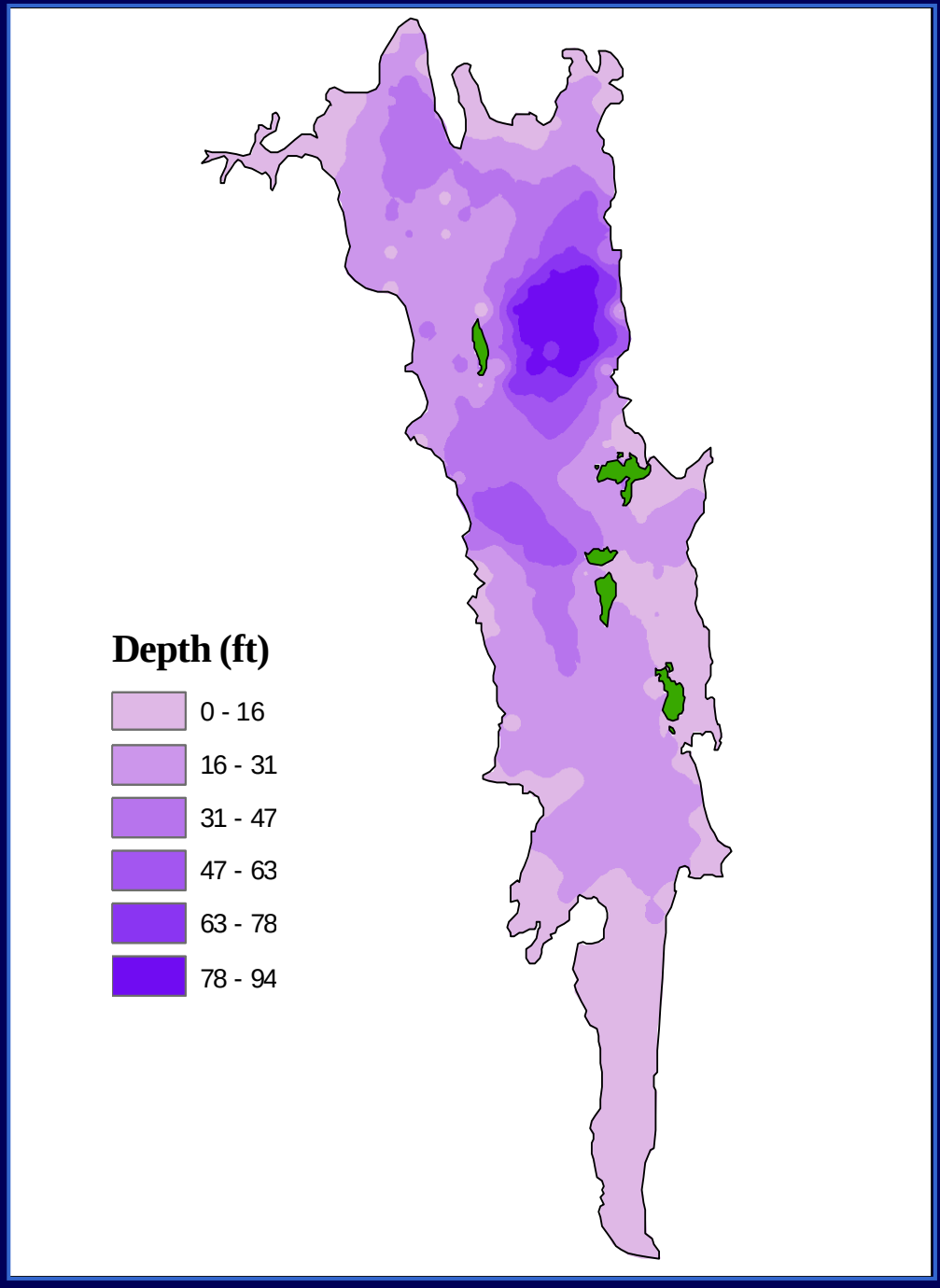
- Erosion Potential and Erosion Impact - Jessica Harold
- Road Survey - Anna Birnberg
- Septic and Buffer Survey - Rosalind Becker
- Future Projections - Eva Gougian
- Summary and Recommendations - Kristyn Loving


Long Pond South
Characteristics
Dave Bethoney

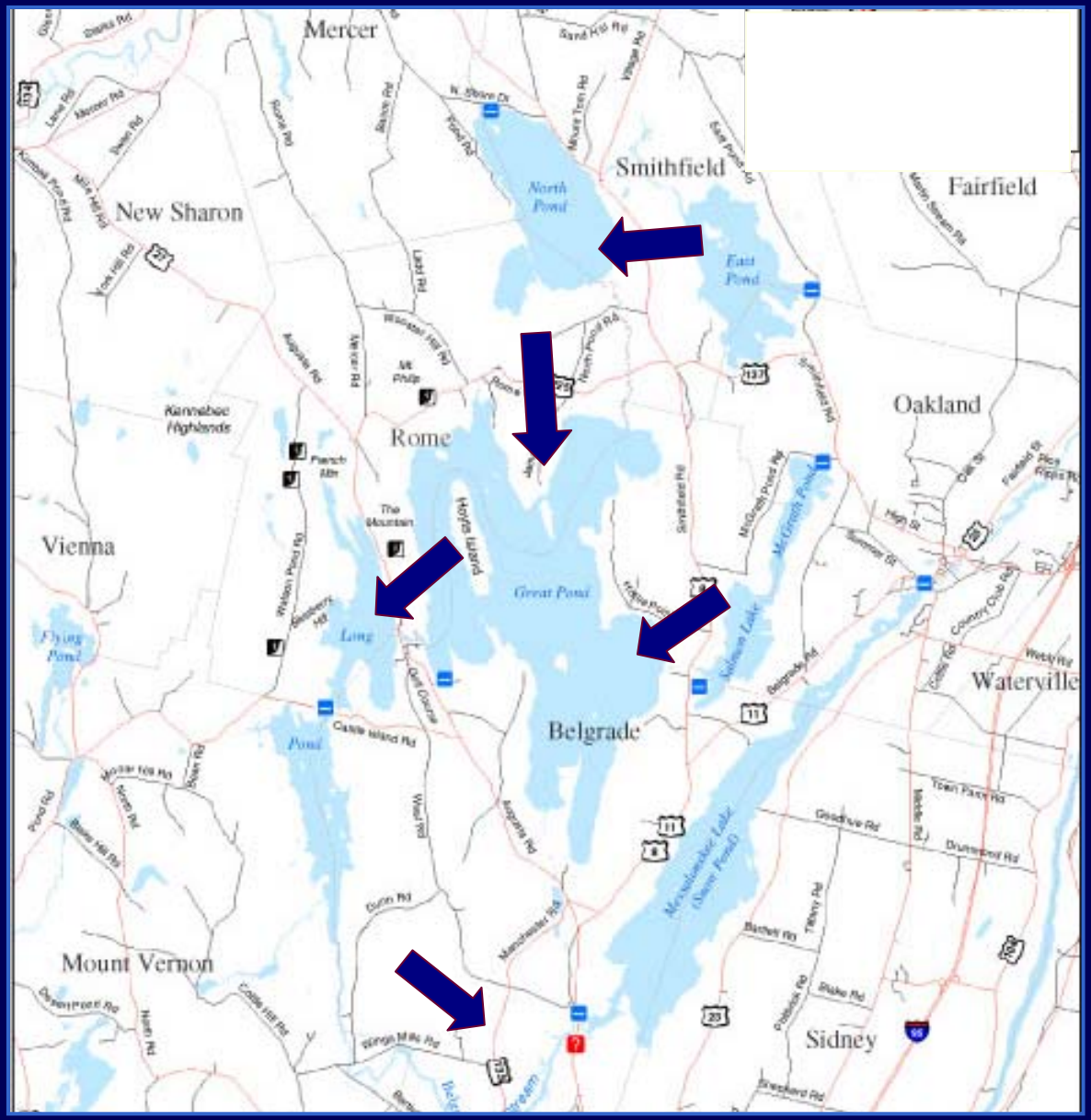
Lake Formation

- Pleistocene
- Glaciers
  - Southeast movement
  - Scouring
- Granite
- Glacial till
- Deep hole in lake

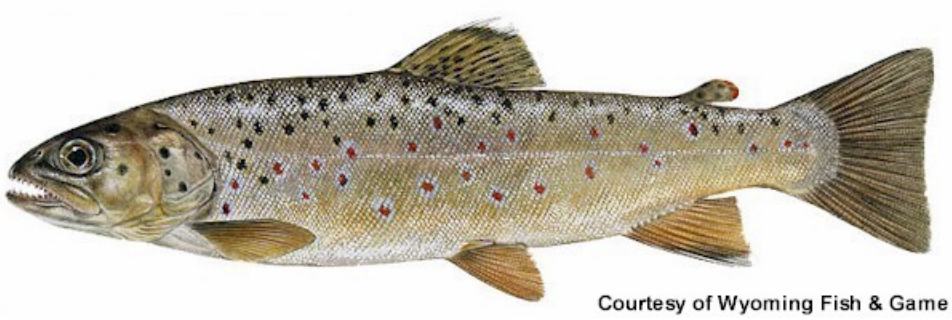
From Maine Geological Survey, Bradford M. Cantor

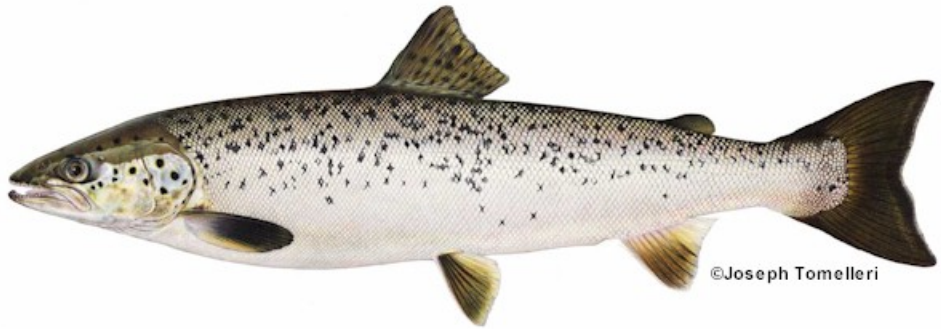


Water Flow through the Belgrade Lakes



Belgrade Area Fisheries





- Prominent Fisheries
  - Brook Trout
  - Brown Trout
  - Landlocked Salmon
- Status
  - Used for recreation
  - Generally healthy

Fisheries Management

- Stocking
  - Aquaculture
  - Fry size
  - Management plans
- Fishing
  - Licensing
  - Catch and release
  - Regulations: size, amount, season

Potential Threats

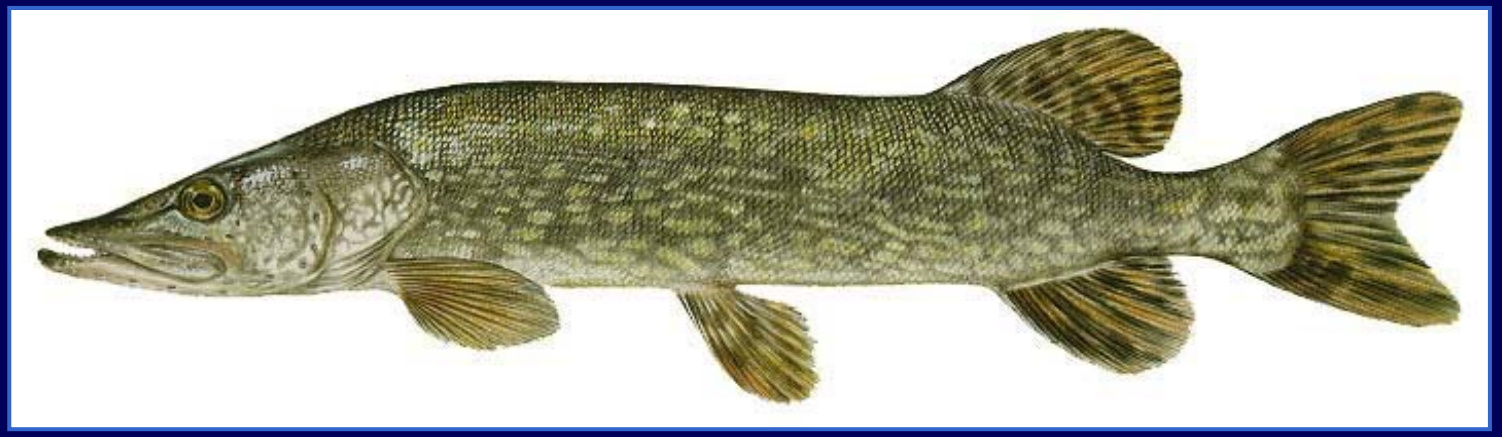
- Dissolved Oxygen (DO)
  - Declining trend
  - Salmonid
  - Deep water fishes
- Erosion
  - Sedimentation
  - Reduced habitat and spawning areas
  - Increased phosphorus
- *Gloeotrichia*
  - Blue-green algae
  - Phosphorus indicator

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Gloeotrichia

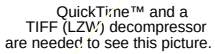
Northern Pike

Esox lucius



http://www.maine.gov/ifw/fishing/species/management_plans/northernpike.pdf

- Non-Native
- Problems
  - Carnivorous
  - Rapid growth
  - Long lifespan
- Actions
  - Fines
  - Unregulated fishing
  - Ice fishing



QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

http://www.maine.gov/dep/blwq/topic/invasives/invunwant.pdf

Variable-leaf water milfoil

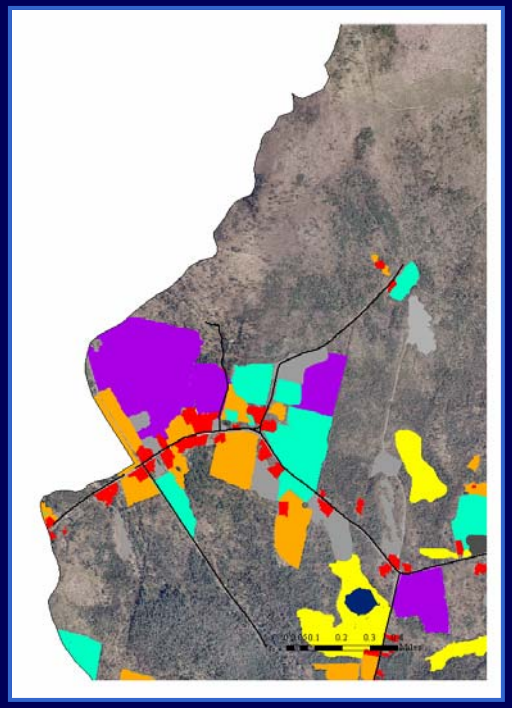
Myriophyllum heterophyllum

- Non-native
- Problems
  - Rapid growth
  - Reproduction
  - Dense mats
- Actions
  - Fines for transportation
  - Courtesy Boat Inspectors (CBI)
  - Milfoil sticker

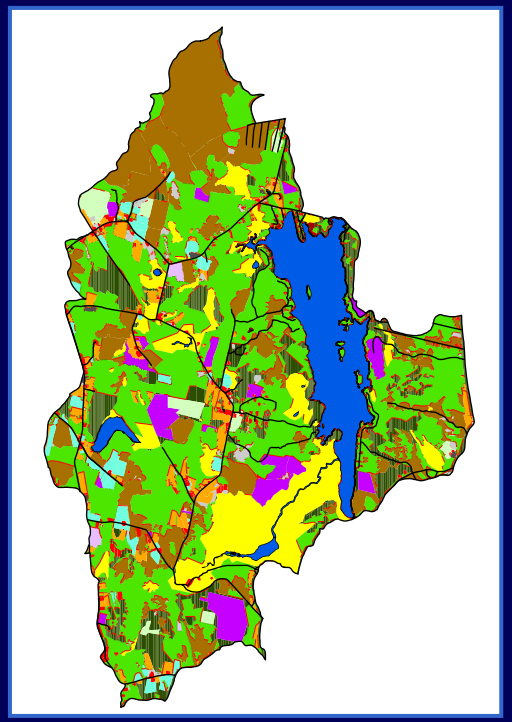

GIS and Land-Use Analysis
Kerry Whittaker

Long Pond South Land-Use

Watershed



Land-Use
Polygons



Land-Use Map

Land Use Introduction

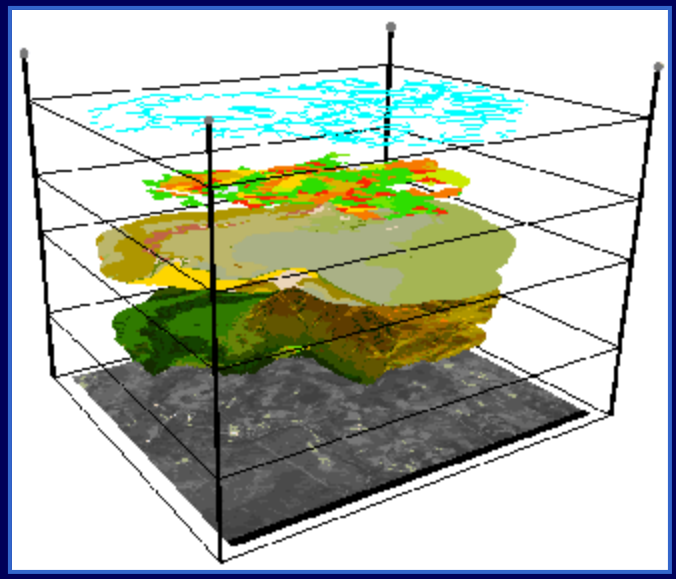
- GIS as an Analysis Tool
- Digitizing Land-Use
- Land-Use Descriptions
- 2003 Land-Use Analysis
- 1966 Land-Use Analysis
- Land-Use Changes





What is a GIS?

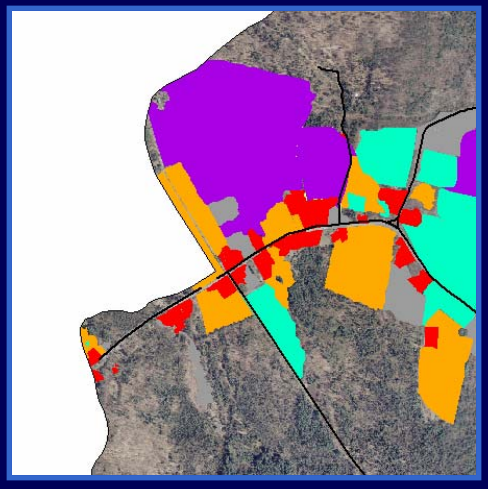
- Computer system that uses data linked to location
- Four subsystems
  - Data input
  - Data storage and retrieval
  - Data manipulation and analysis
  - Data output and display



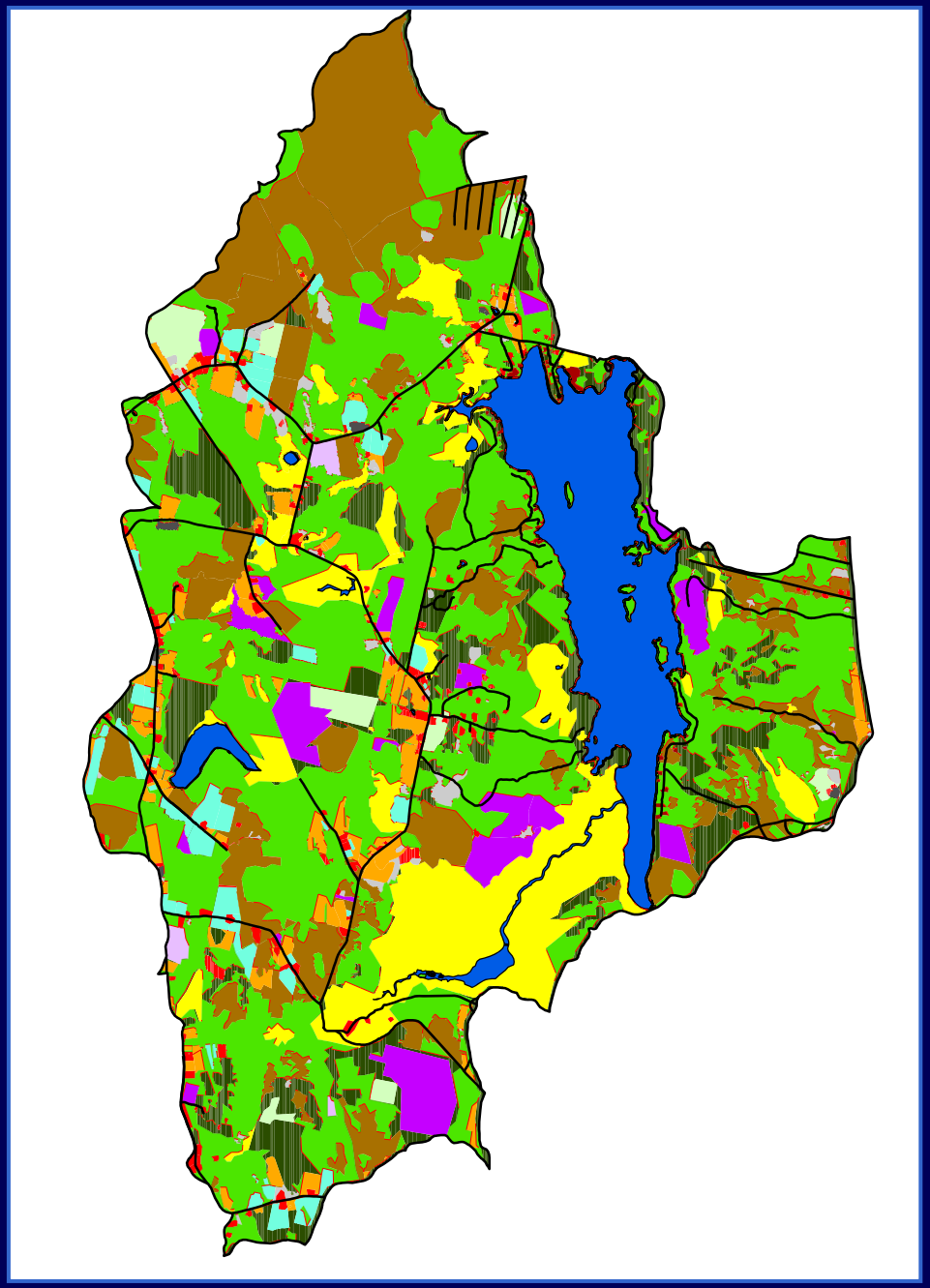
Land-Use Types

- High-Impact Development
- Residential Land
- Agricultural Land
- Successional Land
- Forest
- Wetland

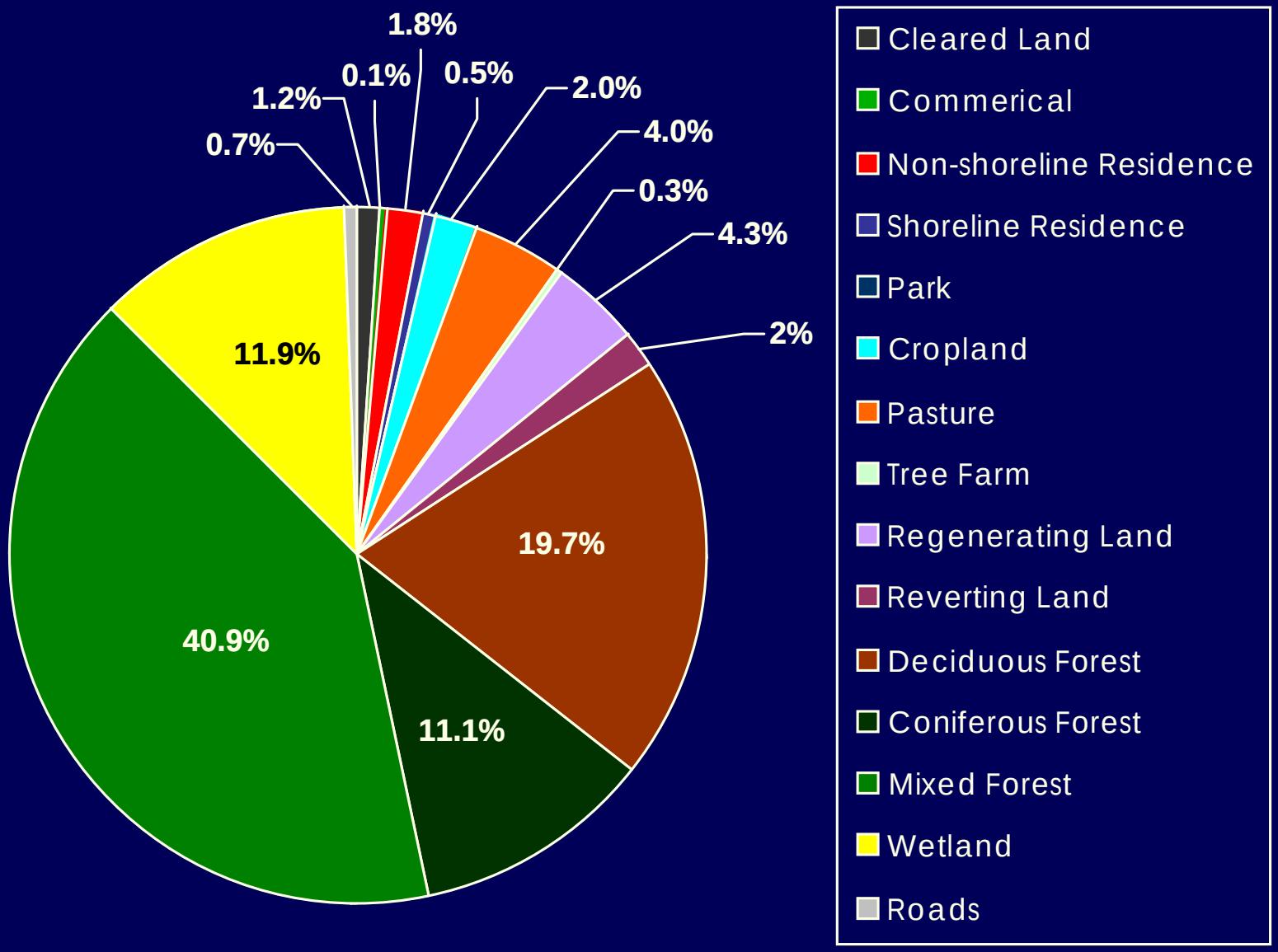
Digitizing Land-Use Types



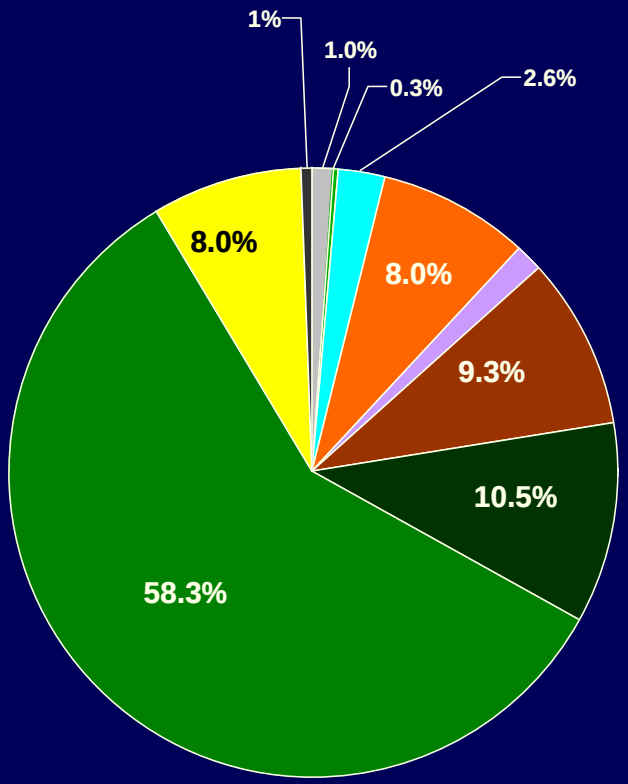
Land-Use 2003

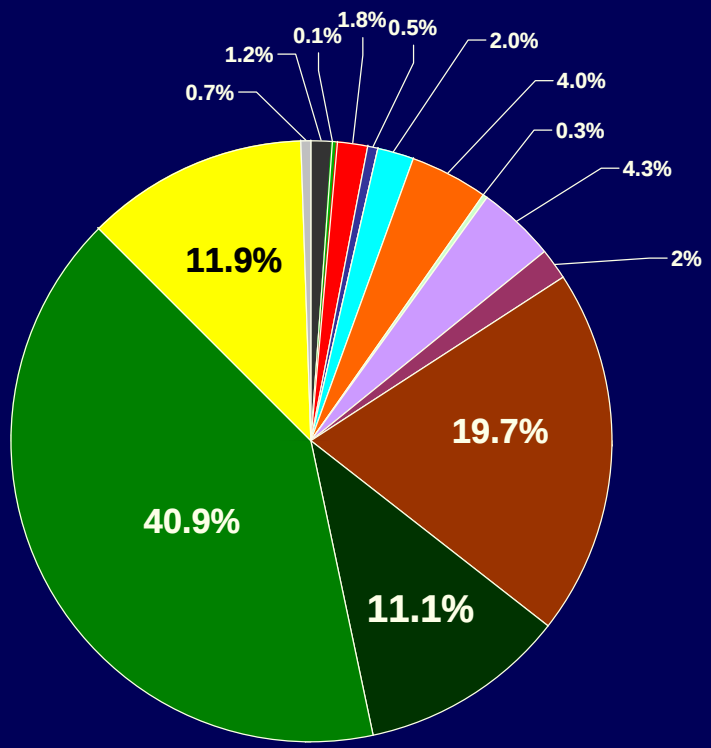


Land-Use 2003



Land-Use Comparison

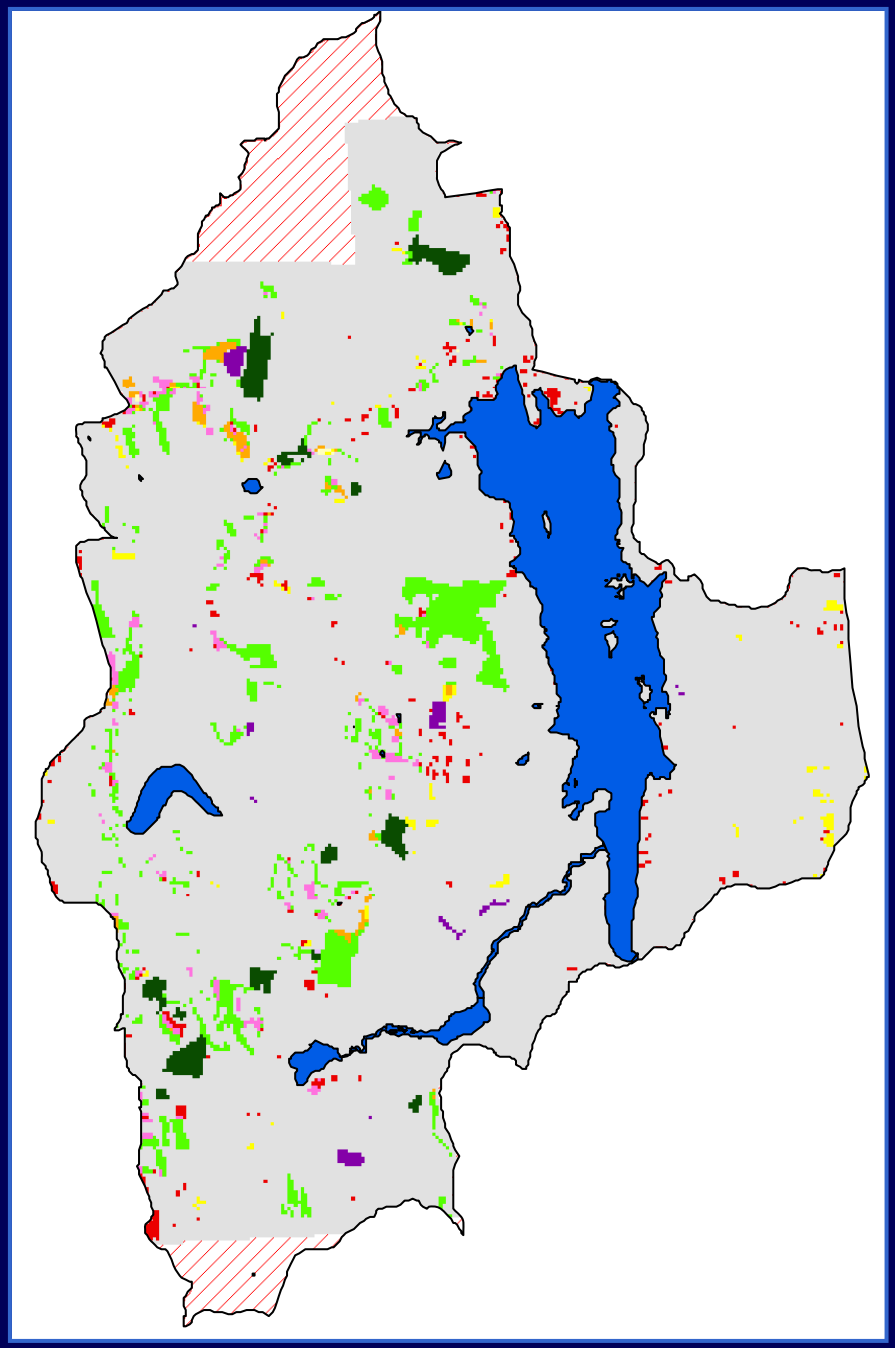




1966

2003

Land-Use Changes



Land Use Changes (1966-2003)

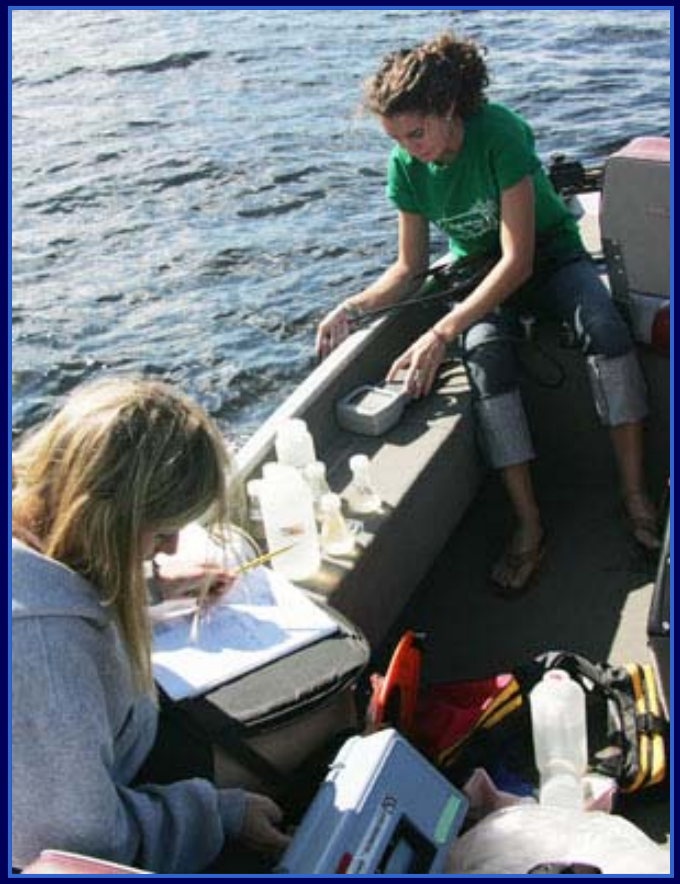
- No change
- Residential to High Impact Development
- Agriculture to High Impact Development
- Forest to High Impact Development
- Agriculture to Residential
- Forest to Residential
- Agriculture to Successional
- Forest to Successional
- Agriculture to Forest
- Successional to Forest
- No Data

Water Quality

Jamie O’Connell

Water Quality

- Parameters
  - Physical
  - Biological
  - Chemical
- 14 sample sites
- May to September 2007



Physical Tests

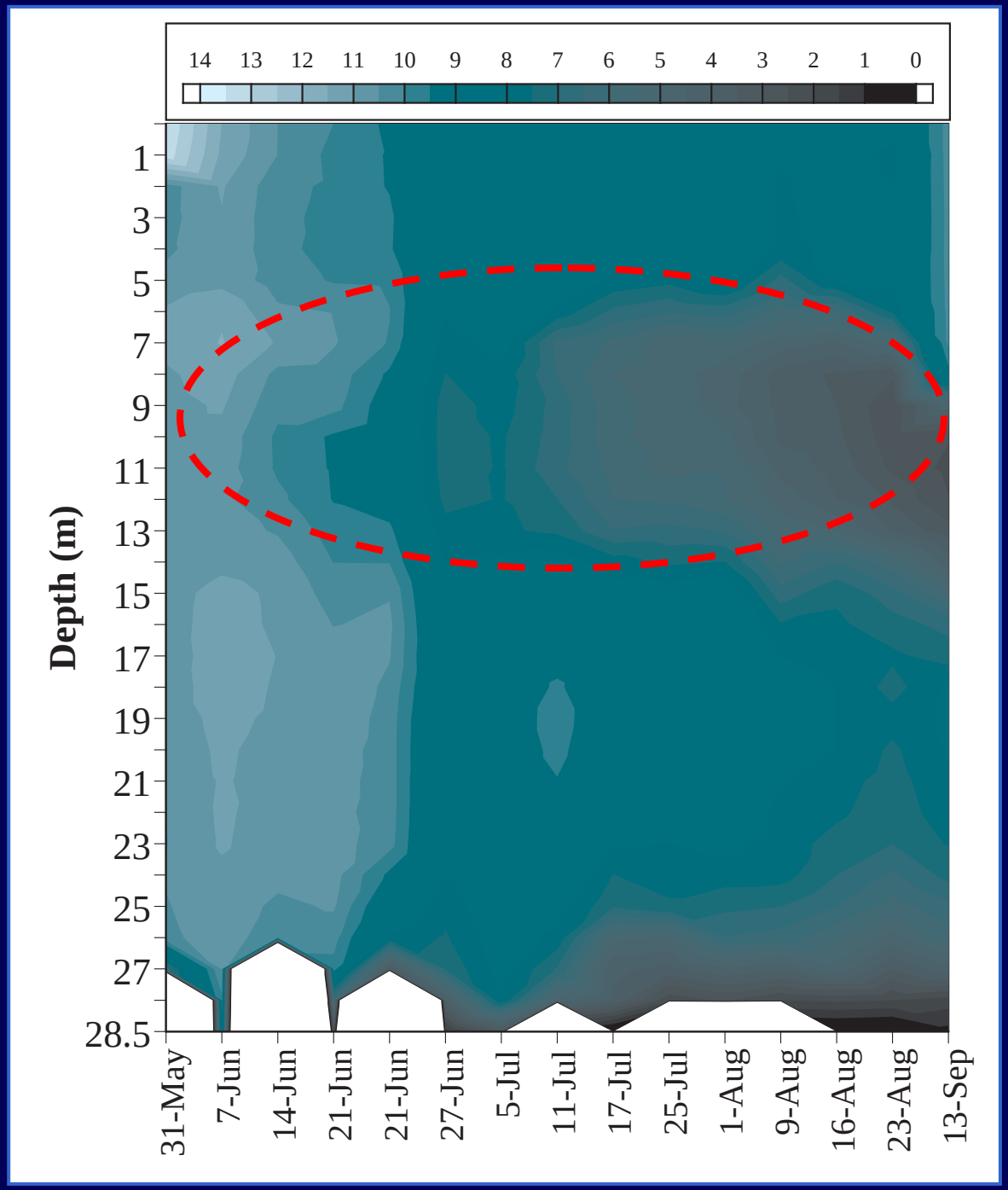
- Dissolved Oxygen and Temperature
- Transparency
- Turbidity
- True Color

DO and Temperature

- Biological importance of DO
- DO: 1 ppm and 5 ppm
- As temp  , DO 
- Trend of  DO levels

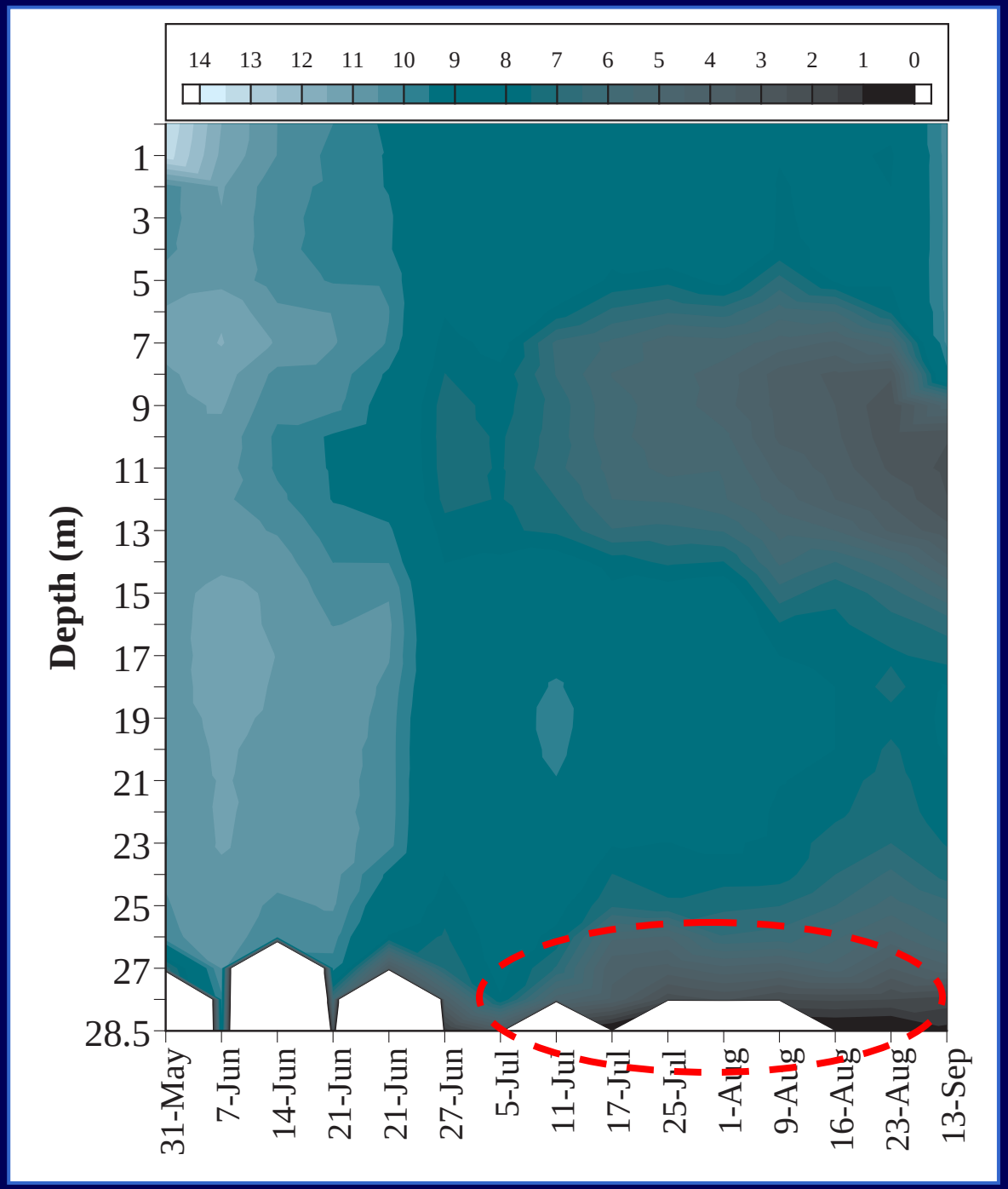
DO (ppm)

- Profile at Site 1
- May to September 2007

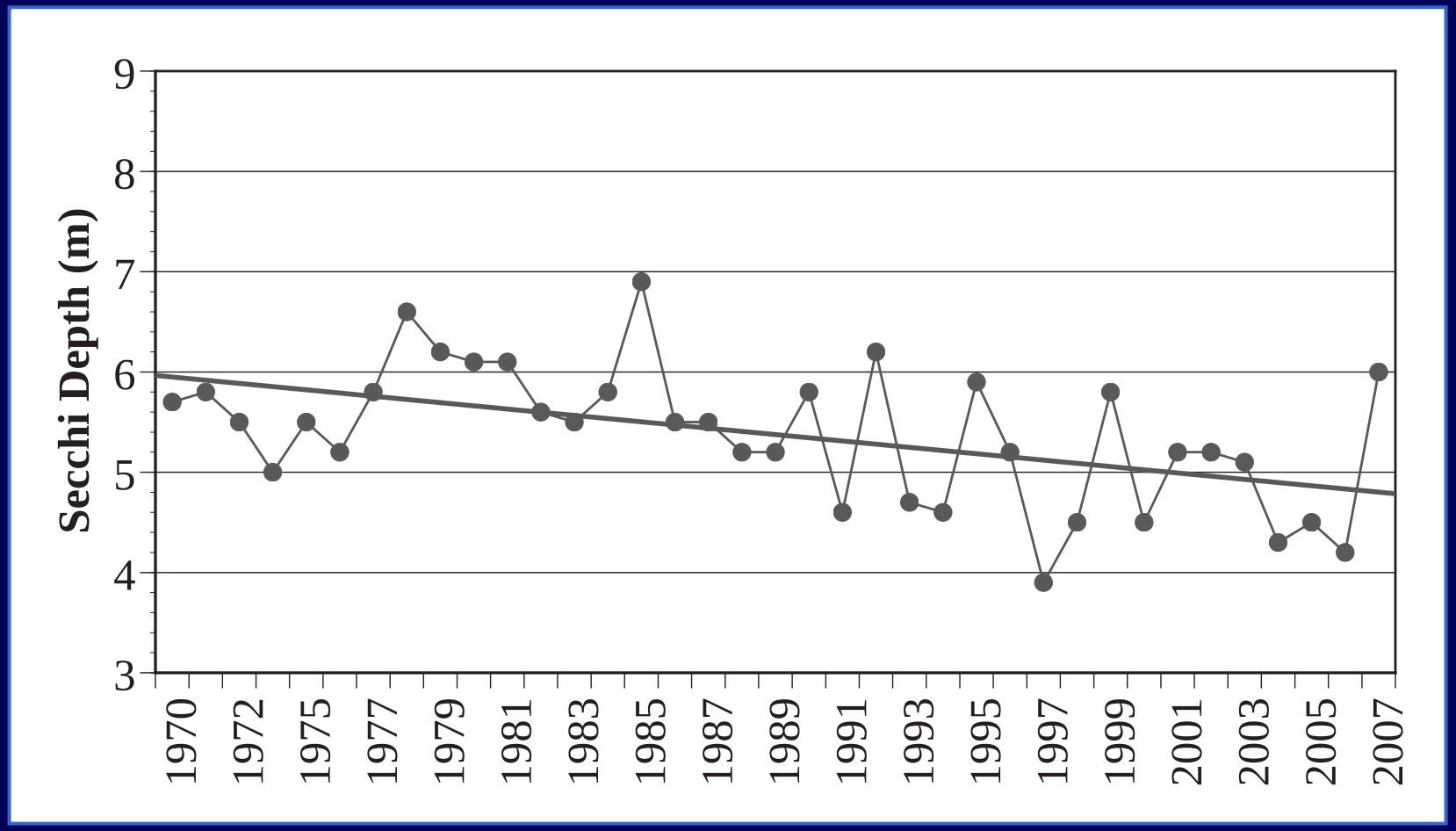


DO (ppm)

- Profile at Site 1
- May to September 2007



Transparency



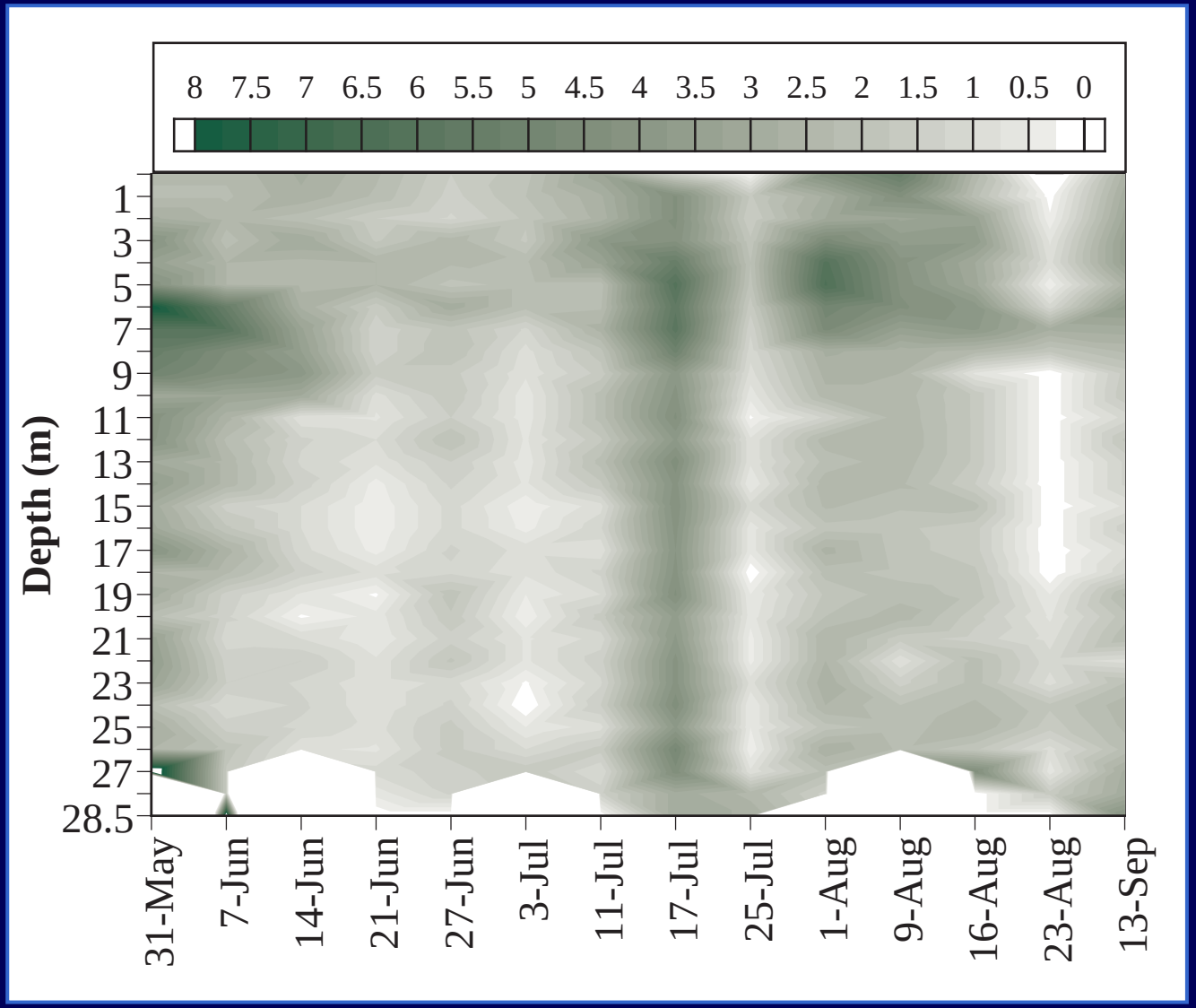
Biological Tests

- Chlorophyll-*a*
  - Productivity indicator
  - Increase since 1976

YSI Sonde Meter

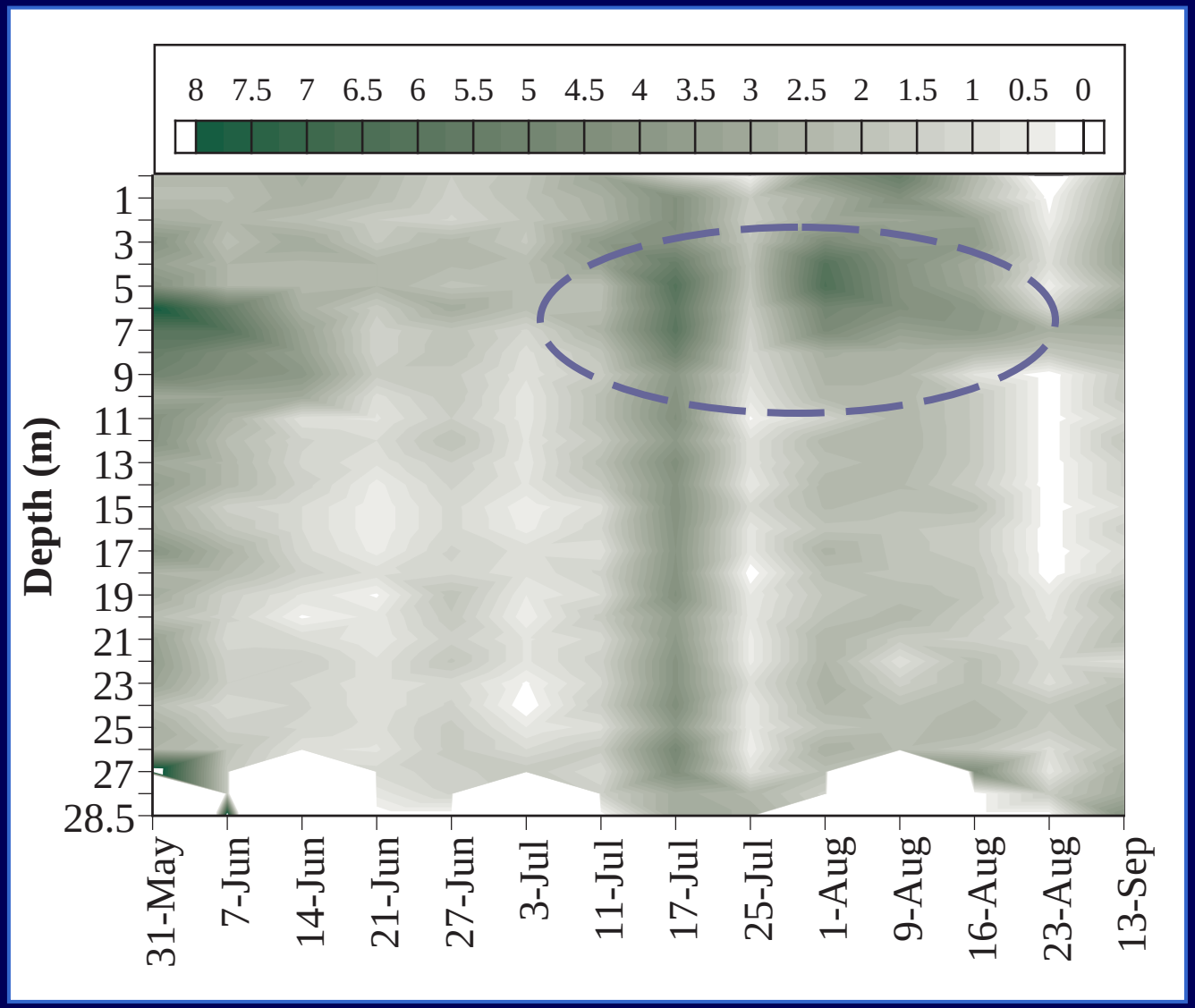
Chlorophyll-*a* (ppb)

- Site 1 profile
- May to September 2007



Chlorophyll-*a* (ppb)

- Site 1 profile
- May to September 2007



Chemical Tests

- pH
- Total Phosphorus
- Conductivity

The Colby Environmental Analysis Center

pH

- Acidic water
  - Impacts fish reproduction
  - ⇧ solubility of metals
  - ⇧ release of phosphorus
- Basic water
  - Productivity

pH meter

Long Pond South pH

- Trend of increasing pH 1976-2007
- 1976-1985
  - pH= 6.8-6.9
- 2001-2007
  - pH=7.0-7.2

Summer student researchers

Total Phosphorus

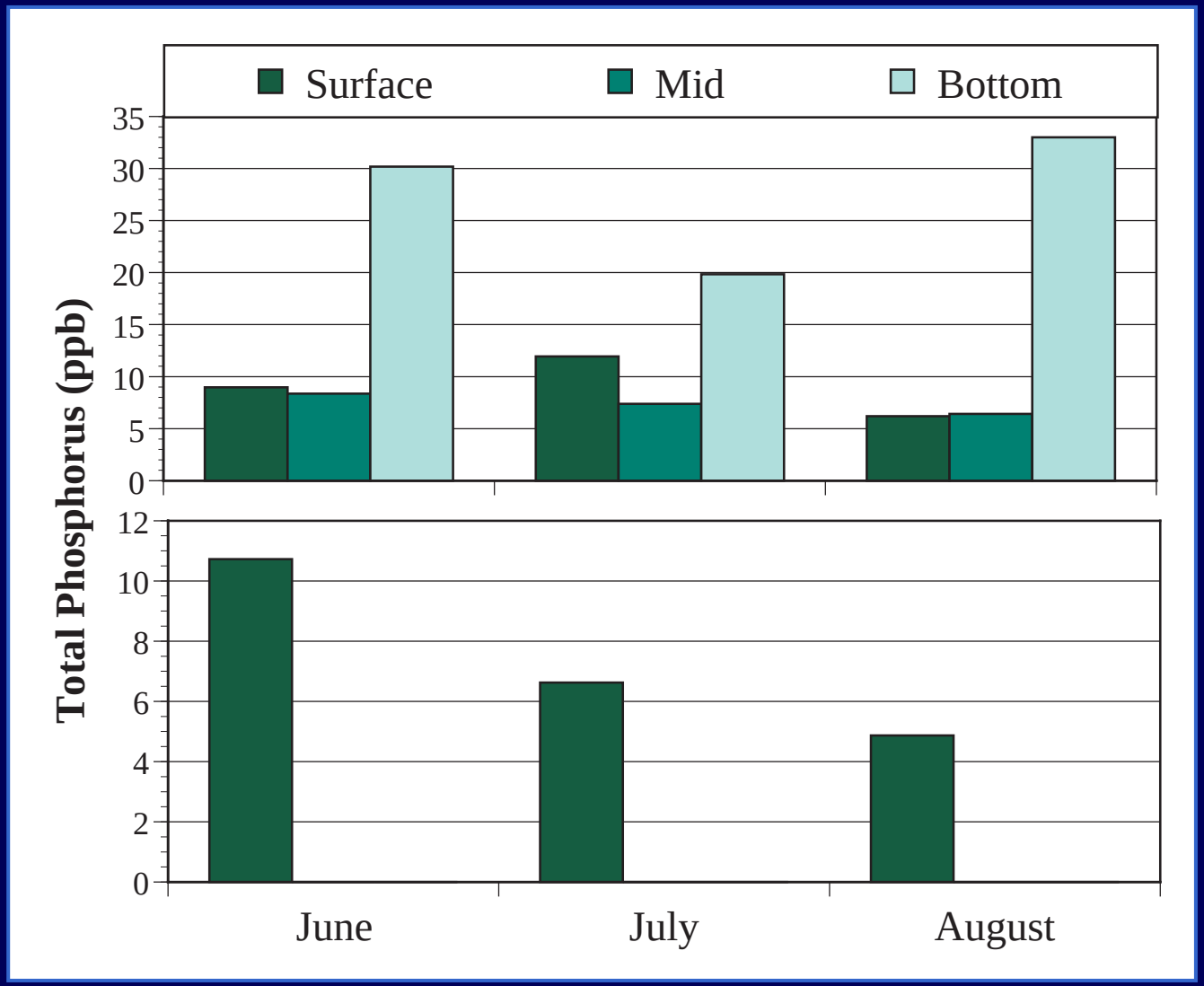
- Limiting nutrient
- External inputs and internal loading
- Phosphorus budget model

Water samples for phosphorus testing

Total Phosphorus

Site 1

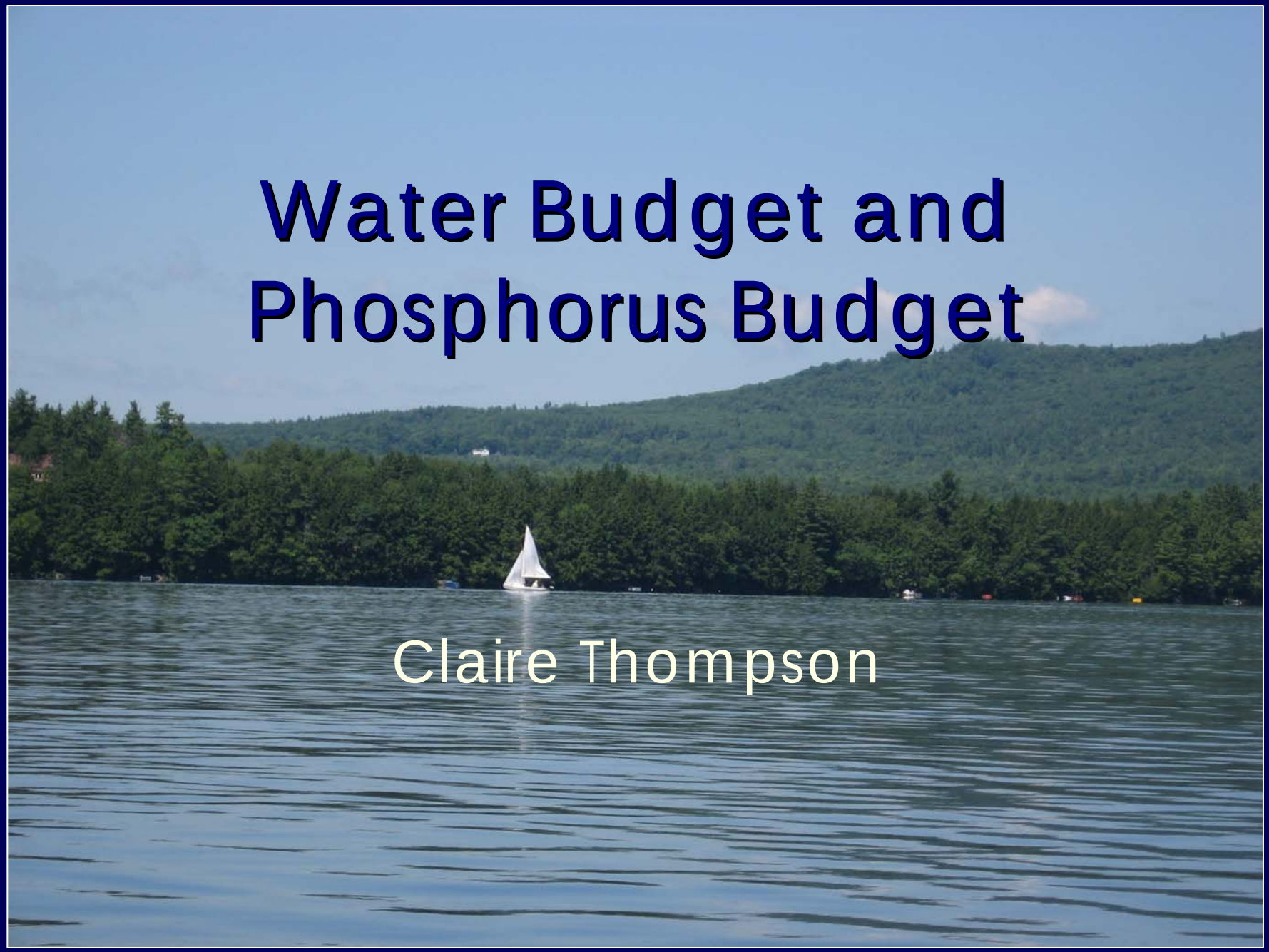
Site 2



Water Quality

- Long Pond South in good condition
- 2007 data confirms declining trends
- Preventative management

Dissolved oxygen meter



Water Budget and Phosphorus Budget

Claire Thompson

Water Budget and Phosphorus Budget

- Water Budget
  - Inputs
  - Flushing Rate
- Phosphorus Budget
  - Inputs
  - Total Phosphorus Concentration

A shoreline view of Long Pond South.

Water Budget Methods

- Input
  - Runoff
  - Precipitation
  - Evaporation
- Input with Point Sources
- Flushing Rate
  - Total Lake Input/Lake Volume

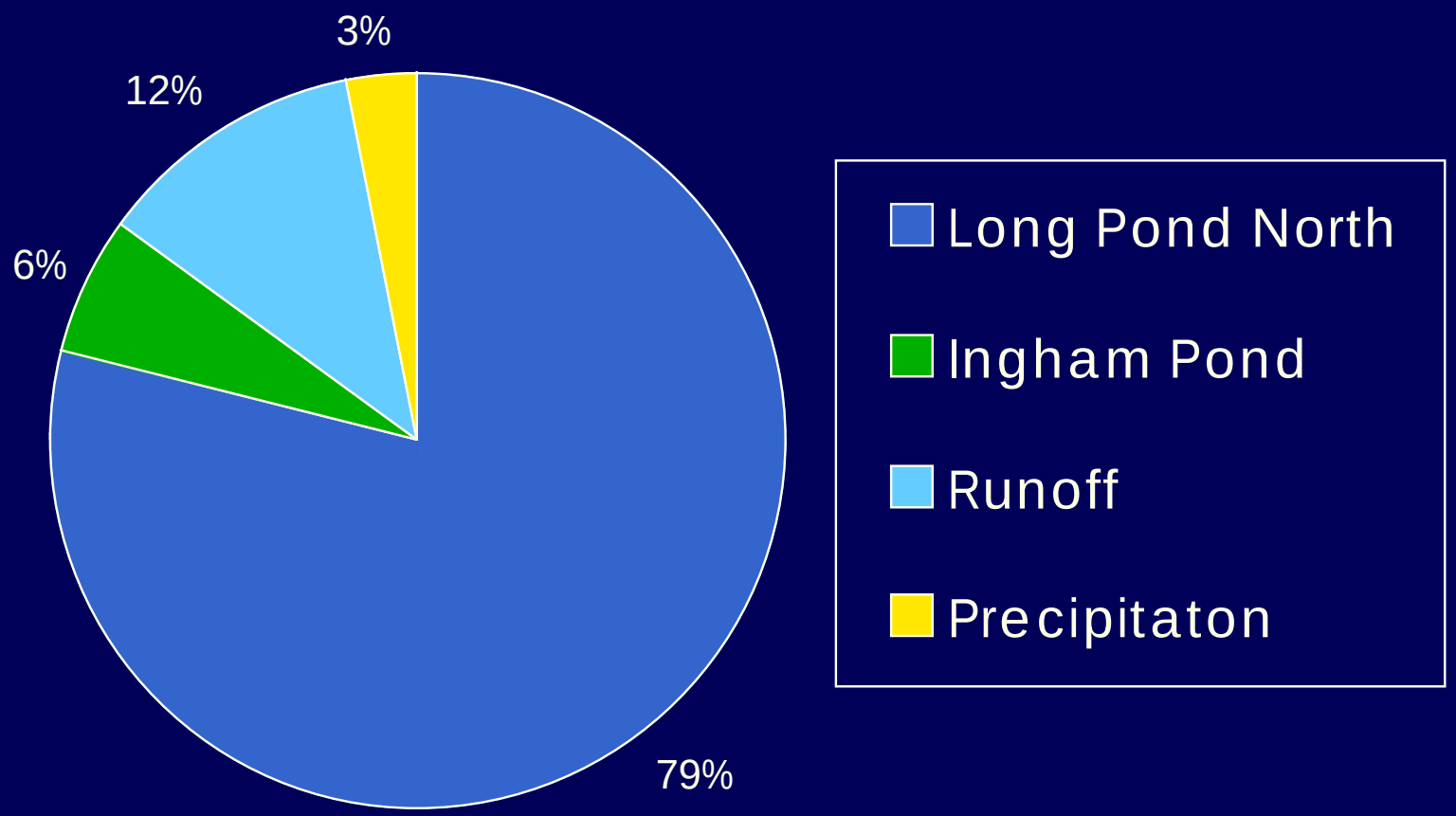
A view of Castle Island Road.

Water Budget Results

- Lake Input
  - 19.9 million m^3
- Lake Input with PS
  - 169 million m^3
- Flushing Rate
  - 3.52 flushes per year

An aerial view of Castle Island Camps.

Water Inputs



Phosphorus Budget Methods

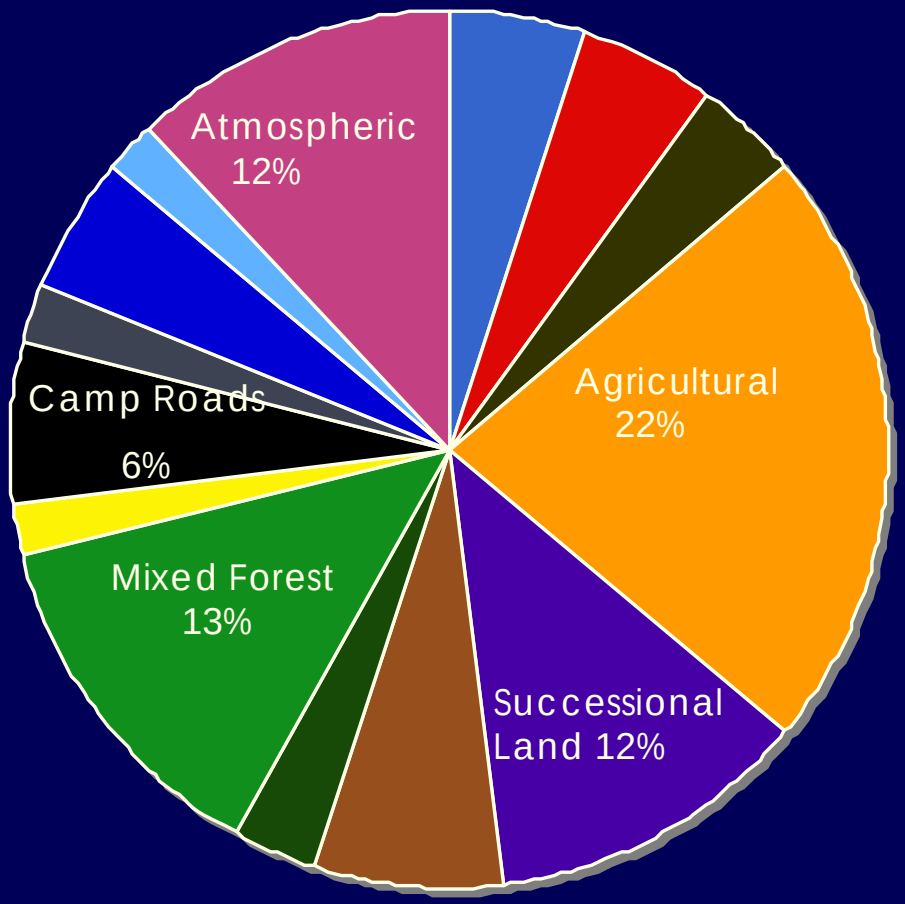
- External Input
- Non-point sources in the watershed
- Internal Input

Non-Point Source Input Within the Watershed

- 15 Land-Use Types
- Export Coefficients
- Percent contribution

Commercial property on the shoreline

Runoff from Land-Use Types

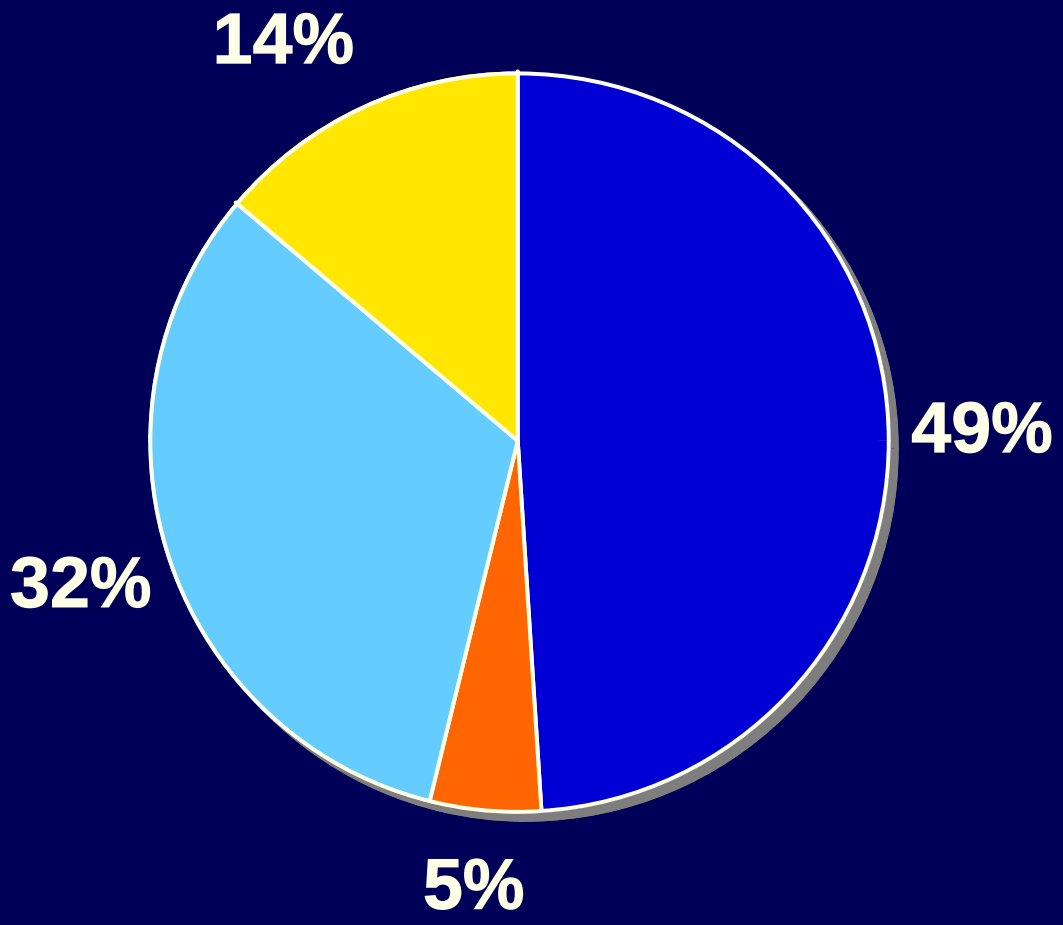


- Cleared Land
- Commercial Land
- Non-shoreline Residences
- Shoreline Residences
- Agricultural Land
- Successional Land
- Deciduous Forest
- Coniferous Forest
- Mixed Forest
- Wetland
- Camp Roads
- State Roads
- Shoreline Septic Systems
- Non-Shoreline Septic Systems
- Atmospheric Input

Total Phosphorus Loading

- Runoff 759 kg
- Point Sources 1,280 kg
- Sediment Release 324 kg
- Total Phosphorus Loading 2,363 kg

Total Phosphorus Loading



Total Phosphorus Concentration

- Annual Phosphorus Input
- Input from Water Budget
- Total Phosphorus concentration = 8.9 ppb

Water Budget and Phosphorus Budget Summary

- High Flushing Rate
- Input from Long Pond North
- Total Phosphorus Concentration
- Application of model

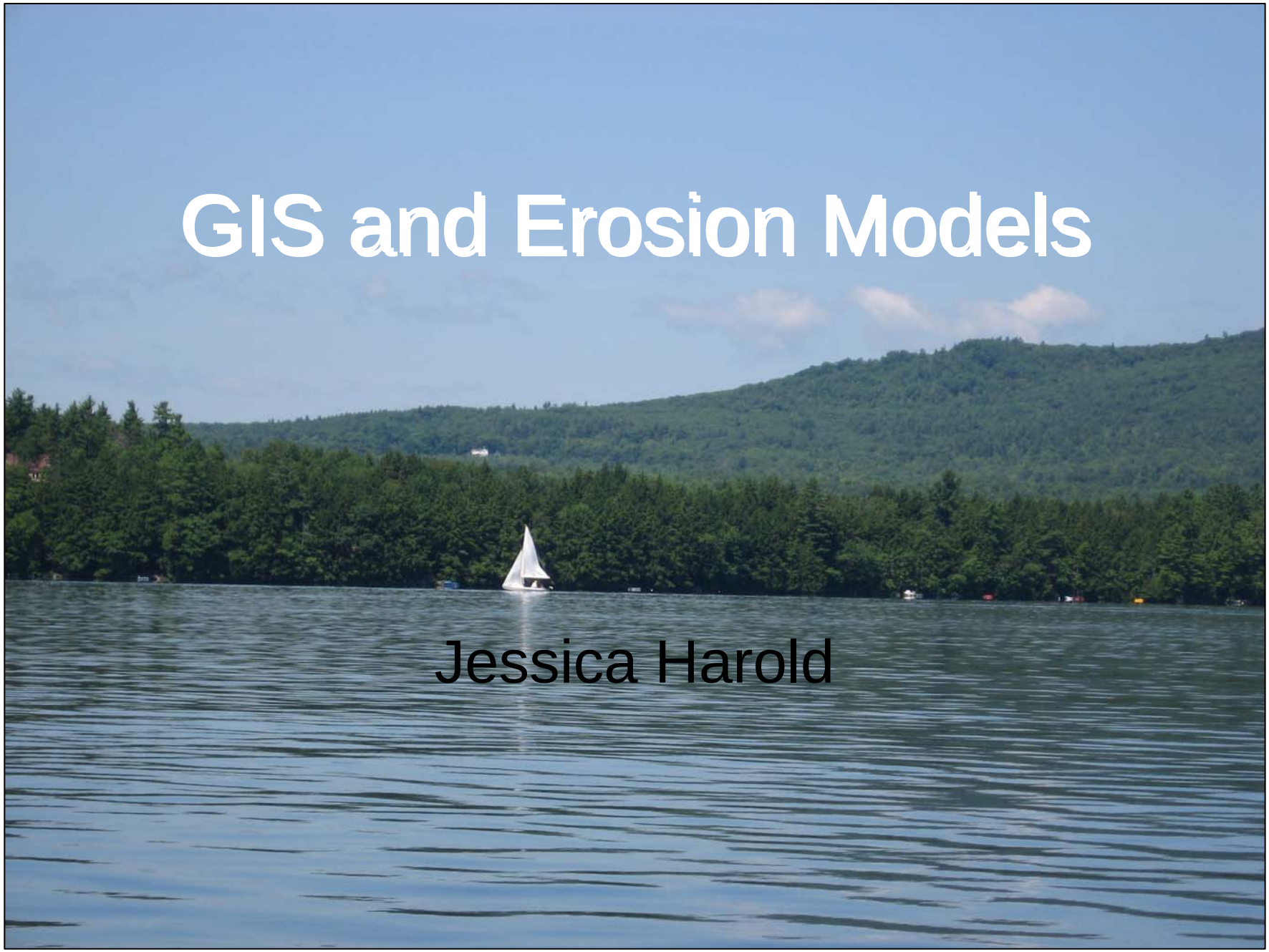

Intermission

Implications for Water Quality and Land-Use Management

Part II

Colby Environmental Assessment Team

December 6th, 2007

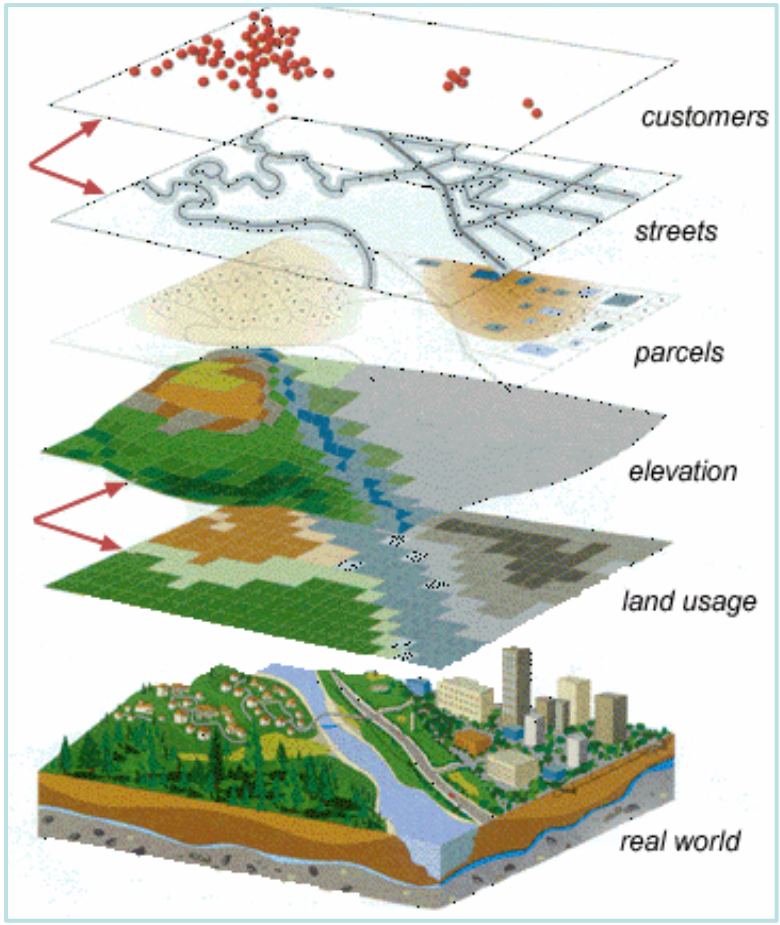


GIS and Erosion Models

Jessica Harold

Layers and Maps

- Layers
  - Set of data
  - Roads, streams, land-use
- Maps
  - Consists of one or more layers
- Models
  - Made by rating and averaging each layer



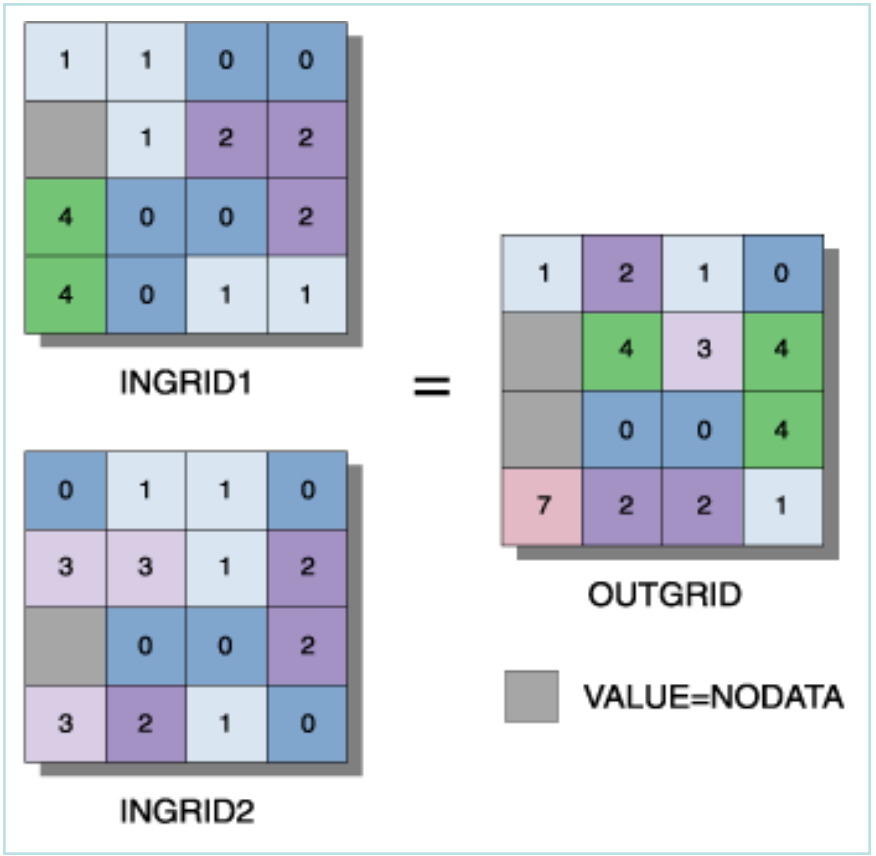
Erosion Potential Model

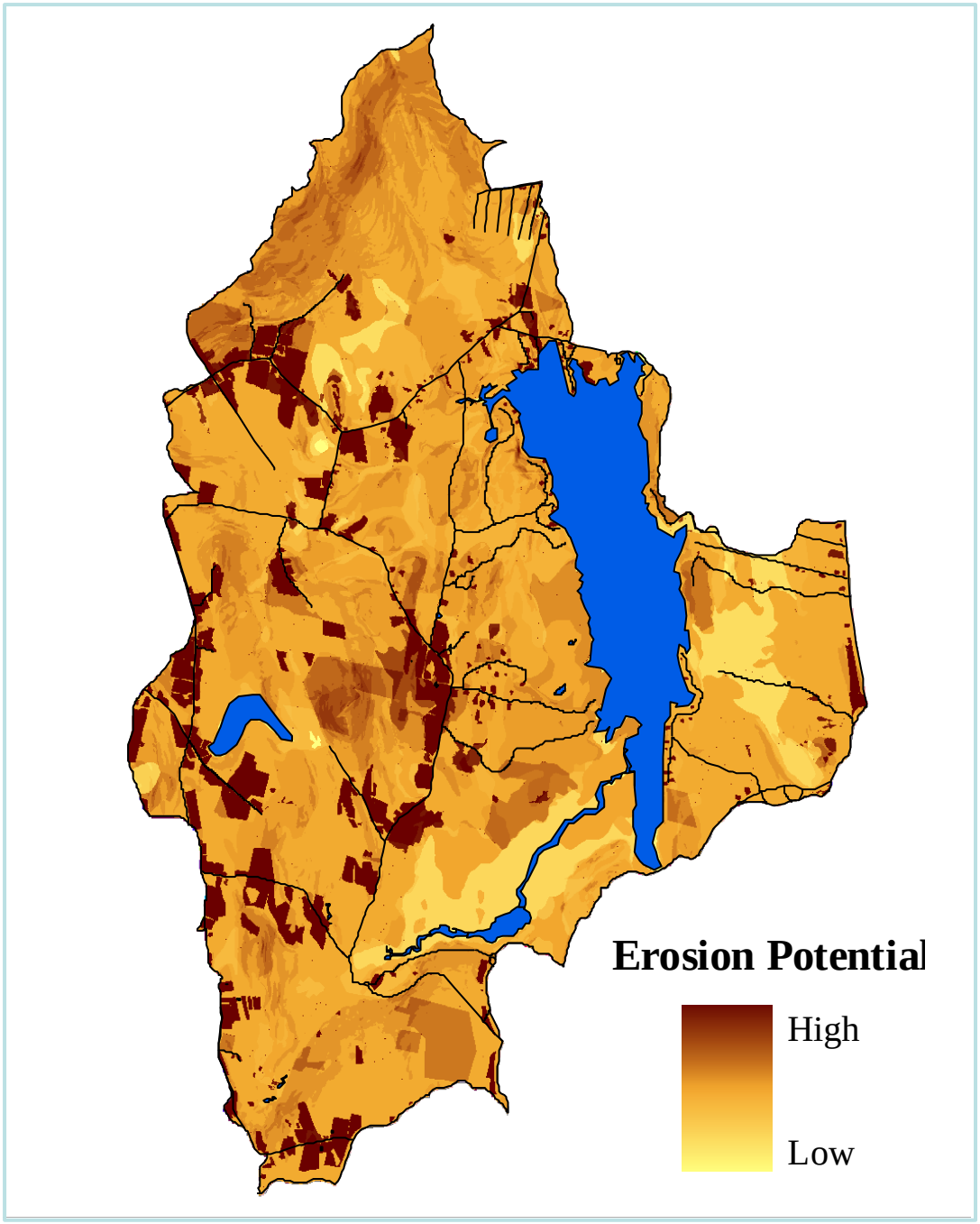
- Erosion
  - Displacement of soil and organic matter
- Causes
  - Soil type, slope, and land-use
- Effects
  - Algal blooms, harmful to organisms

Example of erosion

Creating the Erosion Potential Model

- Use soil type, slope, and land-use
  - Rate each on a scale of 1 to 9 or 0-9
- Weighted overlay
  - Weighted average
  - Soil type – 40%
  - Slope – 30%
  - Land-use – 30%

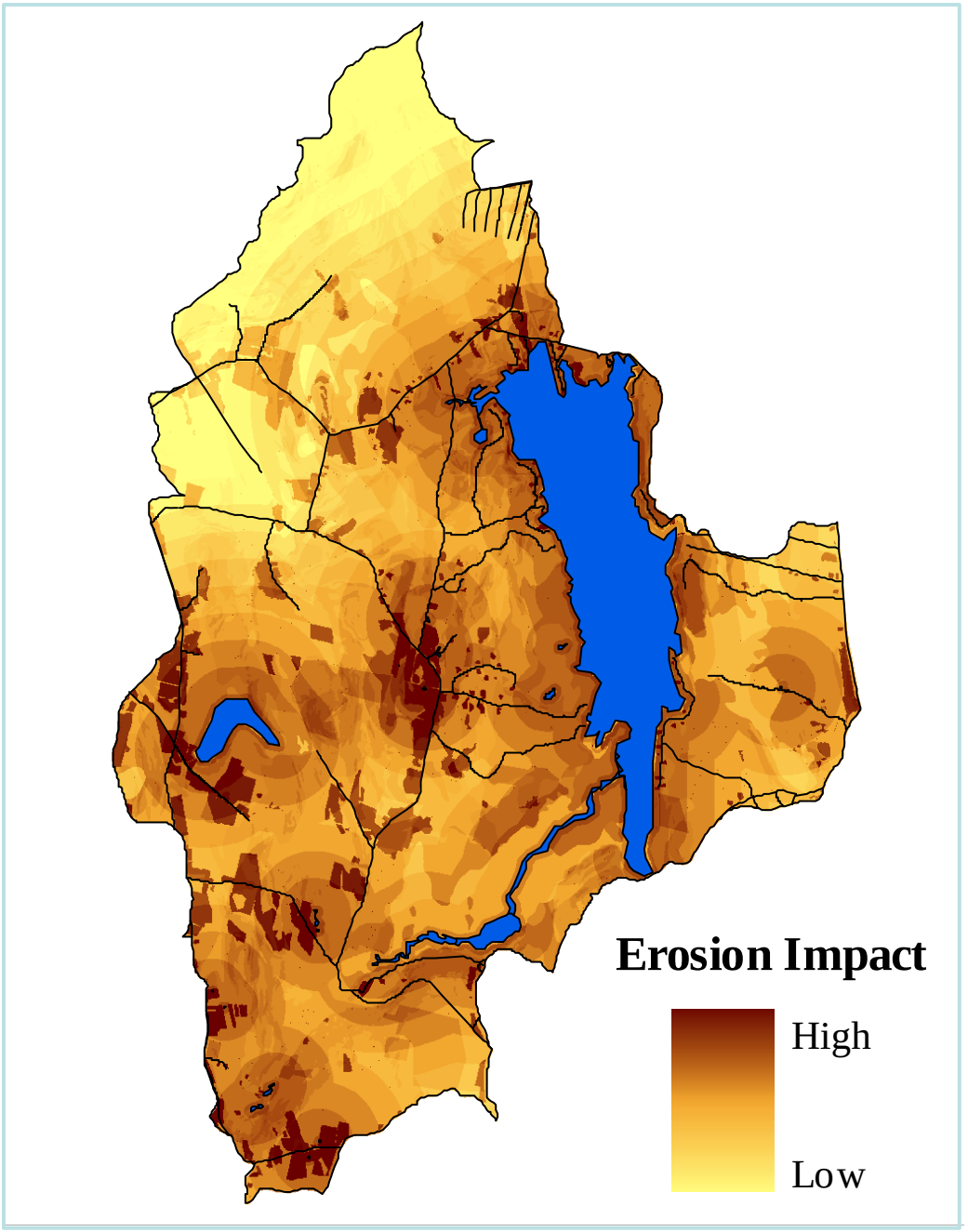




Erosion Potential Model

Erosion Impact Model

- The impact of erosion depends on its proximity to the lake and tributaries
- A new layer was created for proximity to the lake and proximity to tributaries
  - Layer was rated from 1 to 9
- Weighted overlay
  - Erosion potential – 50%, Proximity – 50%

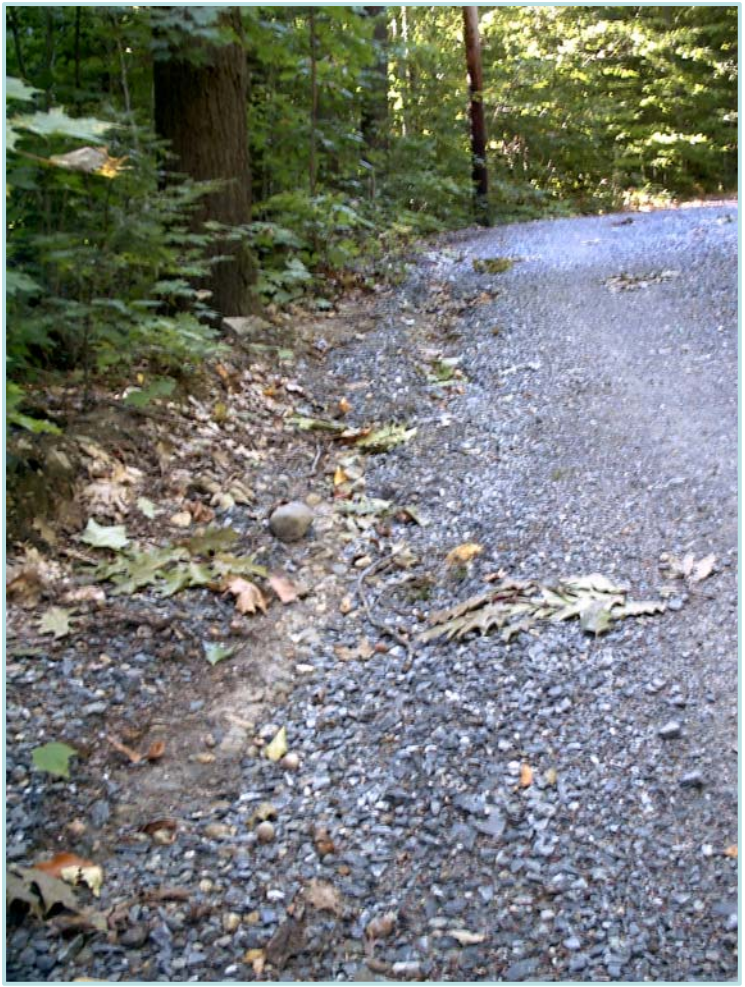


Erosion Impact Model


Roads and Water Quality
Anna Birnberg

Roads and Lake Water Quality

- Roads have the potential to contribute to water quality degradation
- Development leads to increased roads
- Role of maintenance



Proper Drainage: Essential in Preventing Pollution

Crowning, grading, and ditching

Rubber bar

Examples of Culverts

Photo Credit: LMNO Engineering

Good culvert

Poor culvert

The Road Survey

- Paved versus non-paved roads
- “Problem spots”
- House count

CEAT surveyors measuring crowning

Results of the Road Survey

- 52 roads in LPS watershed
  - 2 state roads
  - 8 town
  - 42 camp roads
- 90.3 acres of road area
  - 9.1 acres state
  - 42.7 acres town
  - 38.4 acres camp roads
  - Camp roads make up over 40%

Results of the Road Survey

- Camp Roads:

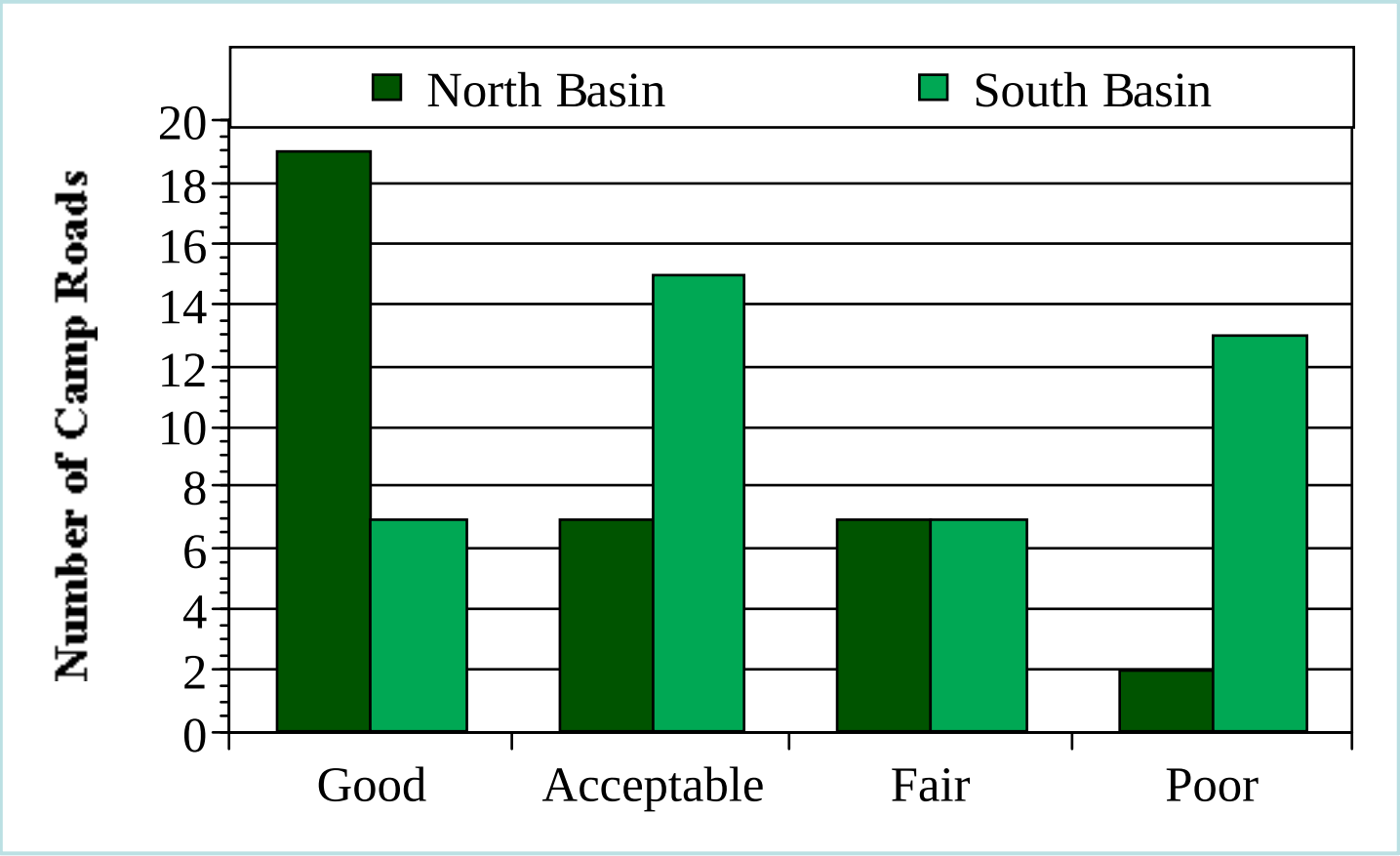
  16.7% Good (7 roads)

  35.7% Acceptable (15)

  16.7% Fair (7)

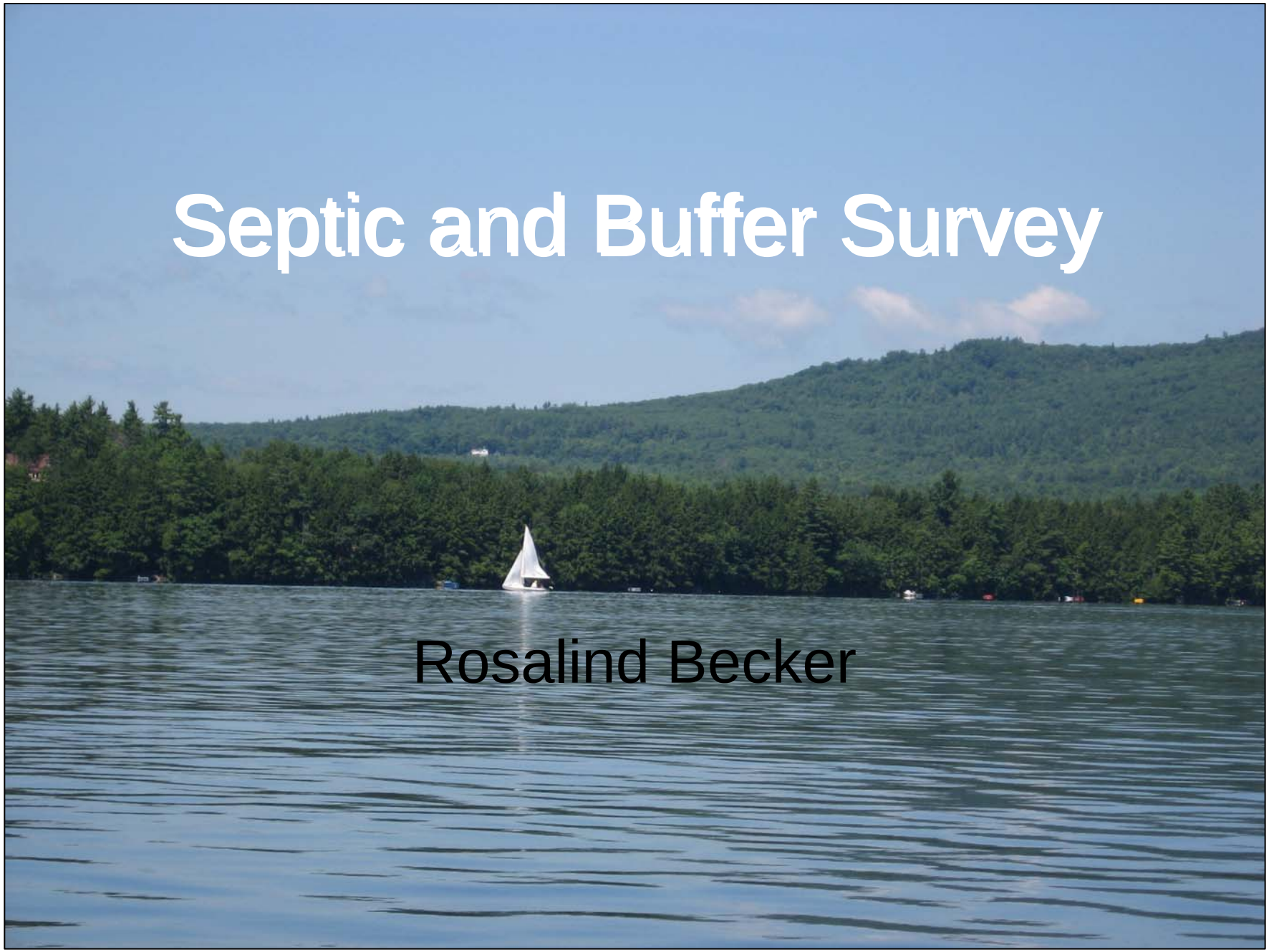
  31.0% Poor (13)

Results of the Road Survey



Road Survey: Conclusions

- LPN has more “good” roads; LPS has more poor quality roads
- Poor condition of ditches and culverts
- Over 40% of road area is camp roads, and nearly 50% of camp roads are in fair or poor condition


Septic and Buffer Survey
Rosalind Becker

Septic Systems

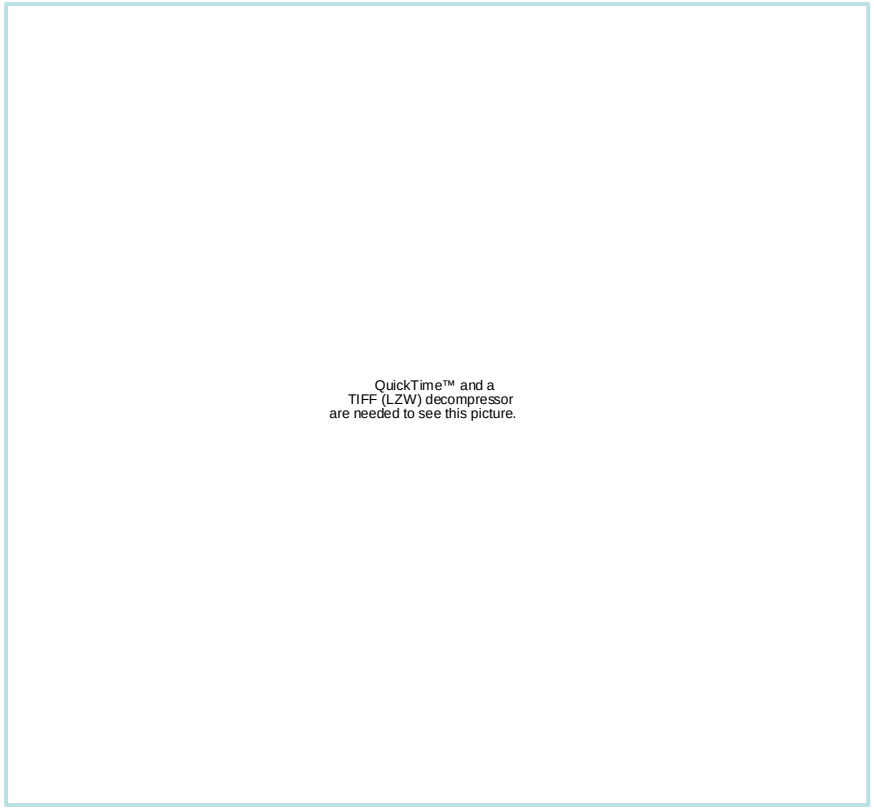
- Contribution to phosphorus loading
  - Leaching effluent
  - Shoreline concerns
  - System age concerns
- 1974 Regulations
  - Site evaluations
  - Installation restrictions

Septic Survey Questions

- How many septic systems are in the watershed?
- What is the relative age of septic systems in the watershed?
- Where do we expect future development?

Septic Survey Methods

- House counts
  - Shoreline survey
  - Road survey
- Interviews with town officials
- Review of town documents



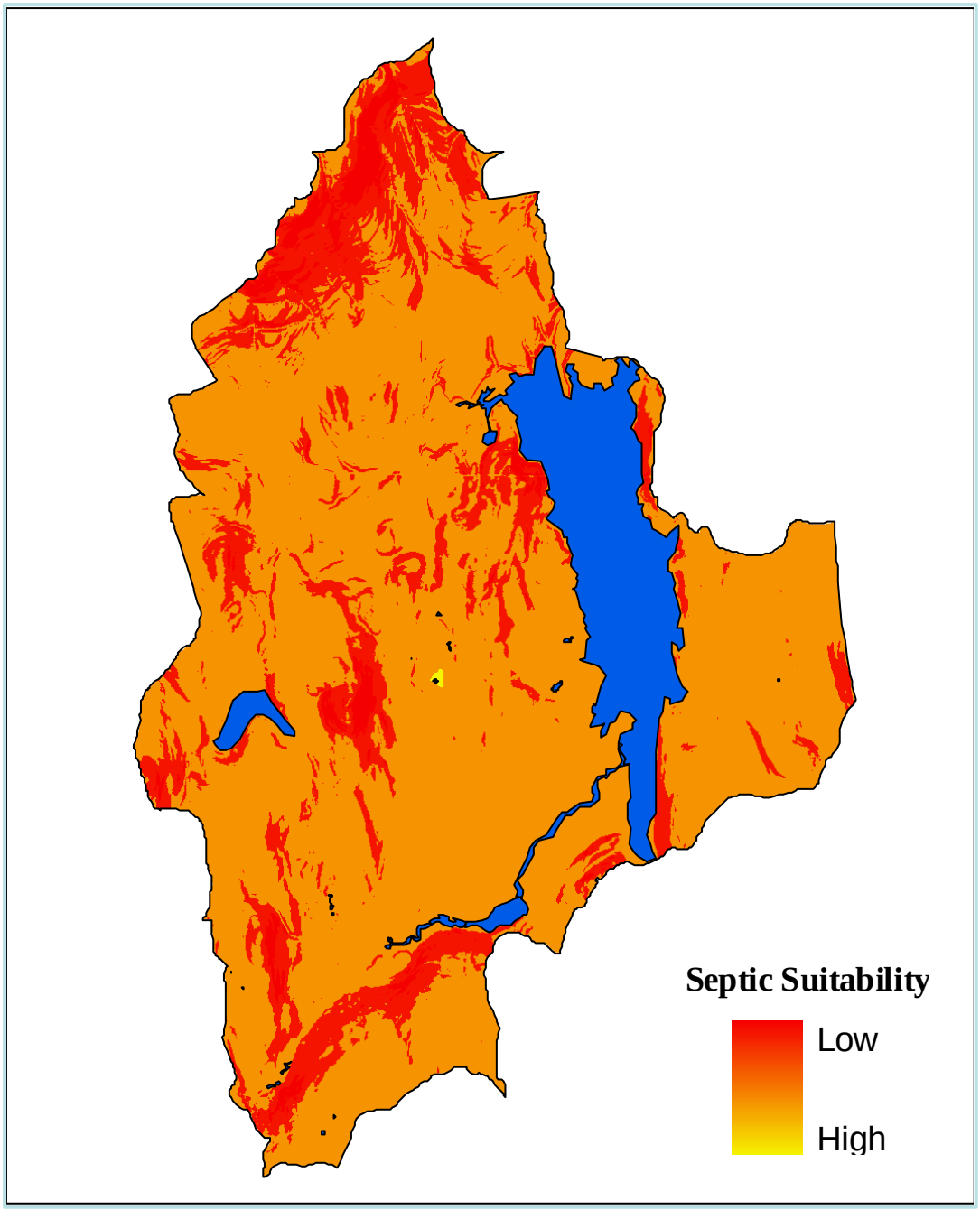
Septic Survey Results

- 365 houses
  - 126 along shoreline
  - 239 non-shoreline
- Replacement of systems
- Restricted development
- Areas of potential development

Septic Suitability Model

- Importance of soils and slope

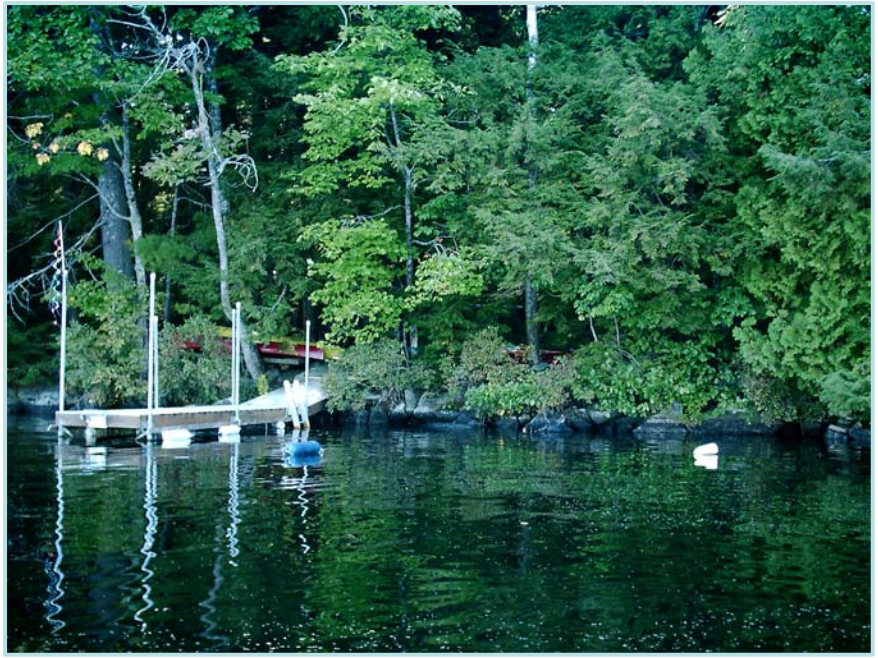
- USGS Criteria
  - Permeability
  - Mean depth to bedrock
  - Erodibility
  - Nutrient absorption capacity



Septic Suitability Model

Buffer Survey

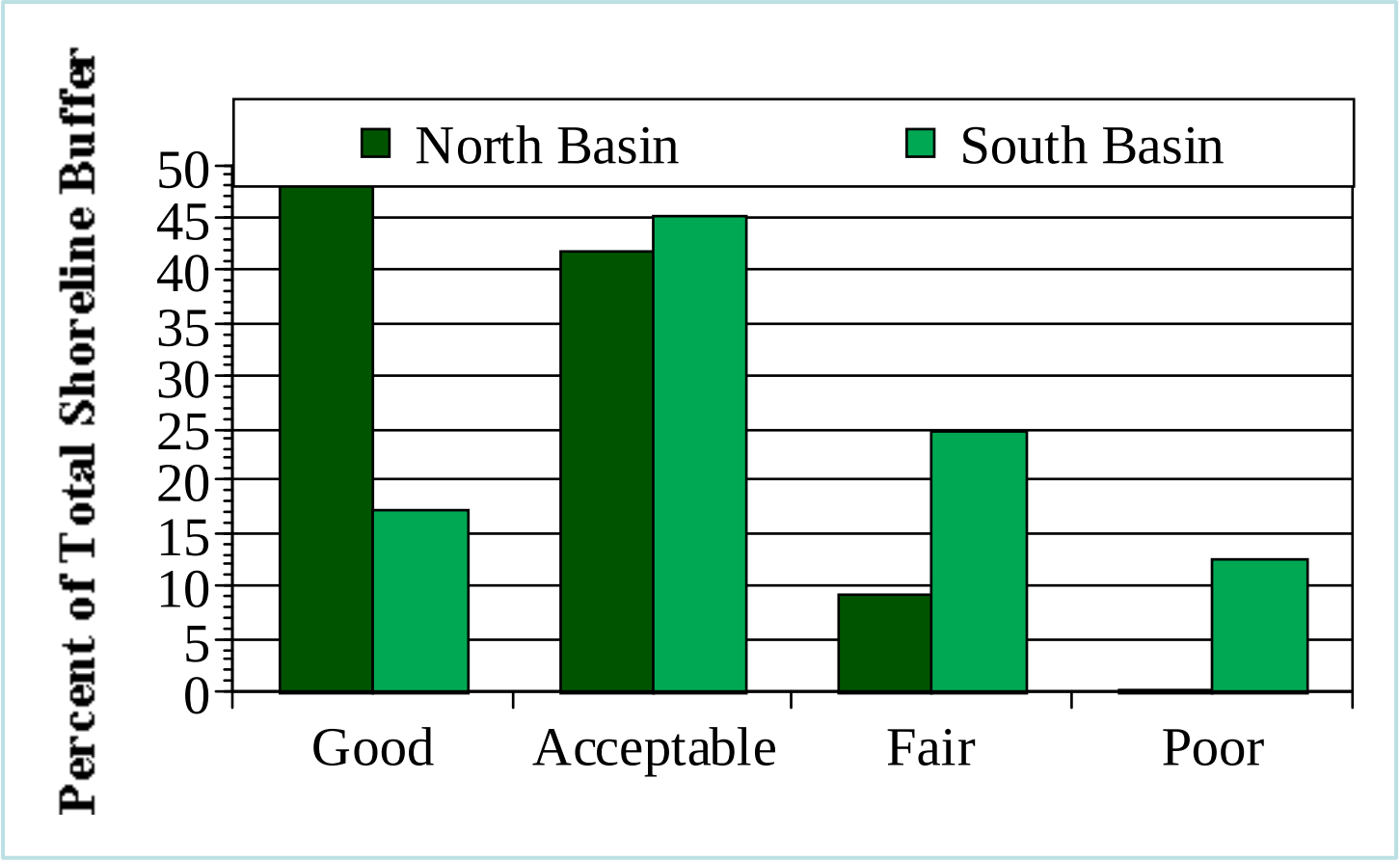
- Importance of buffers
  - Protect soils from erosion
  - Remove nutrients, trap sediments
- Evaluation parameters
  - Percent vegetated buffer
  - Buffer depth
  - Slope rating



Buffer Survey

- Most lots had an acceptable score
- No lots with a perfect score
- Other observations

North Basin vs. South Basin Buffer Quality



Septic System and Buffer Conclusions

- Replacement of grandfathered systems
- Areas of likely development
- Range of septic suitability
- Acceptable buffer conditions


Future Projections
Eva Gougian

Long Pond South Watershed: 2010 to 2030

Variables

- Population
- Development
- Land-Use

Impact on water quality

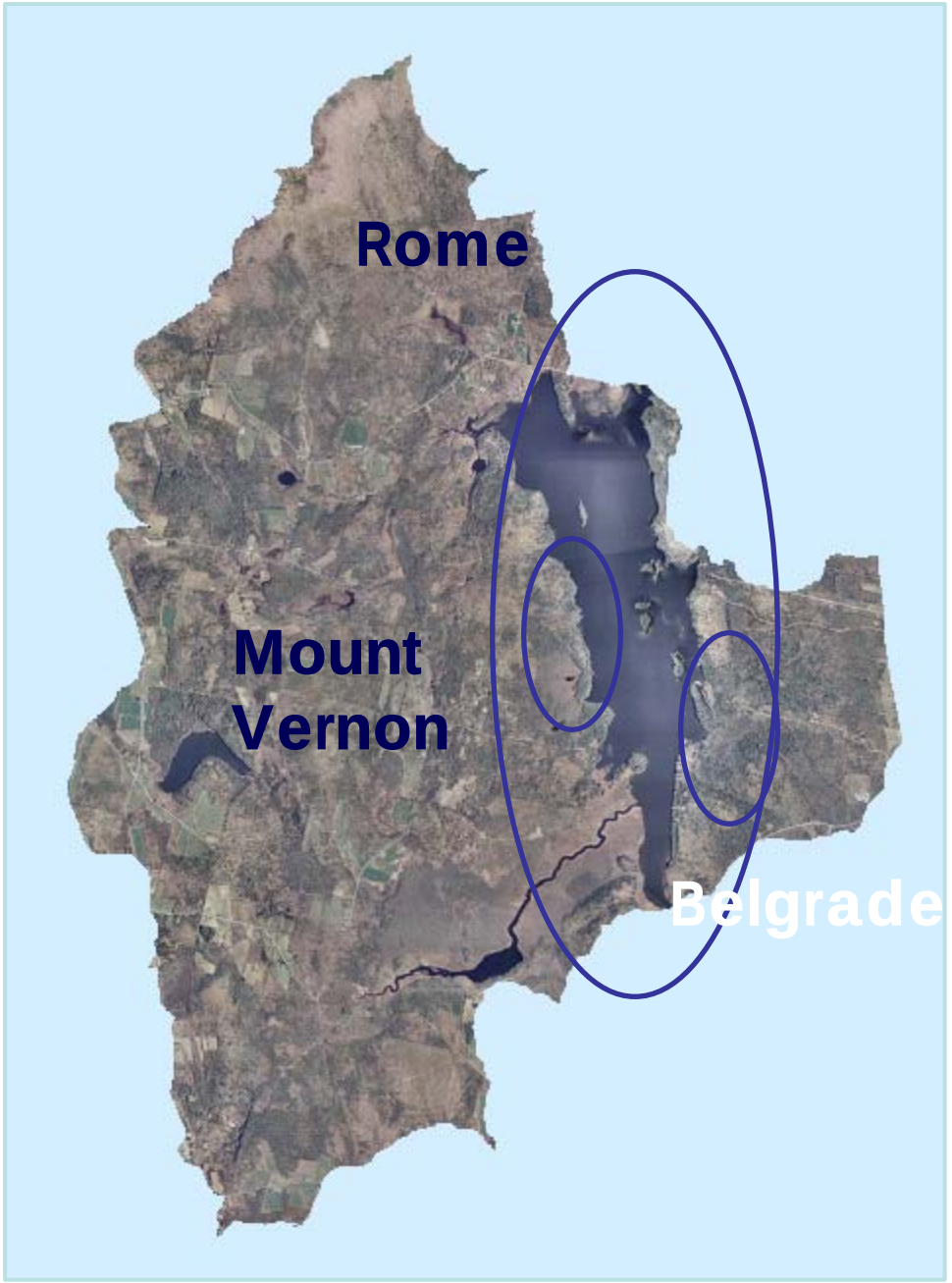
- Phosphorus

Population Projections

- Developable land
- Subdivisions
- Increase in year-round residences

Development Projections

- Possible need for more developable lots
- Development in Belgrade
- Public opinion



Land-Use Projections

- Regenerating land
- Wetlands
- Agricultural land
- High-impact development
- 492 acres of mixed forest converted to residential land

Phosphorus Budget Projections

- Mixed forest to residential land
- Impervious surfaces
- Septic systems

Increase in phosphorus

Best estimate increase in phosphorus concentration:

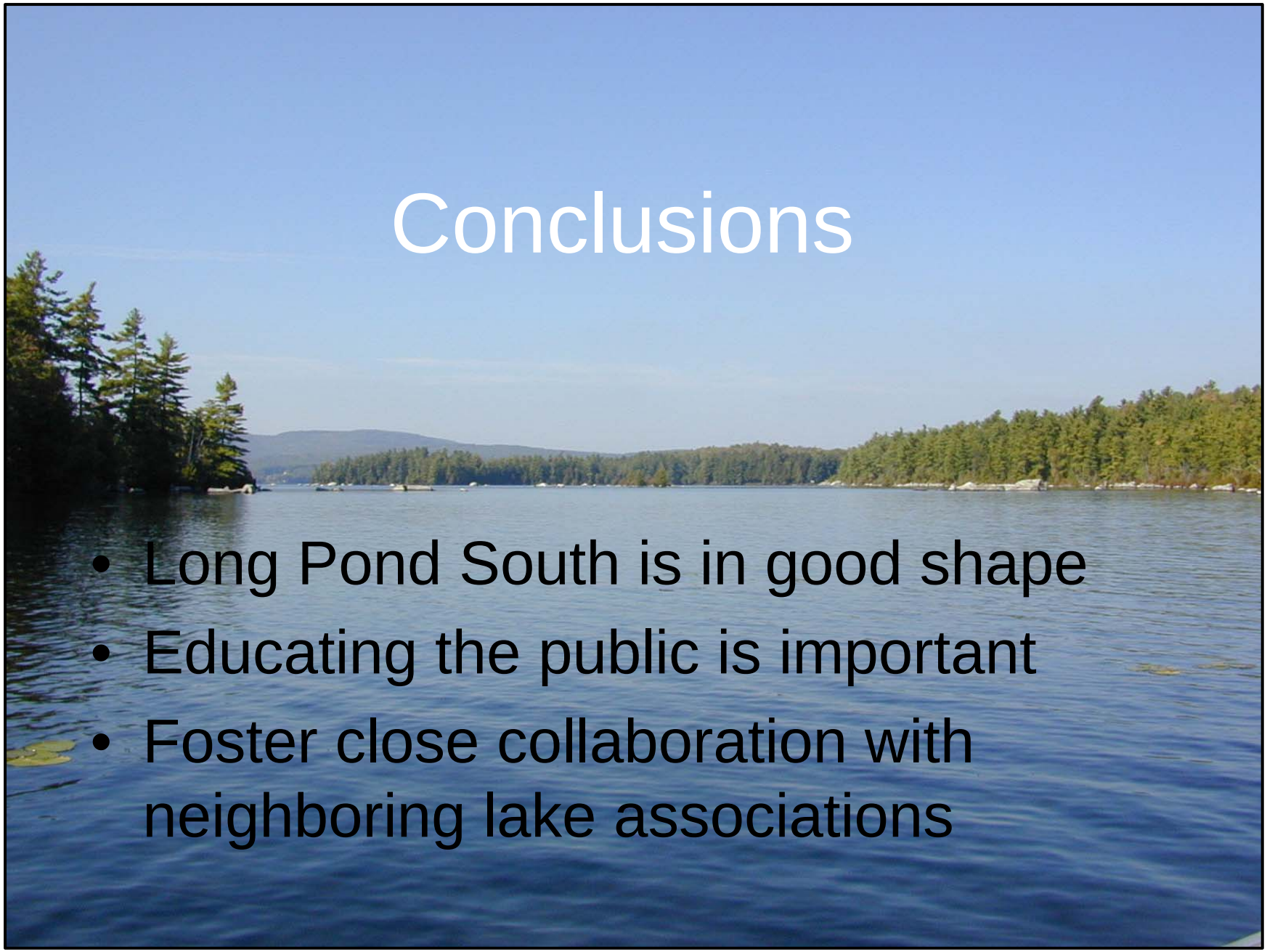
10% by the year 2030.

Recommendations and Conclusions

Kristyn Loving

Recommendations

- Water quality
- Recreation
- Roads
- Buffer Strips
- Septic Systems
- Development



Conclusions

- Long Pond South is in good shape
- Educating the public is important
- Foster close collaboration with neighboring lake associations

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Questions?