



A GIS-based Watershed Model to Map Use Conflicts and Inform Policy-Makers

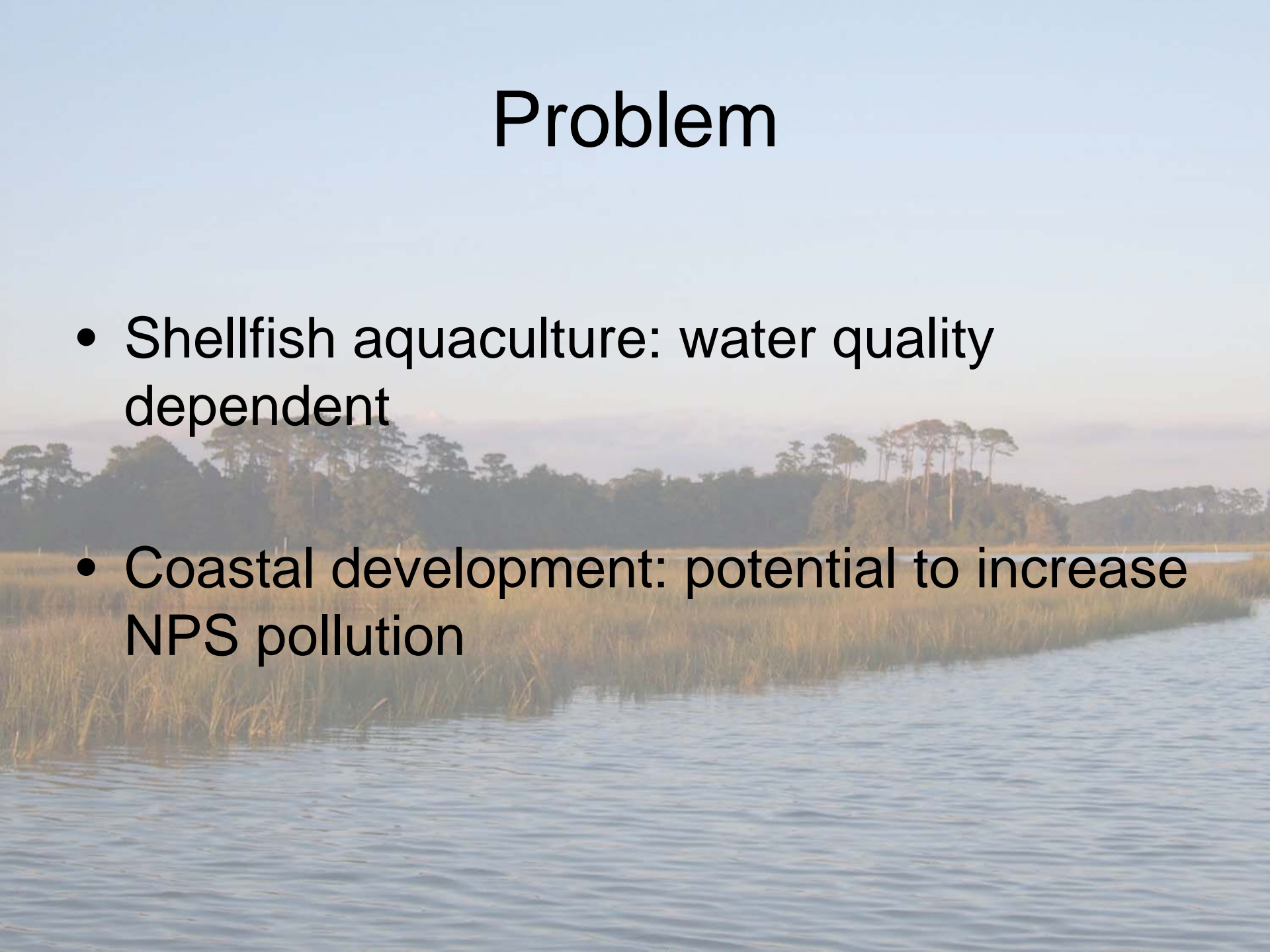
Matthew Strickler

International Submerged Lands Management Conference

October 31, 2007

Problem

- Shellfish aquaculture: water quality dependent
- Coastal development: potential to increase NPS pollution



Aquaculture in Virginia

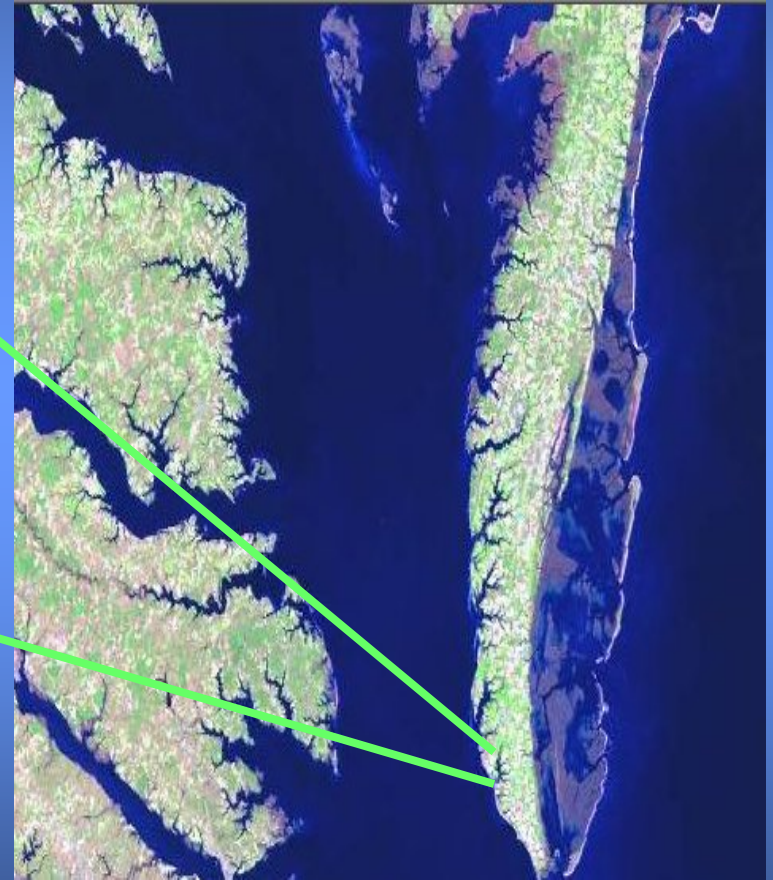
- *Crassostrea virginica*
(eastern oyster)
2005 sales: \$850,000
- *Mercenaria mercenaria*
(hard clam)
2005 sales: \$26.7 million



Necessary conditions for hard clam aquaculture

- Temperature and salinity
 - Physical/spatial constraints
 - Access requirements
 - Environmental concerns
 - Bacterial standards (14 and 43 CFU/100 ML)
- 
- A coastal landscape featuring a body of water in the foreground, a marshy area with tall grasses in the middle ground, and a line of trees in the background under a clear sky.

Introduction to the study area



- Current condition
- Development potential
- Existing use: shellfish culture

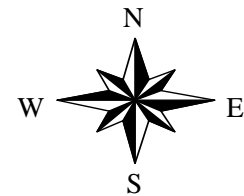
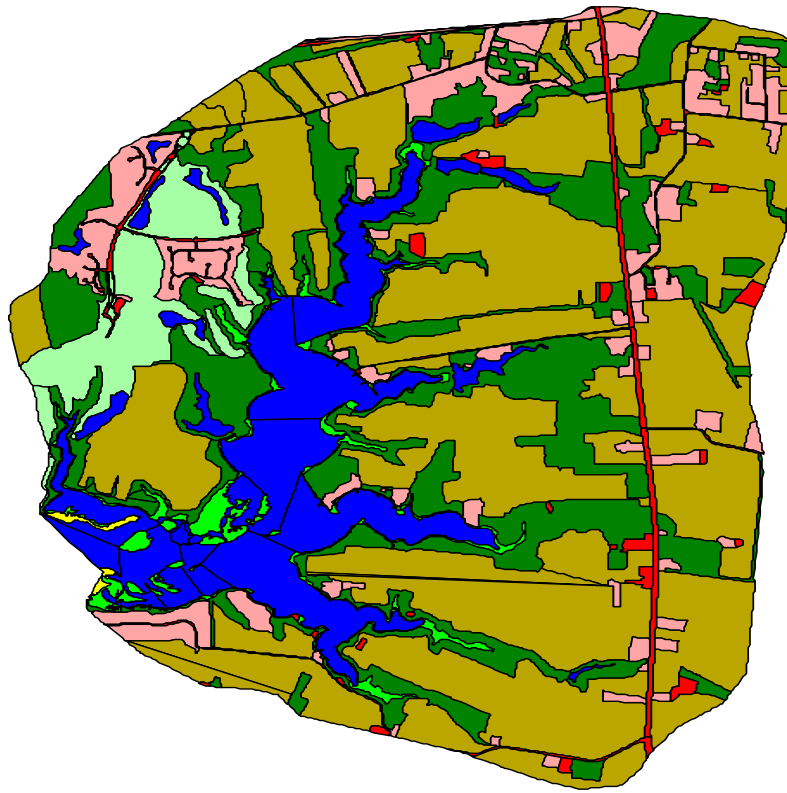
Introduction to the study area

- Eastern Shore's rural character
- Barriers to development
- Recent change
- GIS



Old Plantation Creek Watershed: 2002

Land use - 2002



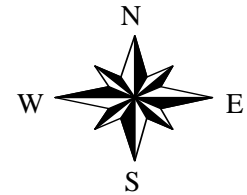
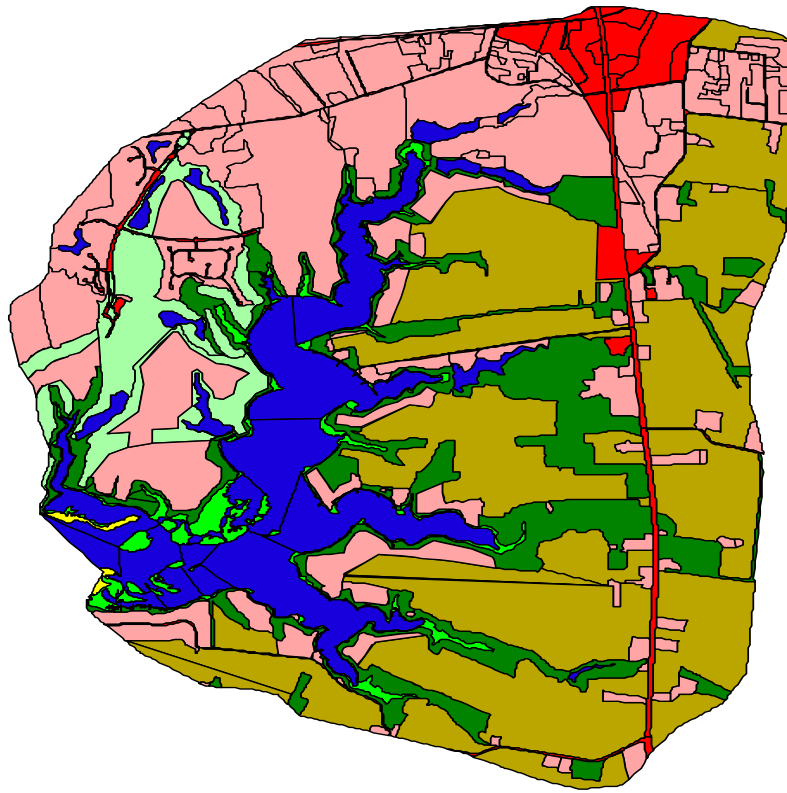
Land02cfinal.shp

- open water
- emergent wetland
- beach
- forest
- golf course
- crop land
- residential developed
- commercial/industrial developed

1 0 1 2 Kilometers

Old Plantation Creek Watershed: Full buildout scenario

Land use - Buildout



Land05c-1finalcopy.shp

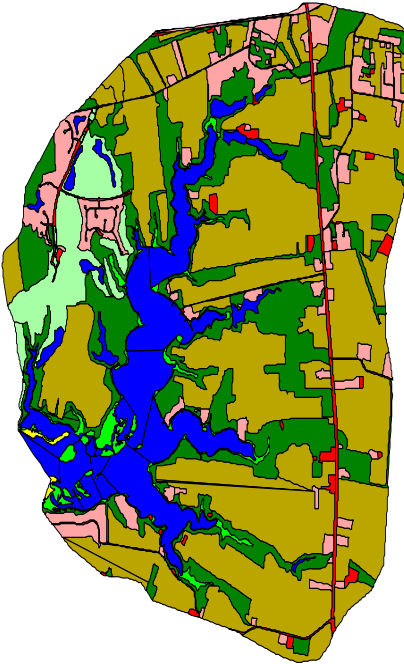
- open water
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- beach
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- golf course
- crop land
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- commercial/industrial developed

1 0 1 2 Kilometers

A scale bar with markings at 0, 1, and 2 kilometers. The bar is black with white markings and a white background.

Comparison

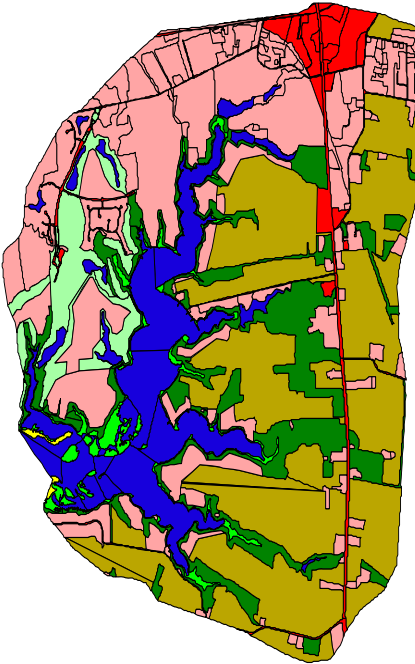
Land use - 2002



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Land use - Buildout



- Land05c-1finalcopy.shp
- open water
 - emergent wetland
 - beach
 - forest
 - golf course
 - crop land
 - residential developed
 - commercial/industrial developed

1 0 1 2 Kilometers

A landscape photograph of a marsh or wetland area. In the foreground, there is a body of water with gentle ripples. To the left and in the middle ground, there are dense patches of tall, golden-brown grasses. In the background, a line of trees, including several tall, thin pines, is visible against a clear, light blue sky. The overall scene is peaceful and natural.

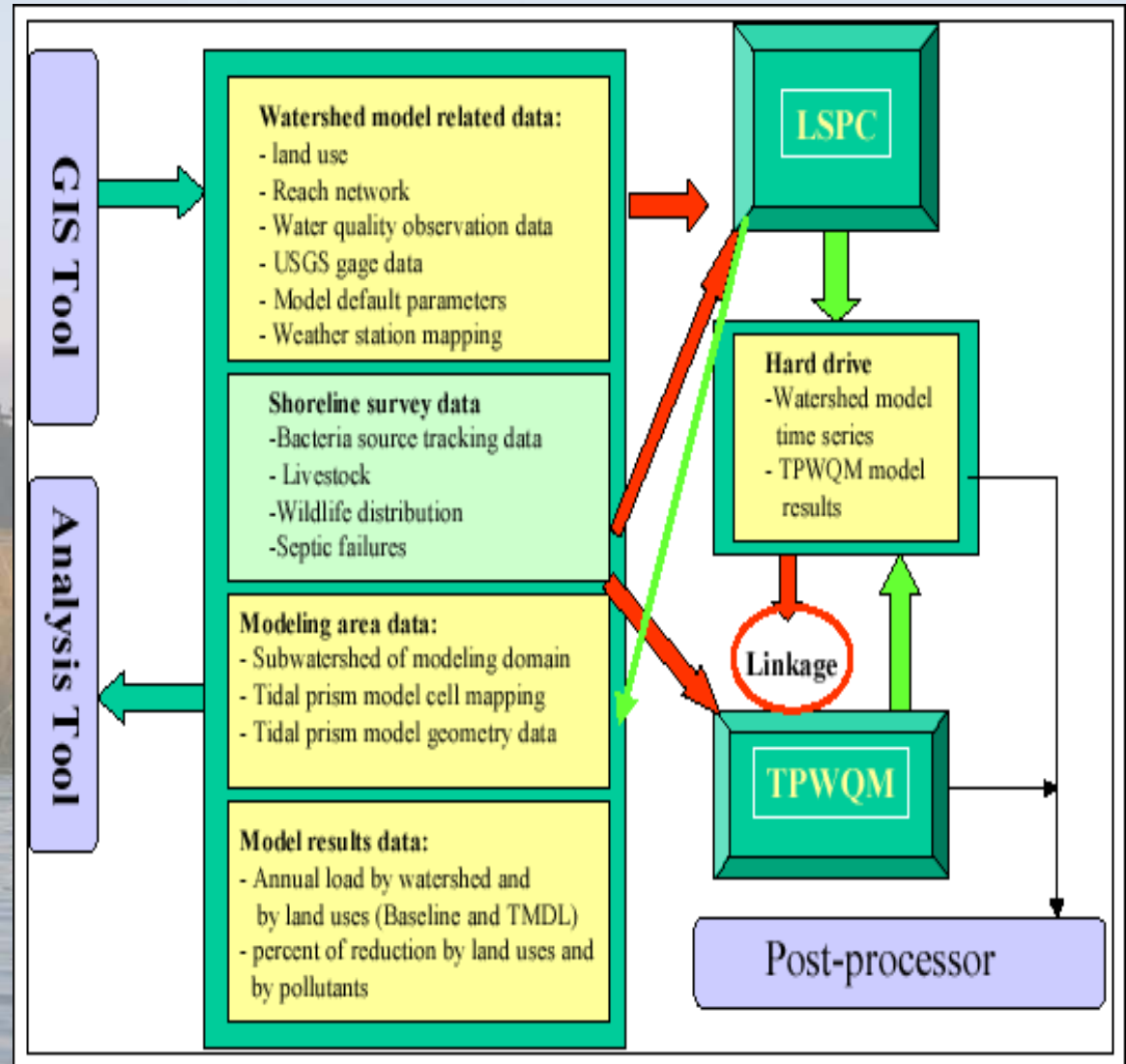
What does this mean and
how can we use it?

Approach

- Target pollutant: fecal coliform bacteria (indicator)
- GIS: Map land use and shellfish leases
- Watershed loading model: Estimate bacterial loading
- Water quality model: Predict bacterial concentrations
- Economic model: Determine impacts of closures

Watershed loading model: LSPC

- Spatially explicit
- Precipitation-driven
- Delivery ratio

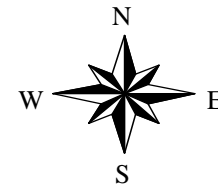
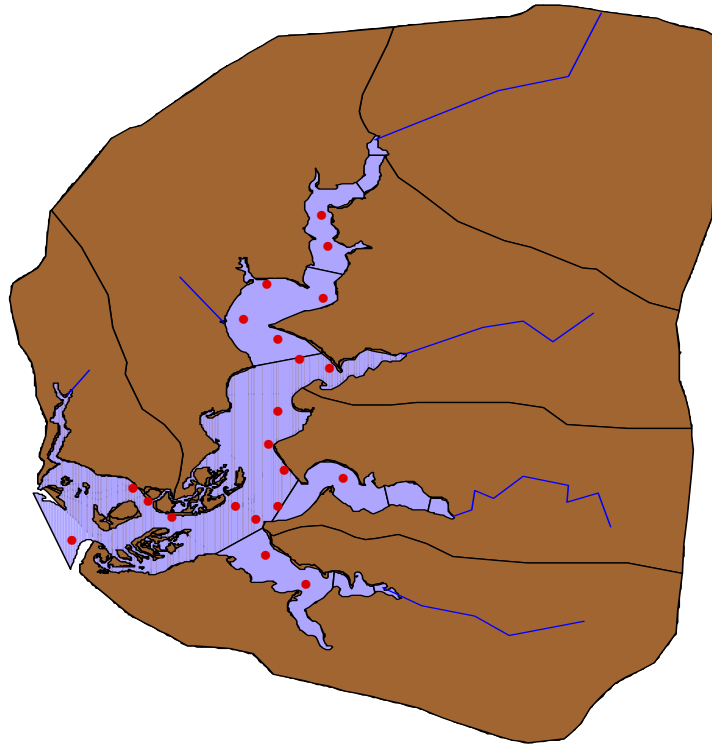







Model outputs, model inputs

- Bacterial loads build up on land over time
- Precipitation creates runoff
- Model measures loading from each subwatershed over time
- This data is used as an input for the next modeling step


Tidal Prism Water Quality Model

Sub-watersheds, monitoring stations, and prism segments



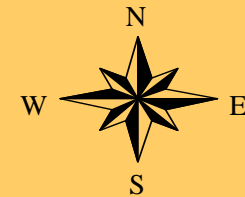
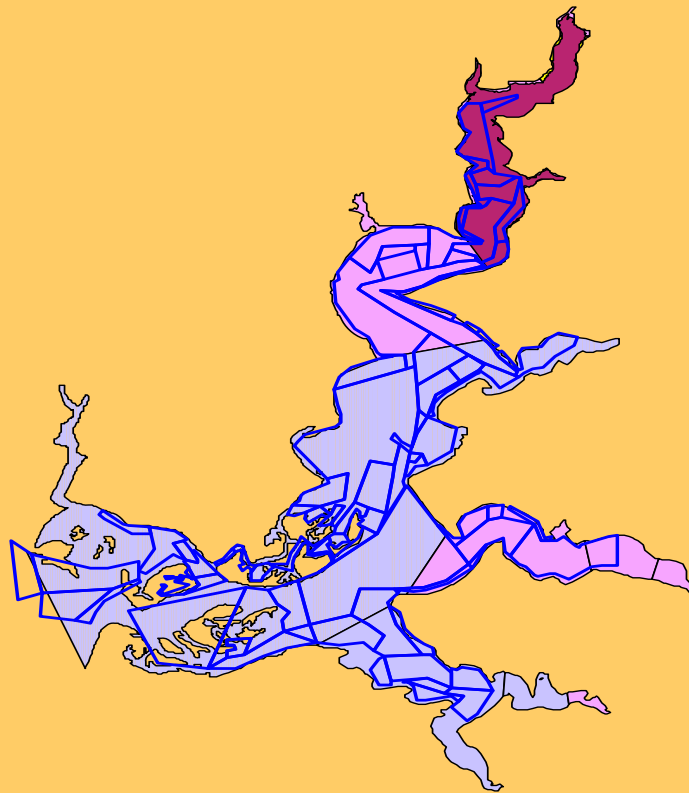
-  Reach1copy2.shp
-  Area90_stations.shp
-  Tpsagall_polygoncopy.shp
-  Subs_polygon.shp
-  Land02cfinal.shp

1 0 1 2 Kilometers



Condemnation of shellfish leases

Closed areas: present and future

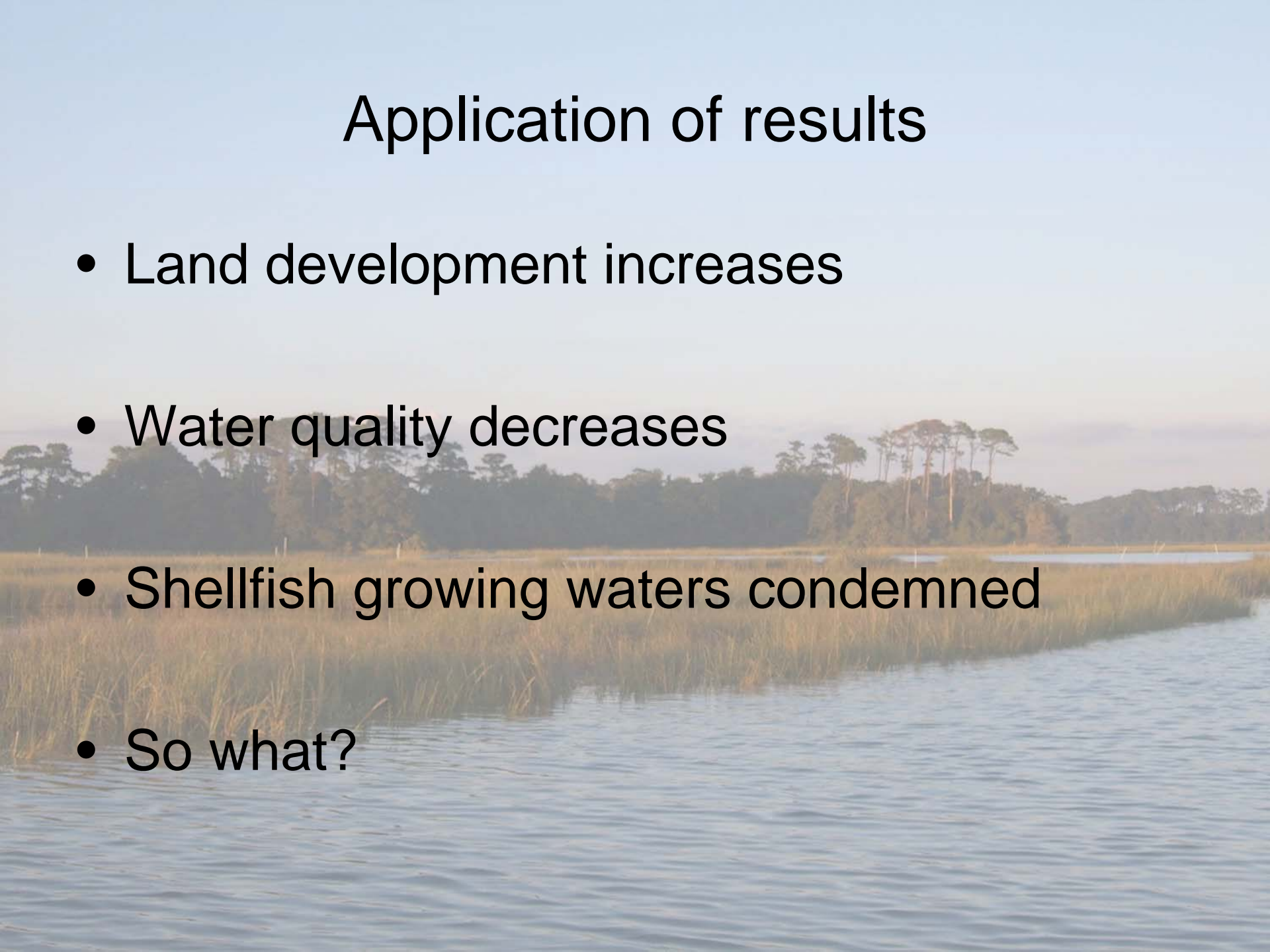


- Opcleases05.shp
- Condemned04.shp
- Opsegall_polygoncopy.shp
- Not - condemned
- Condemned - future

0.6 0 0.6 1.2 Kilometers

Application of results

- Land development increases
- Water quality decreases
- Shellfish growing waters condemned
- So what?



Economic impact study

- *Economic Activity Associated with Clam Aquaculture in Virginia – 2004 (Murray and Kirkley).*
- \$24 million to \$49 million....Input-Output economics
- Direct, indirect, induced impacts

Results

- Economic impact of projected condemnations:

*****\$7,494,234 to \$16,862,025*****

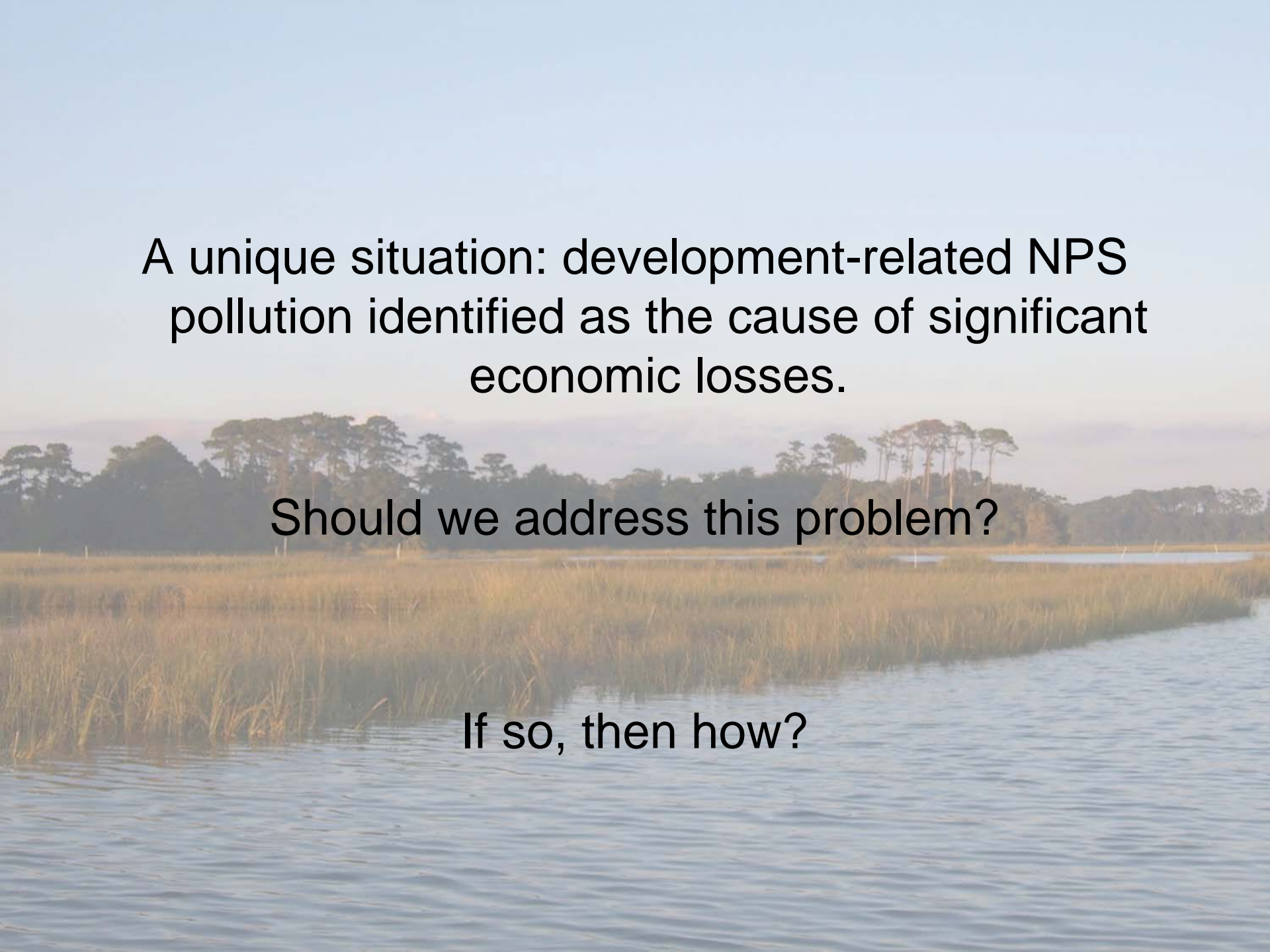
- Impact of re-opening currently condemned areas:

*****\$1 million to \$2.25 million*****

These are annual income flows, not one-time events.

Recap of modeling exercise

- LSPC model – increased development leads to increased bacterial loading
- Tidal Prism model – increased bacterial loads lead to increased condemnations
- I/O model – condemnations lead to significant economic losses

A scenic view of a coastal wetland. In the foreground, there is a body of water with gentle ripples. To the left, a dense patch of tall, golden-brown grasses grows in the water. In the background, a line of trees, including several tall, thin pines, stretches across the horizon under a clear, light blue sky.

A unique situation: development-related NPS
pollution identified as the cause of significant
economic losses.

Should we address this problem?

If so, then how?

Policy Recommendations

- Recognize jurisdictional complexity
- Identify policy gaps
- Eliminate market failure



Policy Recommendations

- Local
 - Pet waste disposal/septic pumpout
 - Proffers for environmental protection
- State
 - Enable localities to limit impervious surface
 - Hold localities accountable
 - Improve balance between public and private uses
- Federal
 - Employ/endorse predictive modeling
 - Step up TMDL implementation schedule

Conclusions

- Coastal development is leading to bacterial pollution in Old Plantation Creek, and to measurable damage to the shellfish aquaculture industry
- Simple predictive modeling techniques can identify potential problems before major economic losses are realized
- Greater efforts at all levels of government will be necessary to address NPS pollution

Questions?

<http://www.vims.edu/library/Theses/Strickler07.pdf>

