

CHESAPEAKE BAY OYSTER METRICS TEAM REPORT



Oyster Metrics Team: *Context*

- Executive Order 13508: “Strategy for Protecting and Restoring the Chesapeake Bay Watershed”

Oyster Outcome:

Restore native oyster habitats and populations in 20 tributaries by 2025

- Goal was defined;

Team was convened by GIT to clarify goal and establish common metrics

Oyster Metrics Team: *Charge*

- Develop common Bay-wide restoration goals, success metrics and monitoring and assessment protocols for the purpose of tracking toward the EO strategy outcome (reef-level and tributary-level)
- For sanctuary reefs only
- Minimum suite of metrics that should be measured across all sanctuary reefs
- Should in no way be seen as limiting additional monitoring and research activity.
- As always: adaptive.



Oyster Metrics Team: *Charge*

- Membership:
 - NOAA (Stephanie Westby)
 - U.S. Army Corps of Engineers (Angie Sowers)
 - Maryland Depart. Natural Resources DNR (Eric Weissberger)
 - Virginia Marine Resources Commission MRC (Jim Wesson)
 - Potomac River Fisheries Commission (AC Carpenter)
 - Virginia Institute Marine Science (Mark Luckenbach)
 - University of Maryland MCES (Ken Paynter)
- Consulting scientists
- **Science-driven consensus process
among the primary governmental agencies
involved in oyster restoration in the Bay**

Oyster Metrics Team: Approach

What constitutes a restored reef?

How many oysters?

What size oysters?

How many year classes?

How long must it persist?

How much of the bar must be covered in oysters?



Oyster Metrics Team: Approach

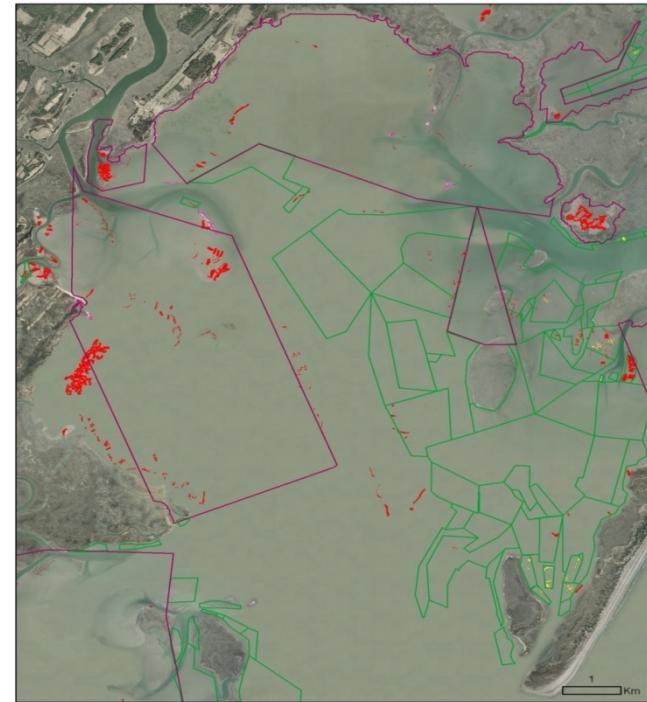
What constitutes a restored tributary?

Contains a restored reef or two?

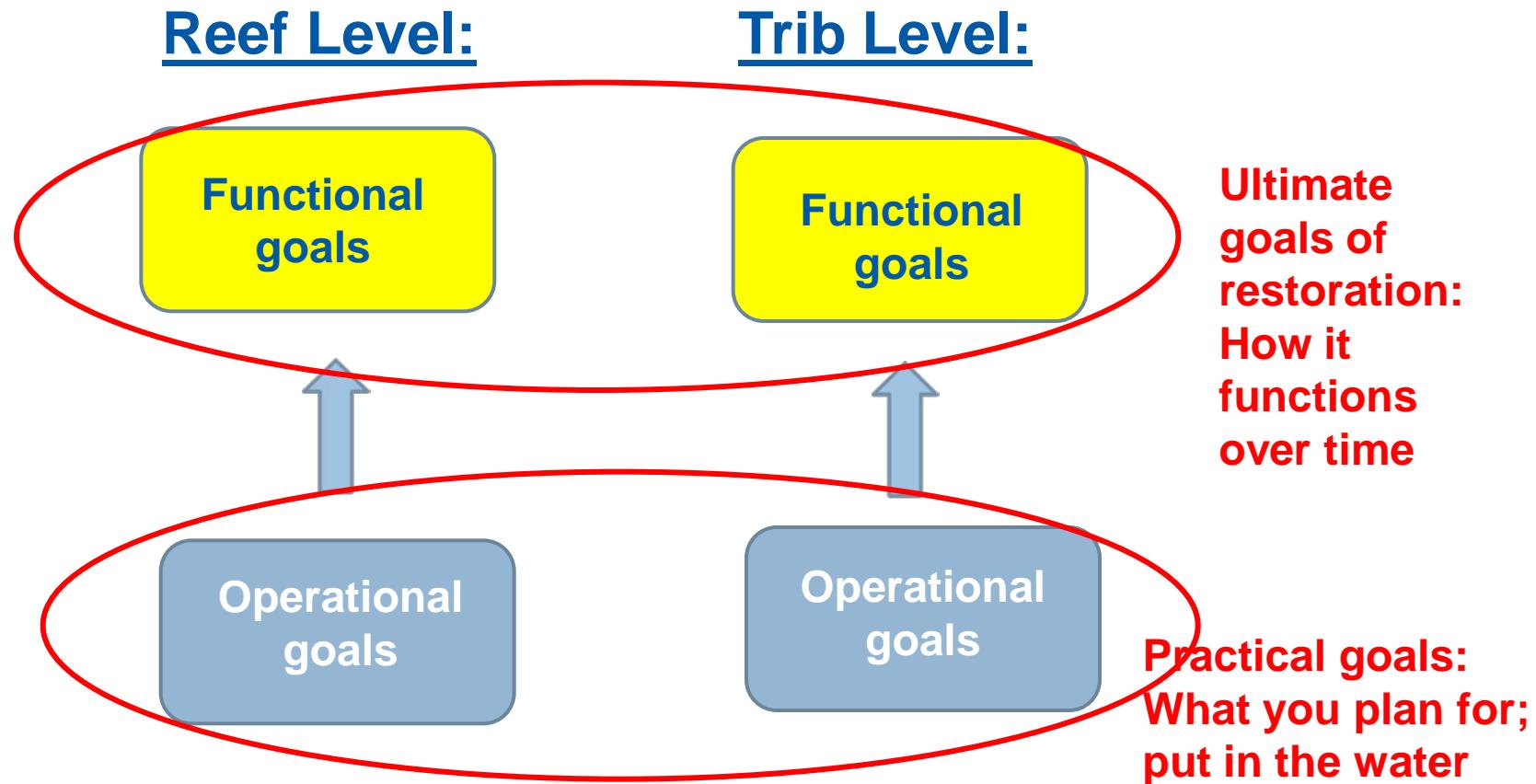
A given percentage of historical oyster bars has been restored?

We've done all we can do?

Or, does it mean that we have actually affected a state change, and that oyster populations have been restored to historical abundances in that tributary?



Oyster Metrics Team: Approach



Goal: Restore native oyster habitats and populations in 20 tributaries by 2025

Oyster Metrics Team: *Goals & Metrics*

Reef Level:

- Stable or increasing spatial extent, reef height and shell budget
- Oyster density:
 - Target: Mean density of 50 oysters/m² and 50 grams dry weight /m² containing at least two year classes covering at least 30% of the reef area
 - Minimum Threshold: Mean density of 15 oysters/m² and 15 grams dry weight /m² containing at least two year classes covering at least 30% of the reef area

Oyster Metrics Team: *Goals & Metrics*

Trib Level:

- Restore, to the reef-level goals, 50 -100% of currently restorable oyster habitat.
 - Recommend that this be pursued in tributaries for which currently restorable bottom minimally meets the ACOE targets related to the percent of historical bottom (min. of 8% of Yates/ Baylor ground)
 - Trib size: recommend TNC 'creek' and 'small tributary' size classifications.
(Recommendation- not a goal)

Findings of the 2011 Chesapeake Bay Stock Assessment Committee (CBSAC)

Blue Crab Advisory Report

Lynn Fegley
Maryland Department of Natural Resources.

For the Sustainable Fisheries Goal Implementation Team
December 19, 2011 Alexandria, Virginia

Presentation Outline:

- Who are the CBSAC?
- Background and 2011 Charge to CBSAC
- Findings of 2011 report:
 - Stock Status
 - Recommendations
- Next Steps

The CBSAC is coordinated by NCBO. Regional, federal, and agency scientists gather each year to review data, summarize population status and provide management advice.

Dr. Daniel Hennen	National Marine Fisheries Service
Dr. Amy Schueller	National Marine Fisheries Service
Derek Orner	NOAA Chesapeake Bay Office
Dr. Tom Miller	Chesapeake Biological Laboratory
Dr. John Hoenig	Virginia Institute of Marine Science
Dr. Eric Johnson	Virginia Institute of Marine Science
Dr. Rom Lipcius	North Florida University
Rob O'Reilly	Virginia Marine Resources Commission
Dr. Alexei Sharov	Maryland Department of Natural Resources
Lynn Fegley (Chair)	Maryland Department of Natural Resources

Benchmark Stock Assessment completed in 2011.

- Assessment generated new biological reference points for female crabs only.
- The assessment was favorably peer-reviewed by Center of Independent Expert (CIE) scientists in March 2011.
- In August, 2011 the Sustainable Fisheries GIT issued a formal charge to CBSAC based on the 2011 assessment.

2011 CBSAC Charge:

- Provide Guidance on Implementation of female-specific biological reference points developed within the 2011 assessment.
- Provide Guidance on methods for determining appropriate reference points for the male component of the population.
- Demonstrate how current reference points compare to the female-specific reference points developed within 2011 assessment.
- Prioritize research needs and science gaps – as identified in the 2011 assessment and Center for Independent Experts (CIE) review

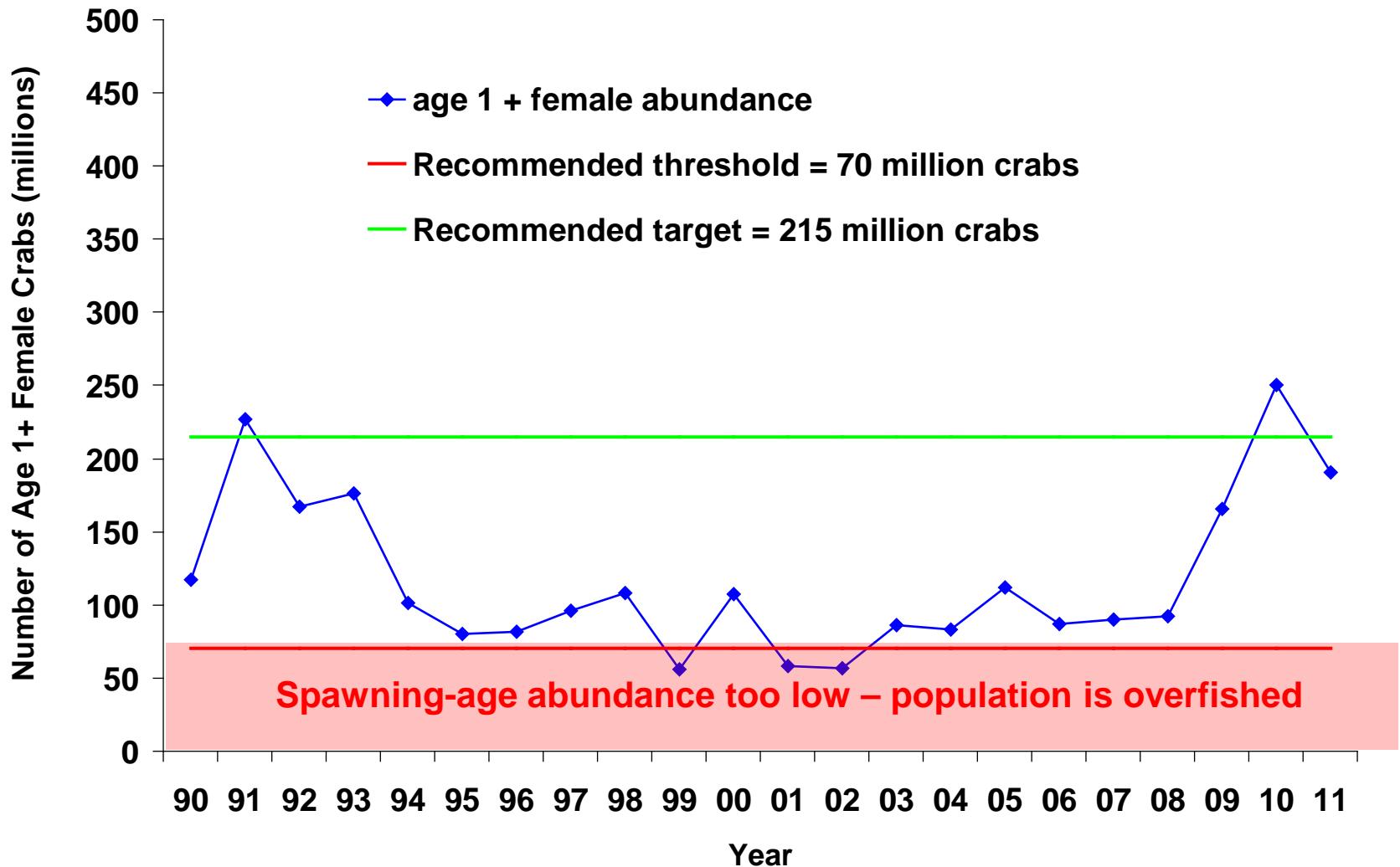
Findings of 2011 CBSAC Report

Comparison of Reference Points and Stock Status
(charge 3)

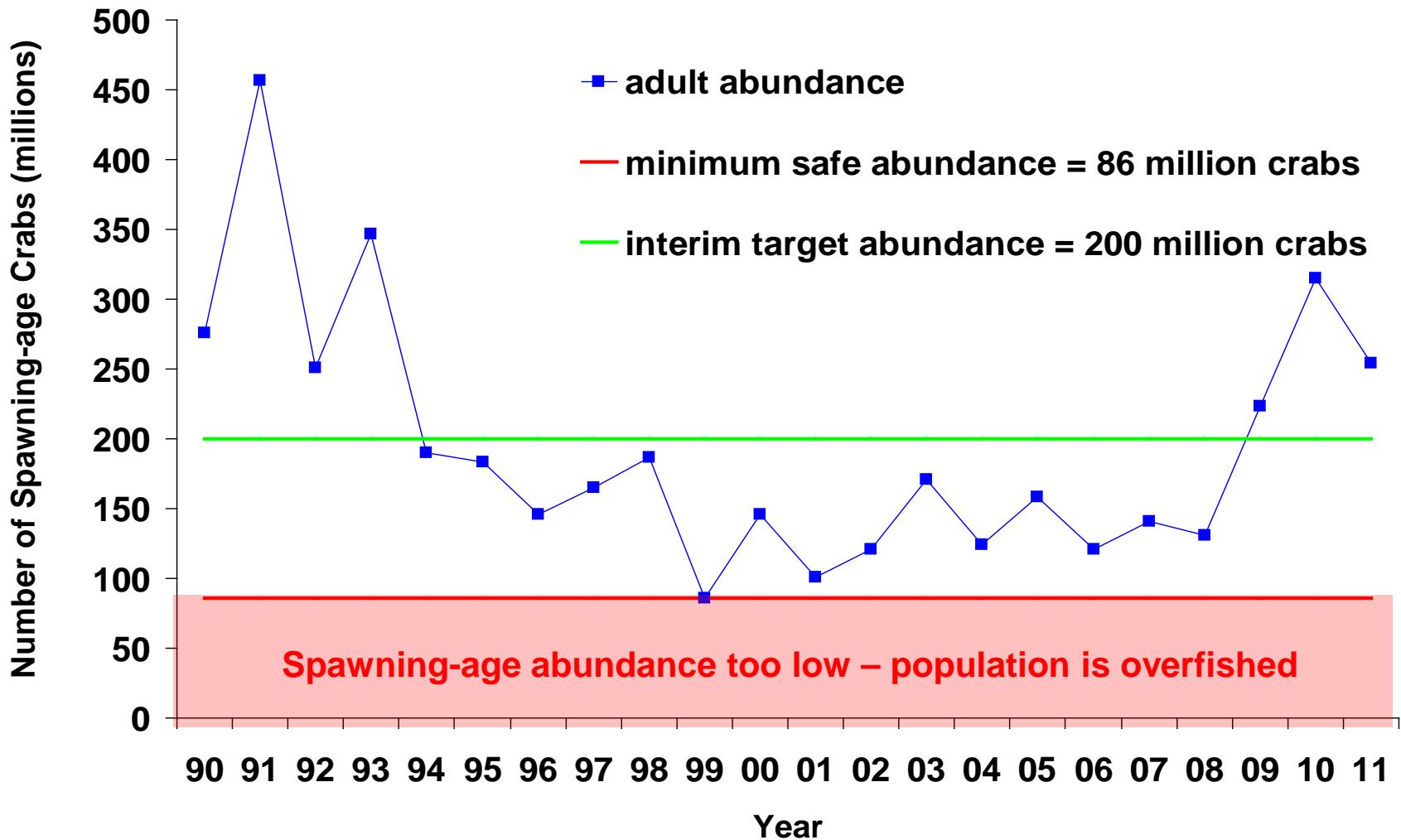
Current (sex-combined) and female-specific reference points.

		Target	Threshold	2010 Stock Status	2011 Stock Status
Exploitation Fraction	Sex-combined	46%	53%	39%	To be determined
	Female specific	25.5%	34%	18%	To be determined
Abundance (millions of crabs)	Sex – combined	200	86	315	254
	Female specific	215	70	251	190

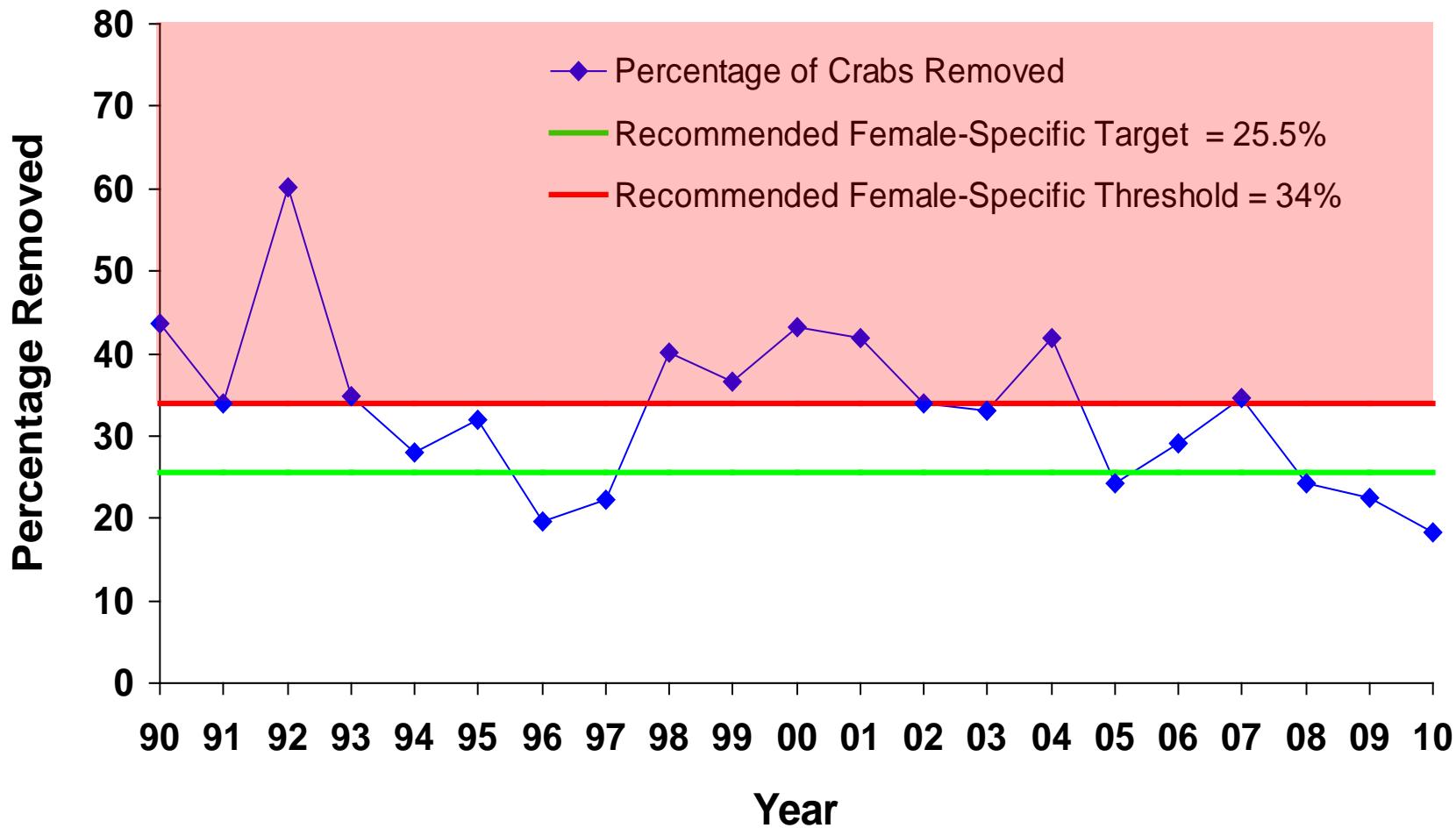
Abundance of Age one-plus female crabs relative to the new, female-specific reference points.



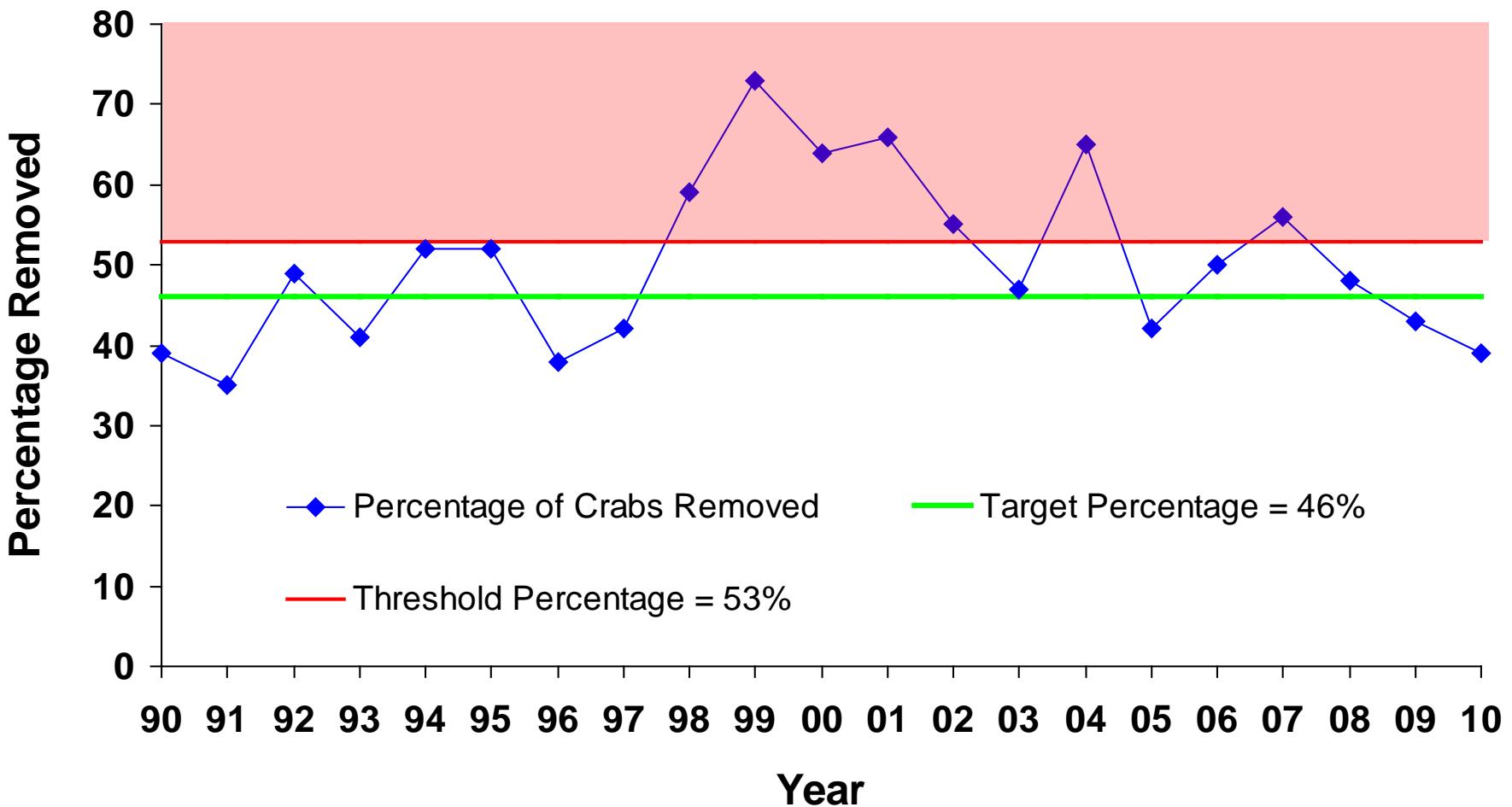
Abundance of Age one-plus male and female crabs relative to the sex-combined reference points.



Annual exploitation fraction (percentage of crabs removed from the population) on female crabs relative to the new, female-specific reference points.



Annual exploitation fraction (percentage of crabs removed from the population) on male and female crabs relative to the sex-combined reference points.



Recommendations

- For Each Charge to CBSAC
- Short Term Management Advice
- Long Term Management Advice

Charge 1:

Provide Guidance on implementation of female-specific reference points developed within 2011 assessment.

CBSAC Recommends:

- Adoption of female-specific reference points.
- Placement of primary focus on female-specific target and threshold exploitation fraction.
- Update benchmark assessment every 4-6 years.
- Closely monitor 2011 harvest and 2012 dredge survey results before adjusting management measures.

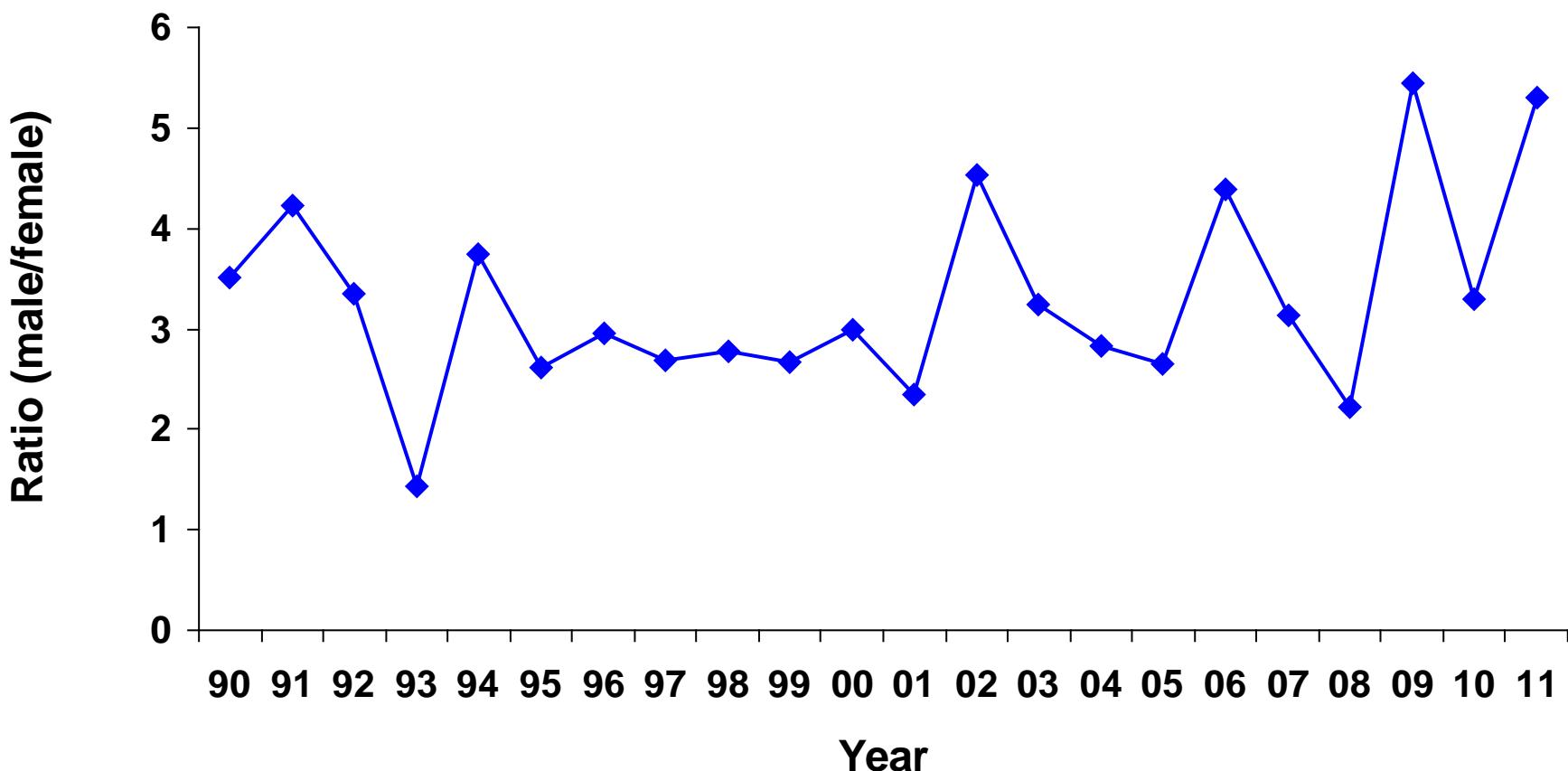
Charge 2:

Provide guidance on development of appropriate reference point for male blue crabs.

CBSAC Recommends:

- Develop threshold reference points for male crabs that provide trigger for male conservation.
- Hold workshop to examine key issues to determining male reference points:
 - gear efficiency and selectivity
 - reproductive biology
 - over winter mortality
- Monitor ratio of male crabs > 60mm to the number of immature female crabs > 60 mm cw.
- Maintain current male conservation measures such as size limits.

An ‘operational’ sex ratio based on abundance estimates from the Winter Dredge Survey. The ratio is the density reproductive males (greater than 60 mm across the carapace) divided by the density of female crabs which would actively be seeking mates (immature female crabs greater than 60 mm across the carapace).



Charge 4: Prioritize Research needs and science gaps.

CBSAC's Top Three:

- Fishery Independent surveys Bay-wide to characterize sex, size and life-stage composition of harvest.
- A recreational survey to provide robust estimate of recreational harvest.
- The continuation of the Winter Dredge Survey “*must be a priority*”.

Charge 4: Prioritize Research needs and science gaps.

Additional CBSAC recommendations:

- Analysis of existing reported effort data to quantify spatial and temporal patterns in CPUE for specific gears and fishery sectors.
- Design a shallow-water complement to the winter dredge survey to estimate the fraction of crabs that are not vulnerable to the winter dredge survey due to their shallow water residence. Pilot studies are ongoing.
- Develop estimates of sex-specific natural mortality rates (research based).
- Investigate variations in fecundity based on season and size (ongoing).
- Determine threshold sex ratio when sperm limitation becomes a problem (research - ongoing).

CBSAC Management Advice

Short Term

- Monitor fishery performance and stock status relative to recommended reference points before adjusting regulations.
- Implement procedures that allow accurate accountability of all commercial and recreational catches.
- Consider methods for more precisely calculating recreational catch and effort, possibly through licensing systems.
- Continue efforts to address latent effort.
- Consider implementing pot tagging programs to improve monitoring of effort.

CBSAC Management Advice Long Term

The CBSAC recommends that jurisdictions evaluate the benefits of quota-based systems. Allocating annual quotas to each jurisdiction would improve performance of a Bay-wide quota and lead to jurisdictional accountability of harvest relative to the Bay-wide exploitation target.

Next Steps:

- Goal Implementation Team Executive Team endorsed the adoption of female-specific reference points.
- Jurisdictions are moving ahead to implement the new framework.

Evaluating Ecosystem Impacts of and Management Strategies for Blue Catfish Populations in the Chesapeake Bay



Andrew Turner¹,
Mejs Hasan²,
Howard Townsend²

¹University of Maryland Eastern Shore,
Princess Anne, Maryland;

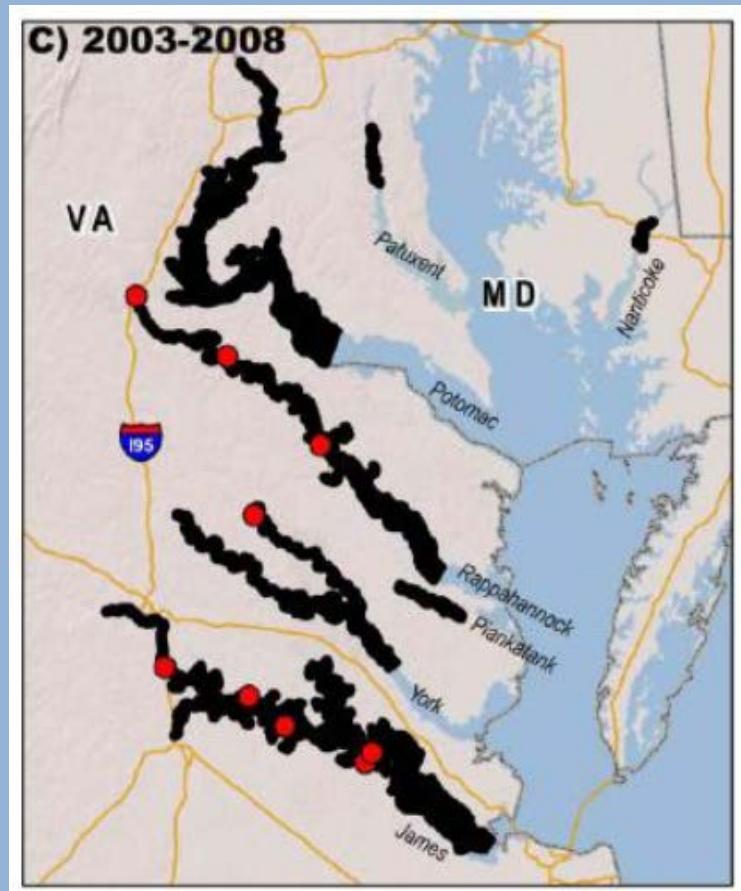
² NOAA Chesapeake Bay Office –
Cooperative Oxford Laboratory, Oxford,
Maryland



Issue

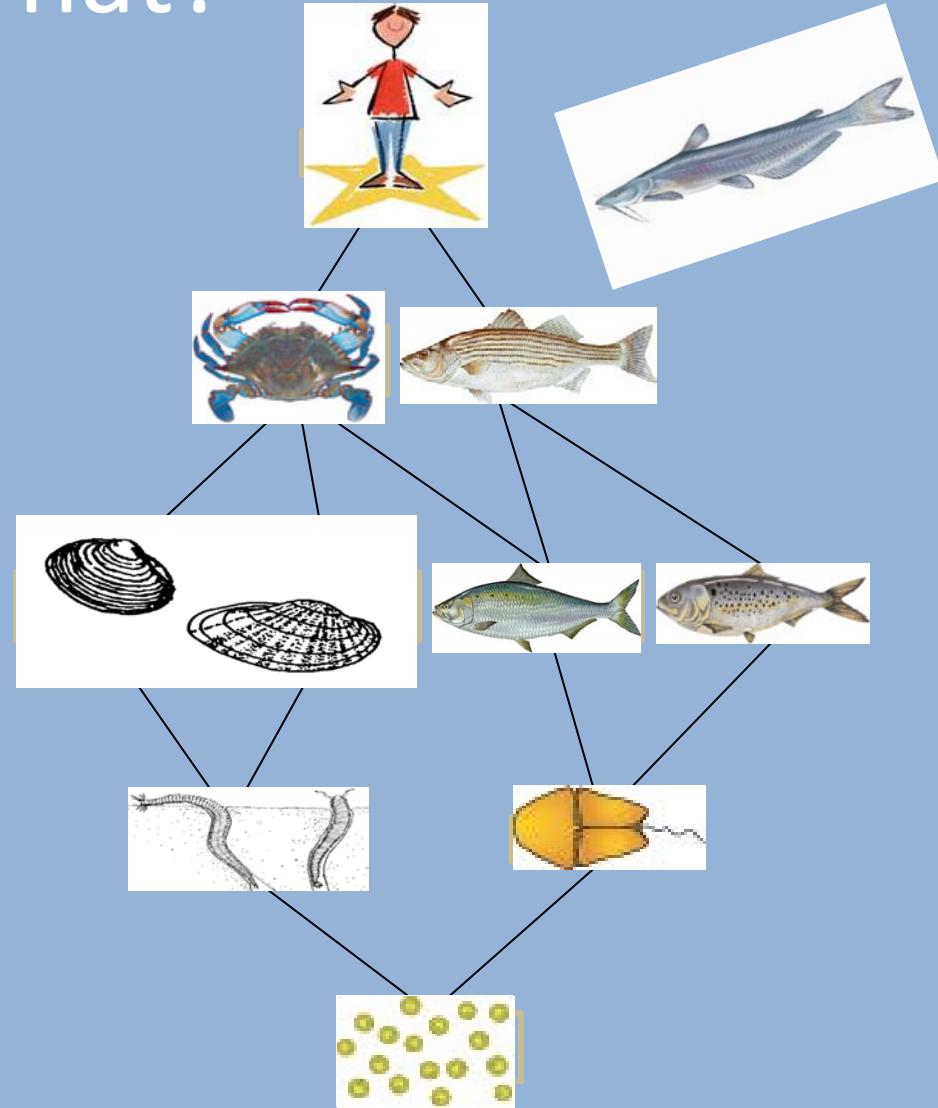
Introduced blue catfish populations are potentially having a negative impact on key fish species of the Chesapeake

- Blue catfish populations are booming around the Chesapeake.
- BCF are likely competing with and preying on key species (striped bass, blue crabs, alosines, etc.).
- Although blue catfish may be having impacts in higher salinity waters, they are also valuable game species in low salinity waters.
- BCF have not been a well-studied and regularly monitored species.



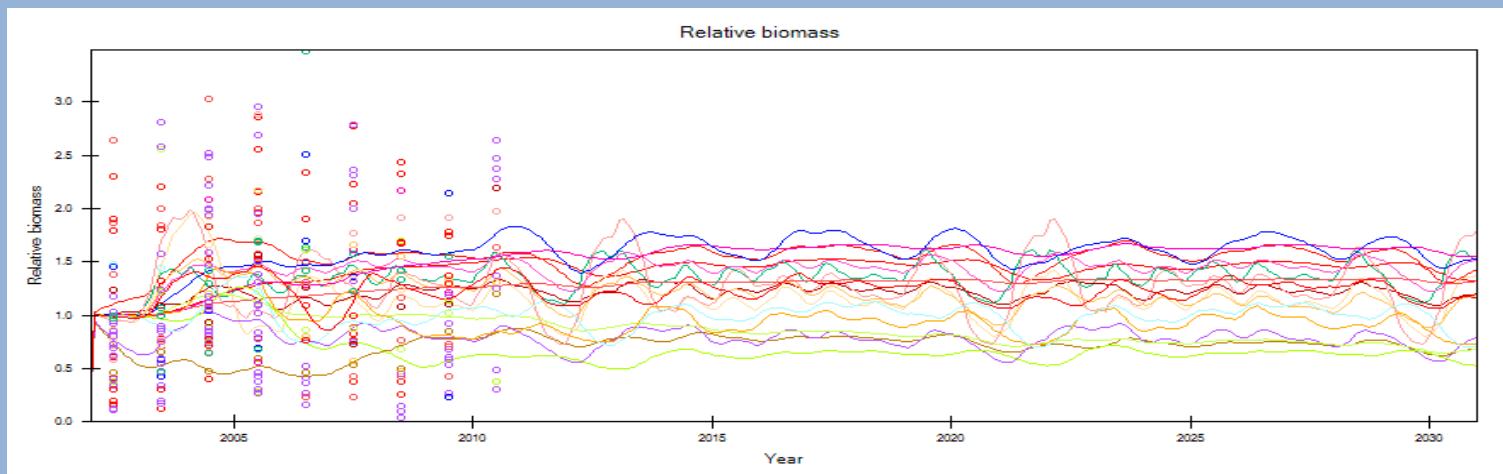
So What?

- If no action is taken to regulate the BCF, then highly valuable Chesapeake Bay fish species may be reduced and restoration efforts may be thwarted.
- Not sure if any typical fisheries management controls could be implemented to help regulate the BCF population
- Can and should other environmental controls be implemented?
- NOTE: Need to exercise caution in controls so that the freshwater fishery is maintained

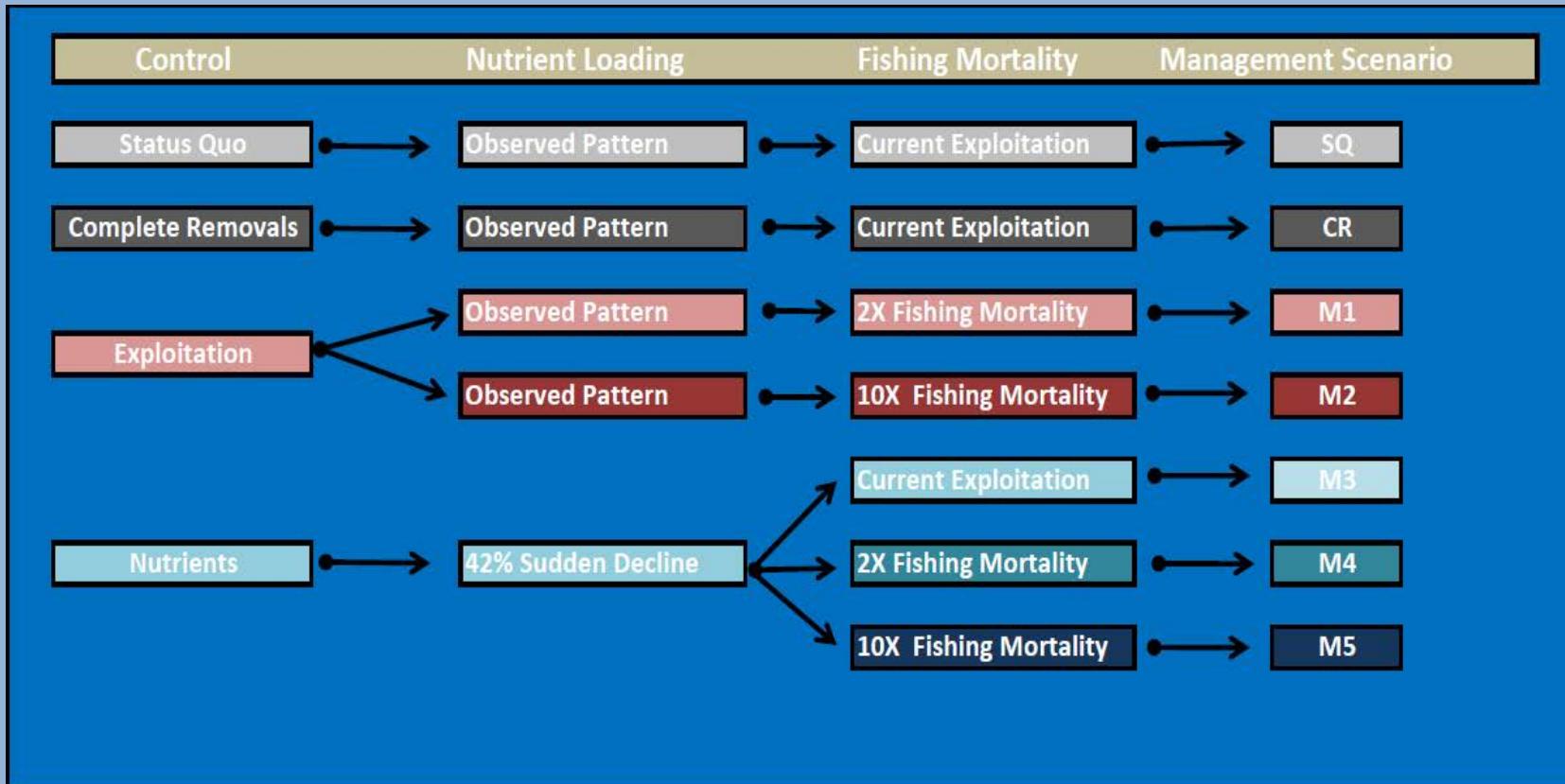


Moving towards solutions

- Applied fisheries ecosystem models (using EwE/) to generate quantitative estimates of the impacts of BCF on other species
- Ran management scenarios to understand how fisheries and water quality management can be used to regulate BCF.
- Used ecosystem model to guide research and monitoring directions.



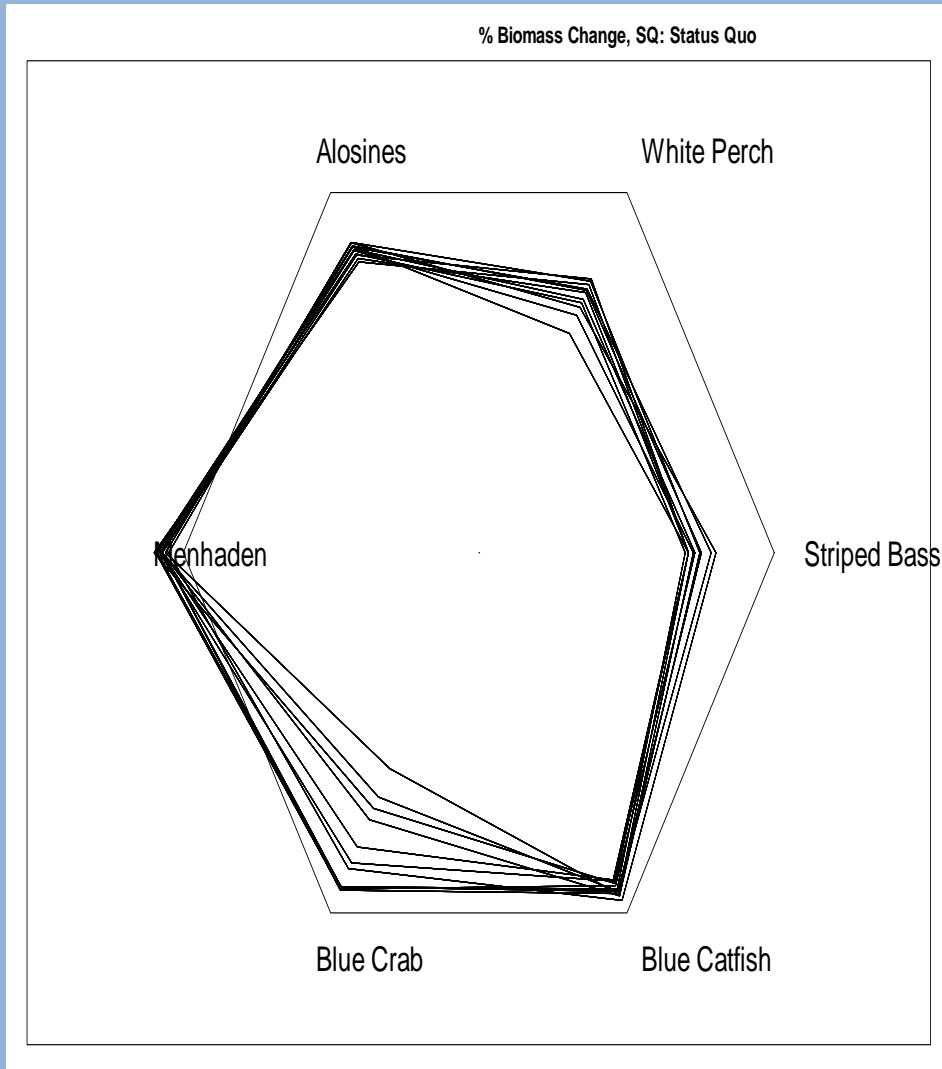
Results: Management Scenarios Evaluated



All scenarios above evaluated using the Fisheries Ecosystem Model complete with

- With 57 functional groups
- 20 year projection
- 100 Monte Carlo simulations varying blue catfish biomass estimates
- Generating over 18,000,000 modeled data points

Results: Identification of impacts



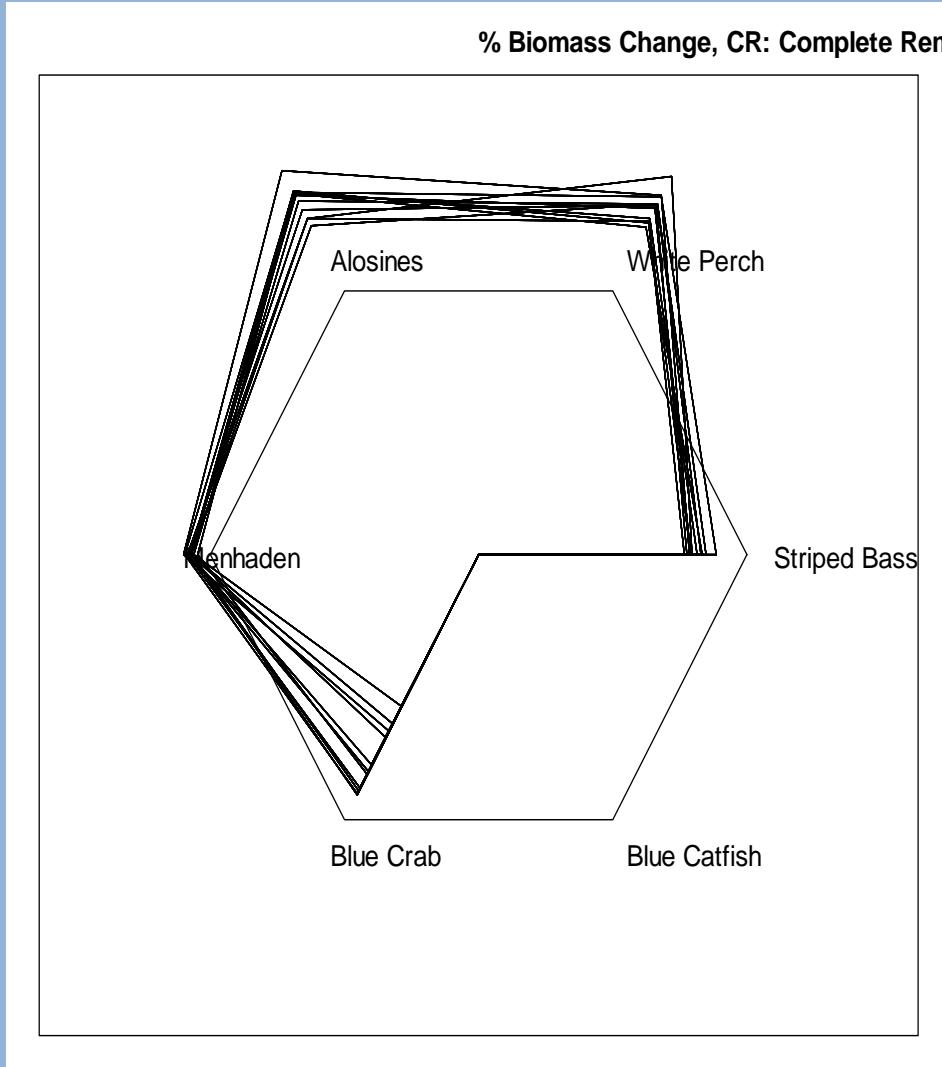
Baseline Scenario

- Hypothetically maintain status quo in current fishing regulations and effort
- 20-yr projection of changes in Biomass of key species

Baseline Major Impacts

- White Perch
- Alosines
- Blue Crabs
- Striped Bass
- Croaker

Results: Identification of impacts



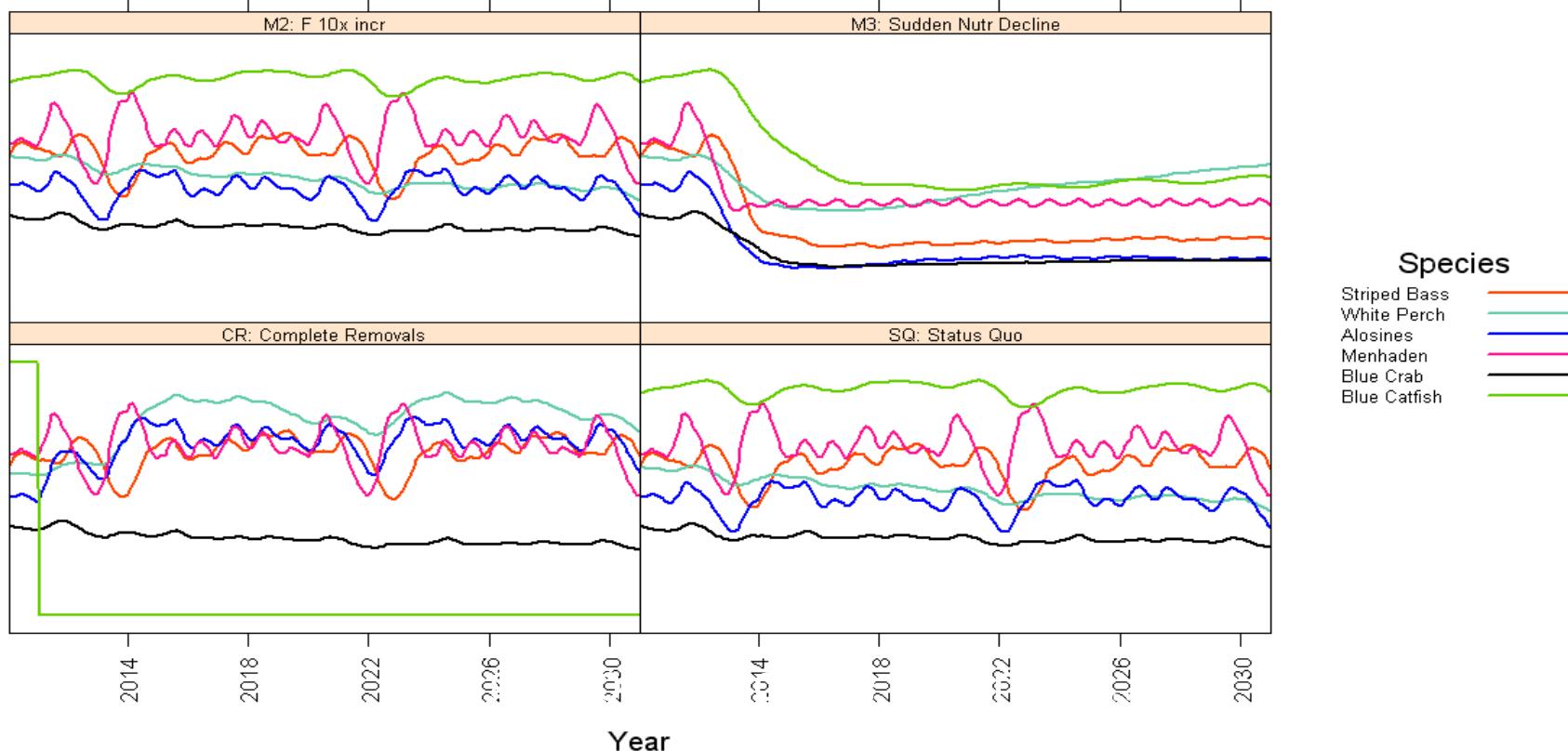
Eradication Scenario

- Hypothetical complete, instantaneous removal of blue fish,
- 20-yr projection of changes in Biomass of key species

Eradication Major Impacts

- White Perch
- Alosines
- Blue Crabs
- Striped Bass
- Croaker

Results



- Increasing exploitation rates had little affect on blue catfish populations.
- An overwhelming control of the system through different levels of nutrient inputs.

What we've learned: Management Implications

- Current inputs suggest commercially and recreationally important species of the Chesapeake are being effected by blue catfish.

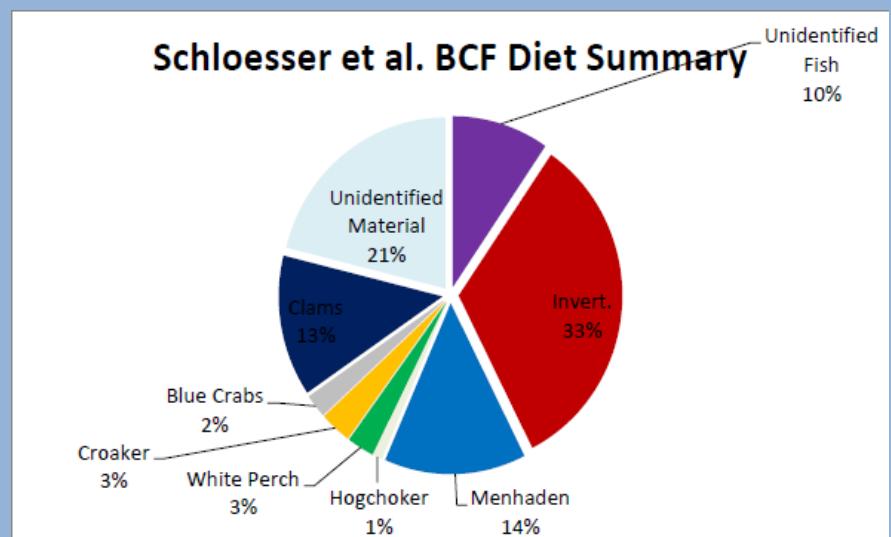
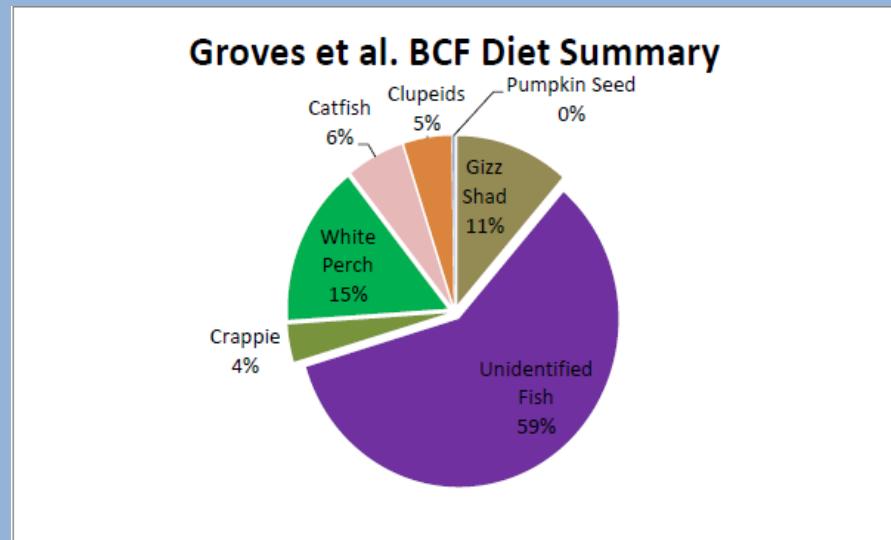


- Increased levels (10X current) of fishing on BCF has less impact on BCF than does decreased nutrient loads

What we've learned: Research and Monitoring Implications

Need research to improve estimates of:

- BCF diet composition – understand what is the unidentified component and spatial variability in diet
- Biomass – bay-wide and trib
- Population vital rates – Natural Mortality (M), Growth (λ), and Colonization (γ)
- Individual rates – Growth (Von Bertalanffy K)



Future Direction (Proposed)



Near Term...

An ecosystem based population viability analysis (EB PVA)

This analysis would provide...

- An estimate of the level of fishing mortality necessary to decrease the population to X% of current level and maintain it at that level
- An understanding of the effects of decreasing BCF by X% on other key stocks
- Possible motivation for further research and development of BCF fishery

Future Direction (Proposed)

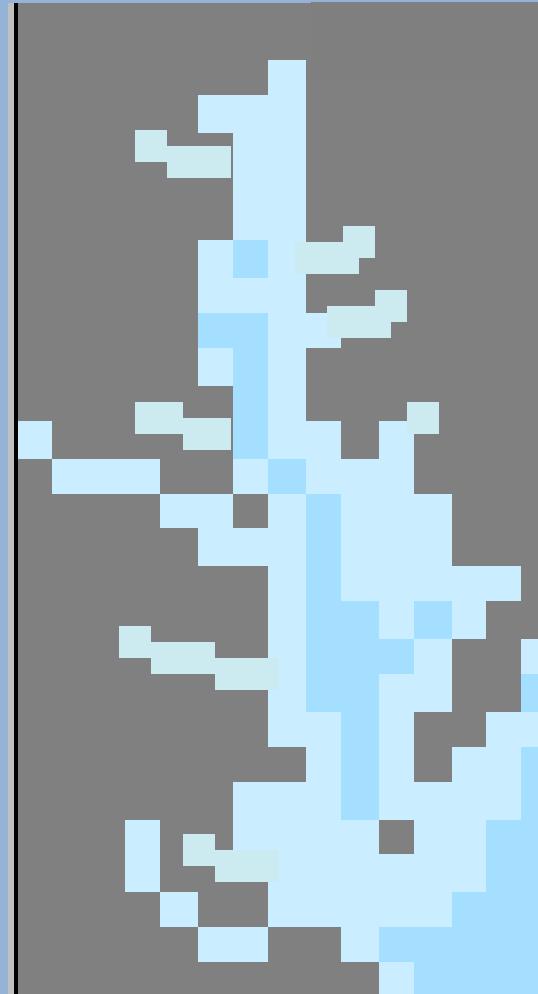


Longer Term...

Finer spatial scale evaluation of BCF in the Chesapeake Bay system. Model would be completed using the Ecospace option within EwE.

Ecospace model could provide...

- Spatially specific predator and prey interactions.
- Better understanding impacts of BCF impacts on anadromous species.
- Opportunity to include current research for more precise parameterization of the CBFEM.
- Recommendations on where tributary specific removal campaigns may be effectively applied.



Future Direction (Proposed)

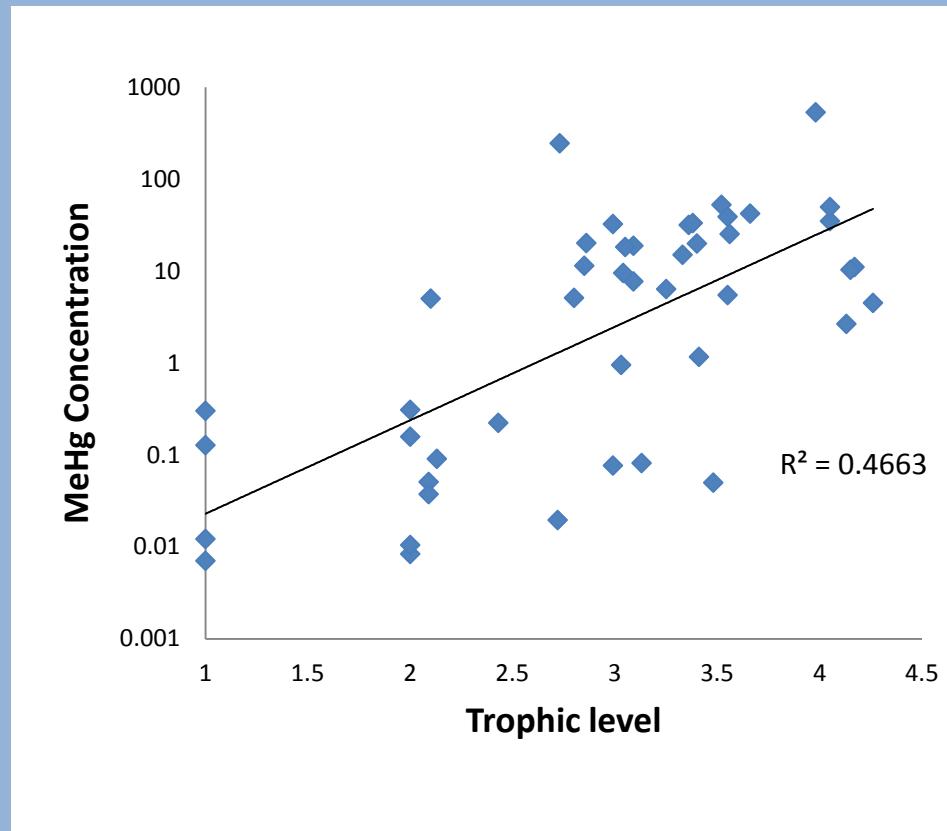


Longer Term...

Evaluation of ecotoxicological of changes in the BCF fishery. Model would be completed using the Ecotrace option within EwE.

Ecotrace model could provide...

- Understanding of how persistent pollutants (e.g., PCBs, Mercury) are biomagnified in BCF
- Quantitative estimates of contaminant loads in BCF under different management scenarios
- Recommendation on how to use harvested BCF



Acknowledgments

Special thanks to the following their help and support.

- Derek Orner of the NOAA Chesapeake Bay Office
- Dr. Mary Fabrizio of the Virginia Institute for Marine Science (VIMS)
- Dr. Greg Garman of Virginia Commonwealth University
- Bob Greenlee of the Virginia Department of Game and Inland Fisheries
- Mary Groves of Maryland Department of Natural Resources
- Ryan Schloesser of VIMS
- Dr. Troy Tuckey of VIMS
- Joe Cimino of the Virginia Marine Resource Commission (VMRC)
- Joe Grist of VMRC



Next Set of Fisheries GIT Priorities

- Oyster Sustainability Charge
- Blue Crab Ecological Reference Points
- Next Generation of Chesapeake Bay Management
- Other Species of Interest?
- Other Ideas?

Oyster Sustainability Charge

Goal

- Goal: Restore native oyster habitat and populations in 20 tributaries out of 35 to 40 candidate tributaries by 2025.

Reasoning

- Need to understand the scientific consensus regarding the sustainability of the Bay's wild oyster fishery as currently managed
 - Consider outcomes of increasing or reducing fishing pressure

Recommendations

- Convene a 'team' of scientists to advise on complex technical issues and develop scientific consensus statement(s) describing (but not limited to):
 - The sustainability of the Chesapeake's wild oyster stock, and
 - What amount of reduction in fishing mortality, if any, is needed to allow the Chesapeake's oyster population to increase?

Blue Crab Ecological Reference Points

Goal

- Maintain a sustainable population and harvest of Blue Crabs within the Chesapeake bay

CBSAC Recommendations

- New biological reference points for female crabs
 - Provide guidance on their implementation
 - Compare to previous reference points
- Prioritize research needs and science gaps

Next Steps

- What do you think needs to be done in order to better manage this species?

Next Generation of Chesapeake Bay Fisheries Management

Goals

- FEP completed in 2006 as a guide for managers to support the coordination of EBFM.
- Review and restructure the implementation of the Fisheries Ecosystem Plan.

Where are we now?

- From the original 88 recommendations in the FEP what actions have been taken?
- What progress has been made?

Where should we go from here?

- Identify the next steps towards interjurisdictional multispecies management.
- How can the existing plan support an alternative, and realistic ecosystem based approach?
- How will our fleet of ecosystem models support this?

What's ahead for the SFGIT?

Menhaden

- ASMFC passed 37% reduction in landings, what's next?

Alosines

- Stock status, evaluation of restoration efforts shad and river herring.

Clams: soft and hard-shell

- Population changes, disease, ecosystem dynamics.

Striped Bass

- Banner YOY report, what does this mean for Chesapeake Bay?

Blue Catfish

- Invasive catfish policy statement.
- 6 newly funded research project to fill critical knowledge gaps and understanding impacts of the invasive catfish.

Cownose Rays

- What do we do about their impacts on native oyster restoration?



Chesapeake Bay Program
A Watershed Partnership

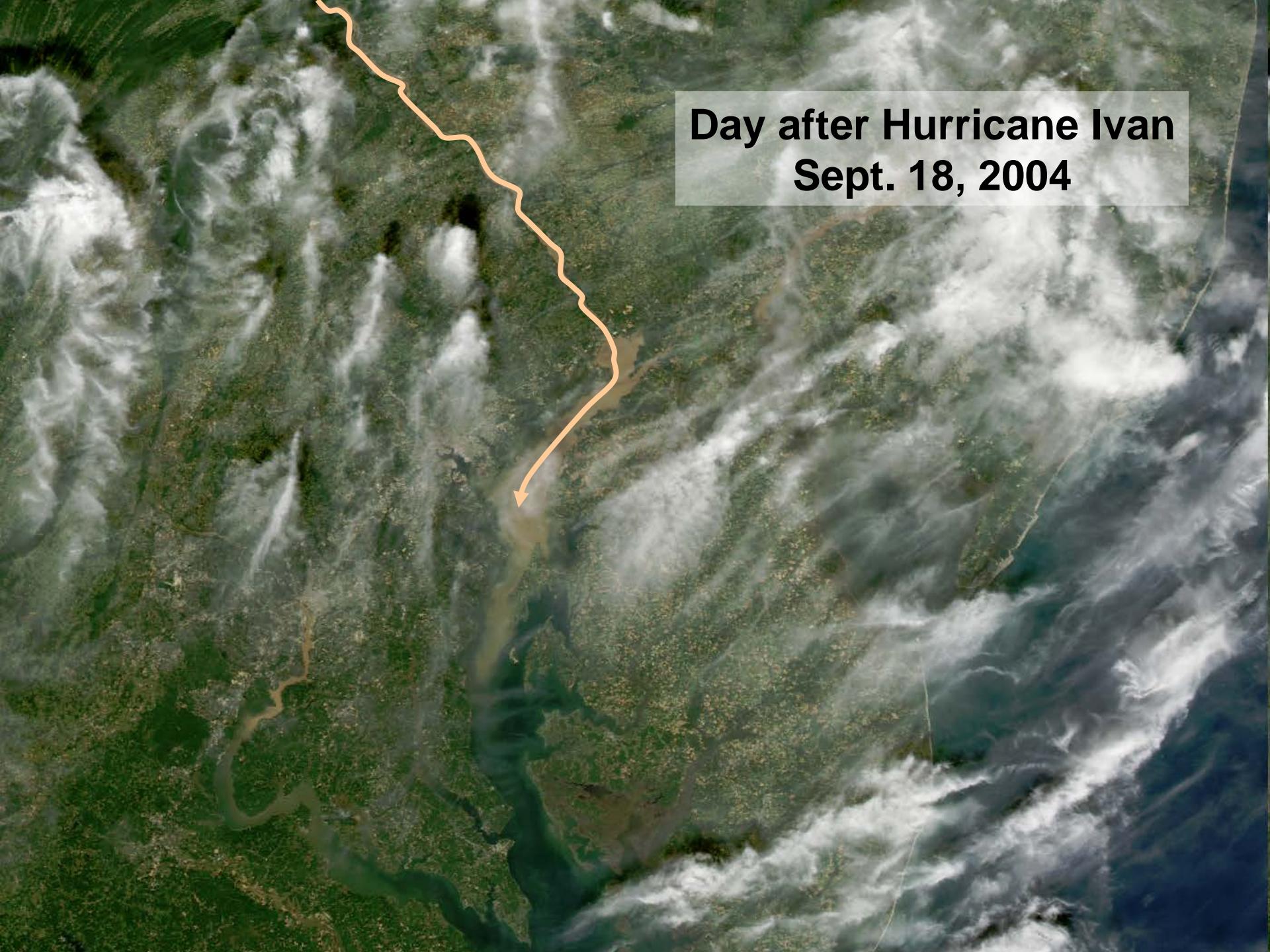
Population Growth, Impervious Surface, and Nutrient Pollution

Peter R. Claggett

Research Geographer, USGS
Chesapeake Bay Program

Sustainable Fisheries GIT Meeting

December 20, 2011

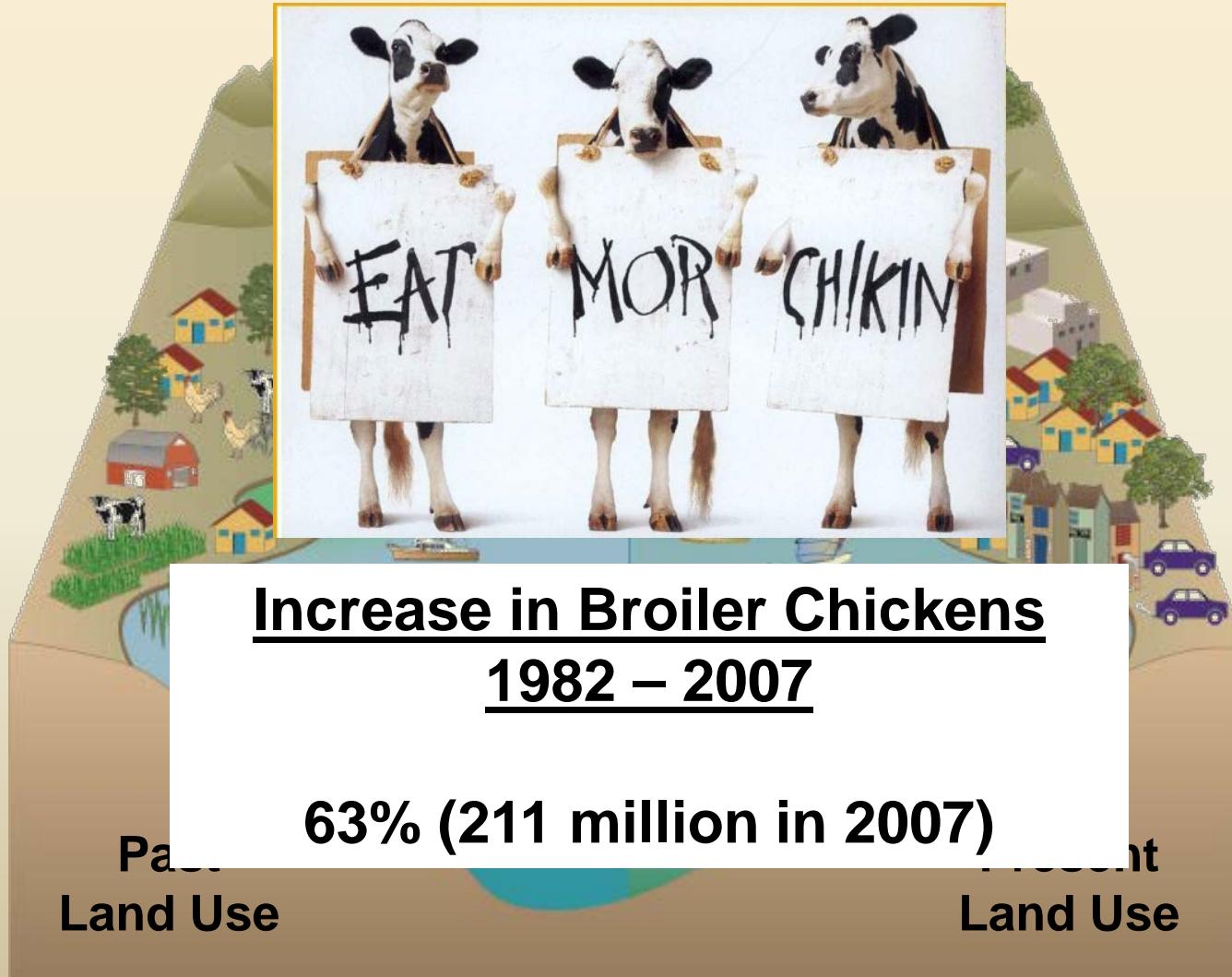
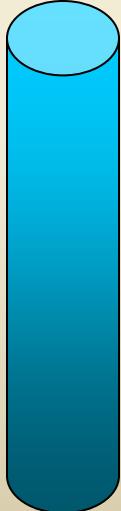


Day after Hurricane Ivan
Sept. 18, 2004

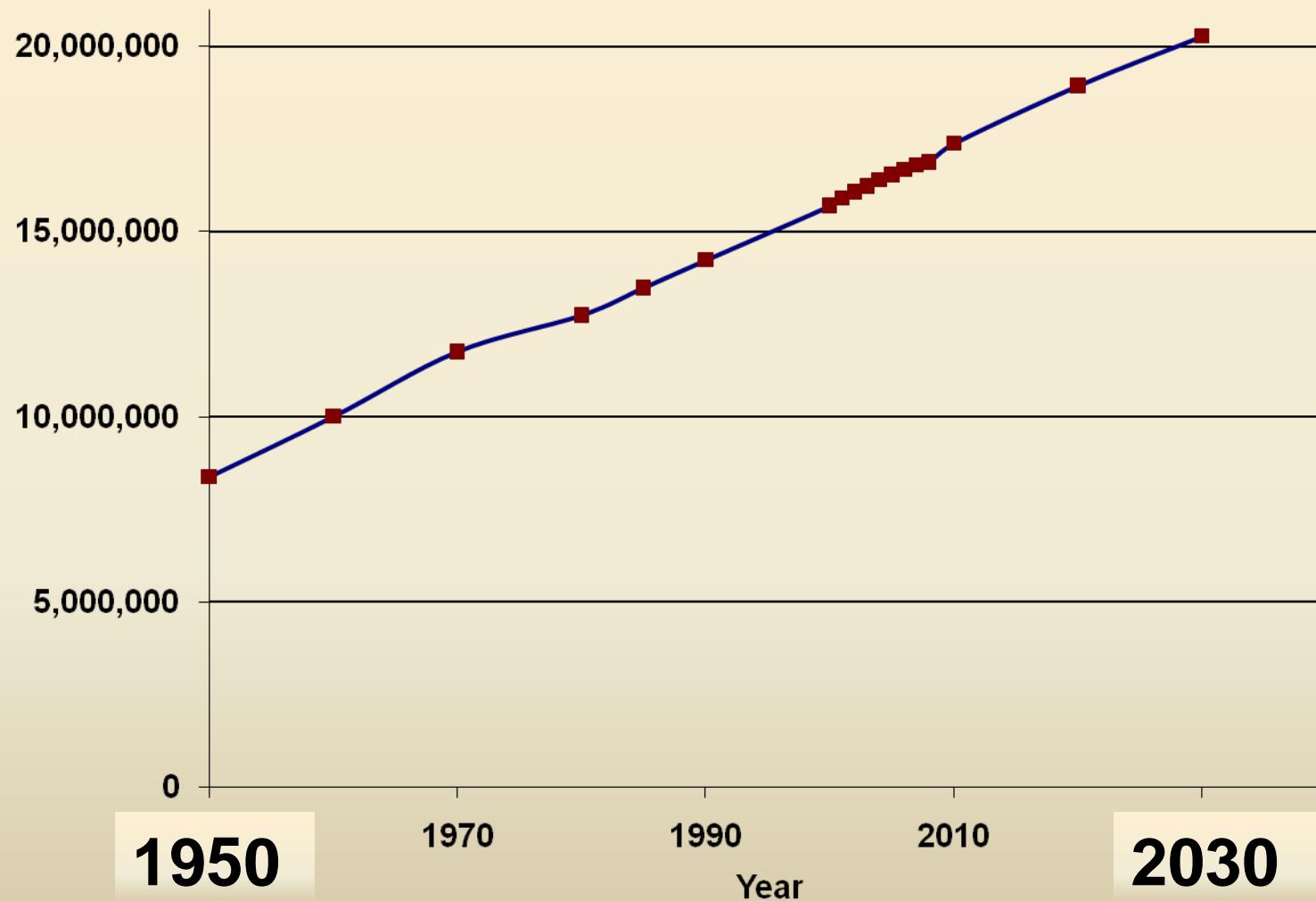
Land Change in the Chesapeake Bay Watershed

- population growth and urbanization
- agricultural intensification and regionalization
- rotational clearing of forests

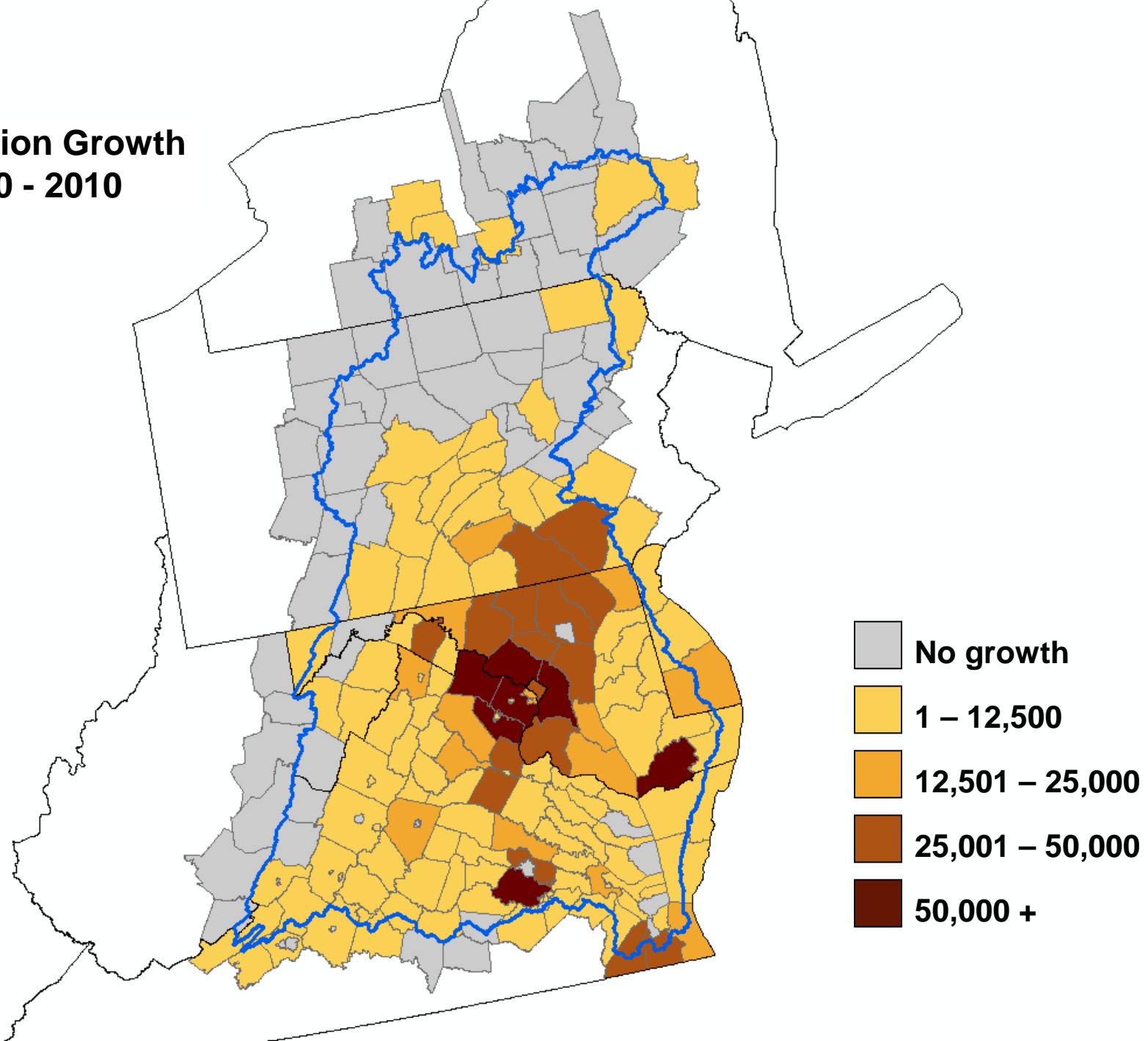
Past
Water
Quality



Bay Watershed Population Trends (1950 – 2030)



Population Growth 2000 - 2010



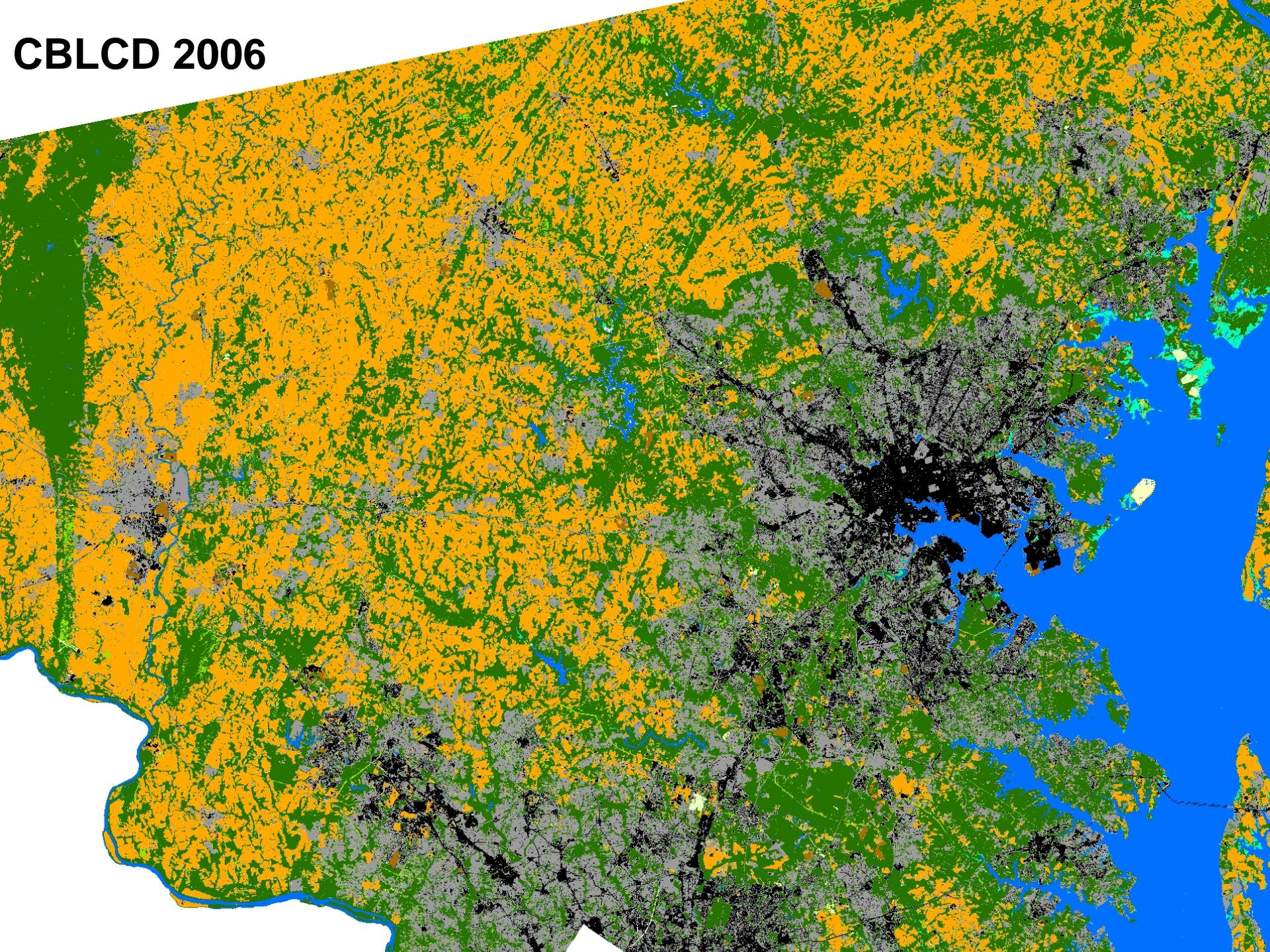
Bay Watershed Land Use Stats

From 1985 to 2005:

- developed lands increased 25% (960,000 acres);
- farmlands decreased 8% (856,000 acres);
- other lands decreased less than 0.5% (104,000 acres)

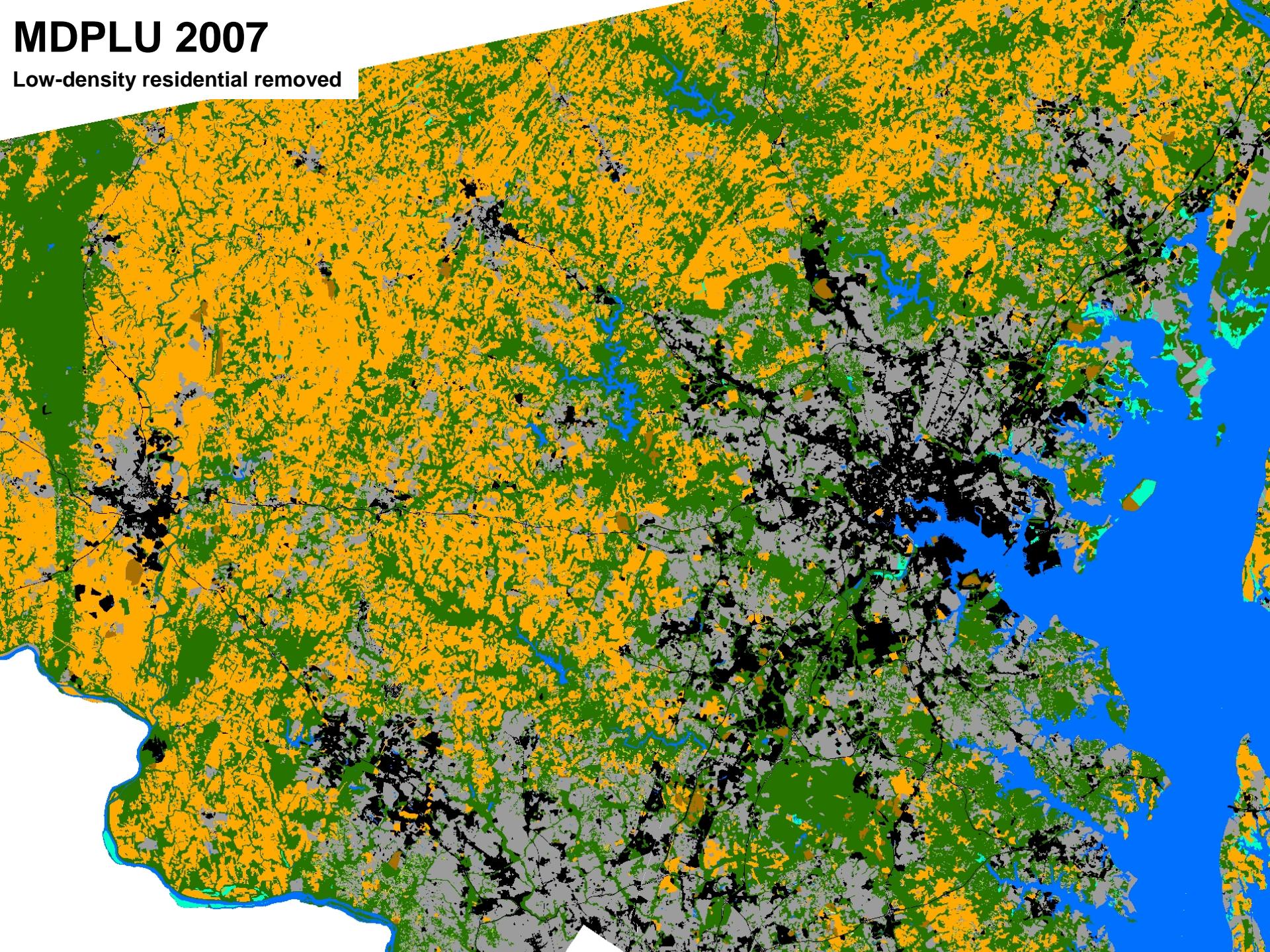
USDA Forest Inventory and Analysis data reveal that forests in the Bay watershed are declining at a rate of up to 100 acres per day.

CBLCD 2006



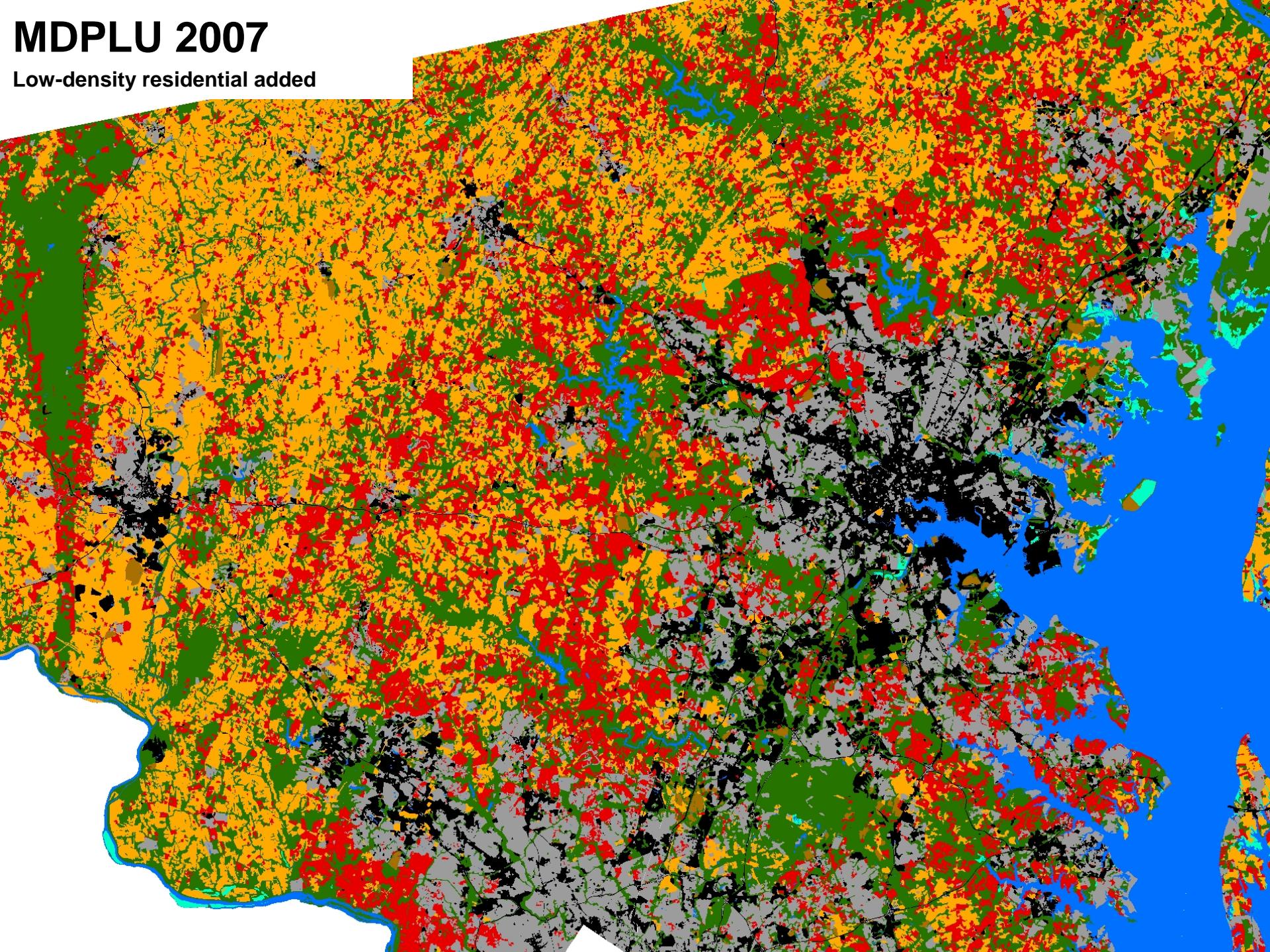
MDPLU 2007

Low-density residential removed



MDPLU 2007

Low-density residential added



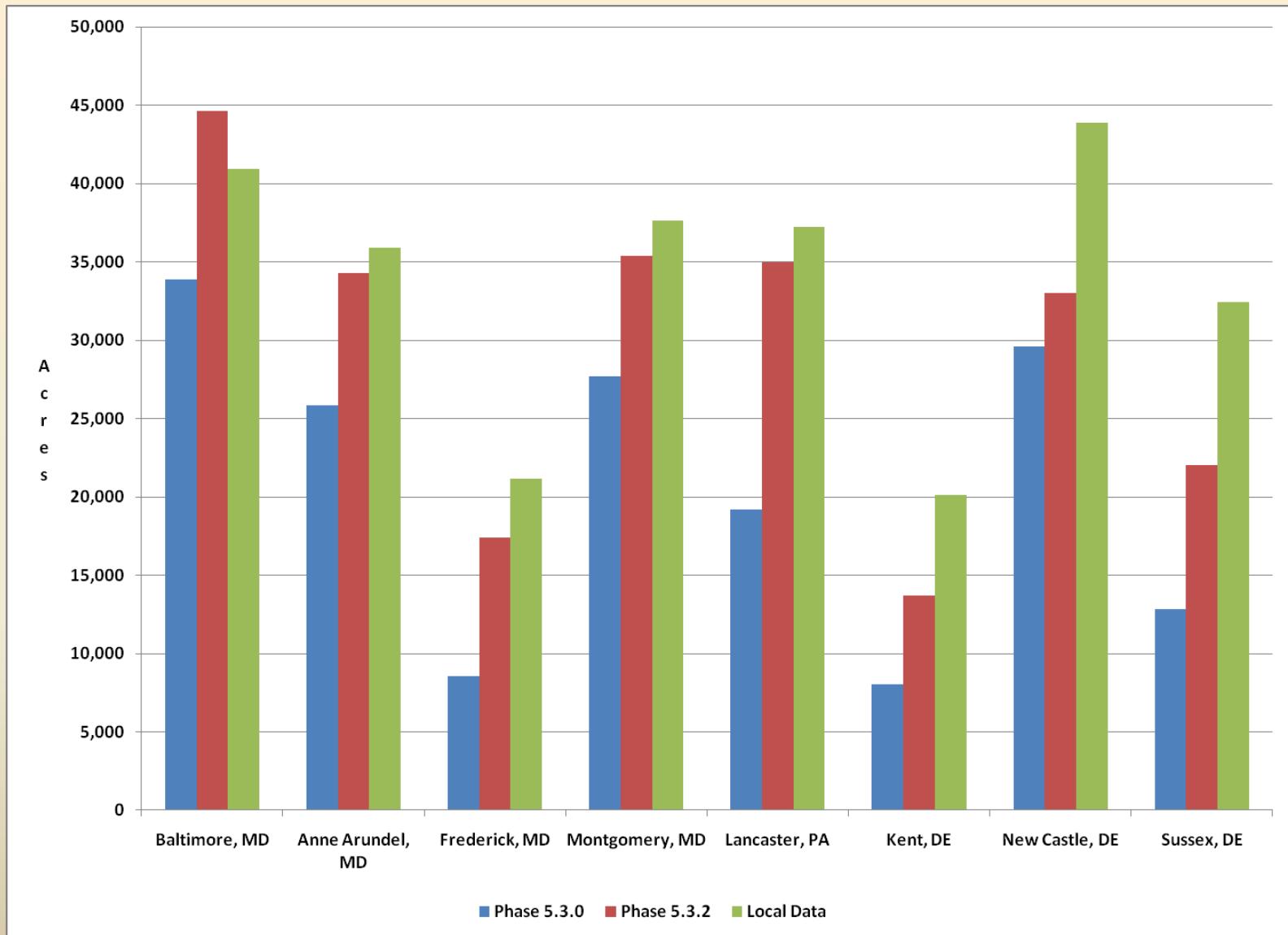
Estimating Impervious Surface Area (Landsat vs. Modeled Data)

Model Version	Impervious Surface (circa 2006)	Pervious Surface (circa 2006)
CBLCD (similar to NLCD)	809,311	2,341,555
Modeled with multiple datasets	1,269,018	3,398,701

2005 Turf Grass Estimate (Turf Industry Data apportioned to watershed) = 3,790,000 ac

County-level Impervious Surface Estimates

Landsat (Phase 5.3.0), Modeled (Phase 5.3.2), and Local Data



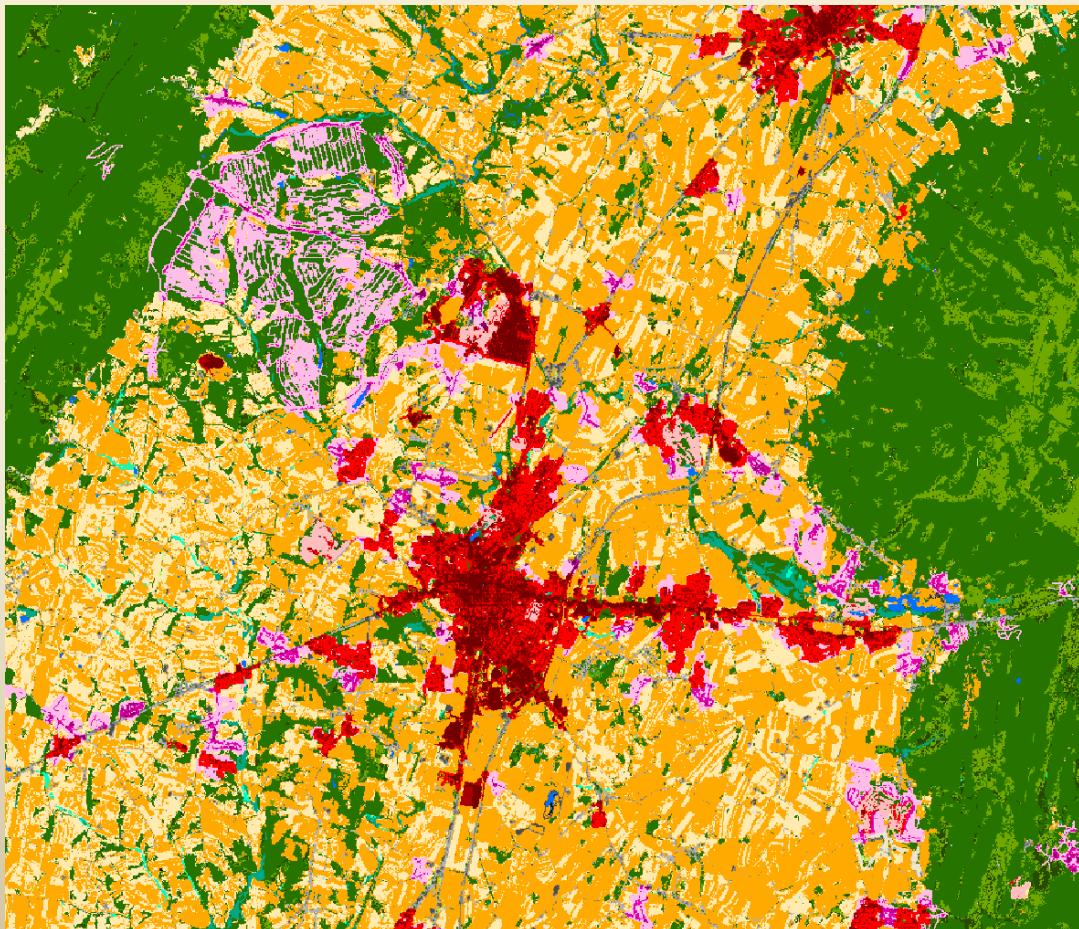
Capturing low density residential development improved accuracy of agricultural classes

P530 2006 Farmland Acres in Maryland = 2,116,531 acres

P532 2006 Farmland Acres in Maryland = 1,639,198 acres

USDA 2007 Ag Census = 1,558,546 acres

P 5.3.0



Chambersburg, PA

P532 Turf Grass Acres in Maryland = **973,510 acres**
NASS Estimate = **1,134,000 acres**

Why the difference?

1. P532 does not capture turf grass associated road right-of-ways, and isolated commercial, industrial, and institutional establishments.
2. Turf Industry estimate is used to substantiate the economic importance of the industry. Therefore, it probably represents the upper bounds of the probable extent of turf grass.

Turfgrass areas used and maintained in Maryland, 2005					
Sector	Turf Acres	Percent of Turf Acres	New Turf Established	Cost of Establishing New Turf	Average Cost per Acre to Establish New Turf
	- acres -	- percent -	- acres -	- dollars -	- dollars -
Airports	5,000	0.4	----	----	
Cemeteries	4,200	0.4	130	361,000	2,777
Religious Facilities	9,400	0.8	250	581,000	2,324
Parks and Athletic Fields	21,800	1.9	320	3,275,000	10,234
Golf Courses	16,400	1.4	310	2,105,000	6,790
County Government	78,200	6.9	480	3,914,000	8,154
State Highways	9,000	0.8	650	1,570,000	2,415
Apartments	7,500	0.7	200	765,000	3,825
Lawn Care	1/		1/	1/	
Sod Farms	8,000	0.7	2/	2/	
Single Family Homes	936,900	82.6	28,190	73,112,000	2,594
Schools	38,400	3.4	360	3,481,000	9,669
Total	1,134,800		30,890	89,164,000	2,887

¹ Maryland Department of Natural Resources, 2006.
² USDA, National Agricultural Statistics Service, Maryland Field Office, 2006.

Turf Grass Area By County in the Bay Watershed

Legend

Bay_basin_albers

p532_counties

p532_counties.Turf_06

799 - 25,000

25,001 - 50,000

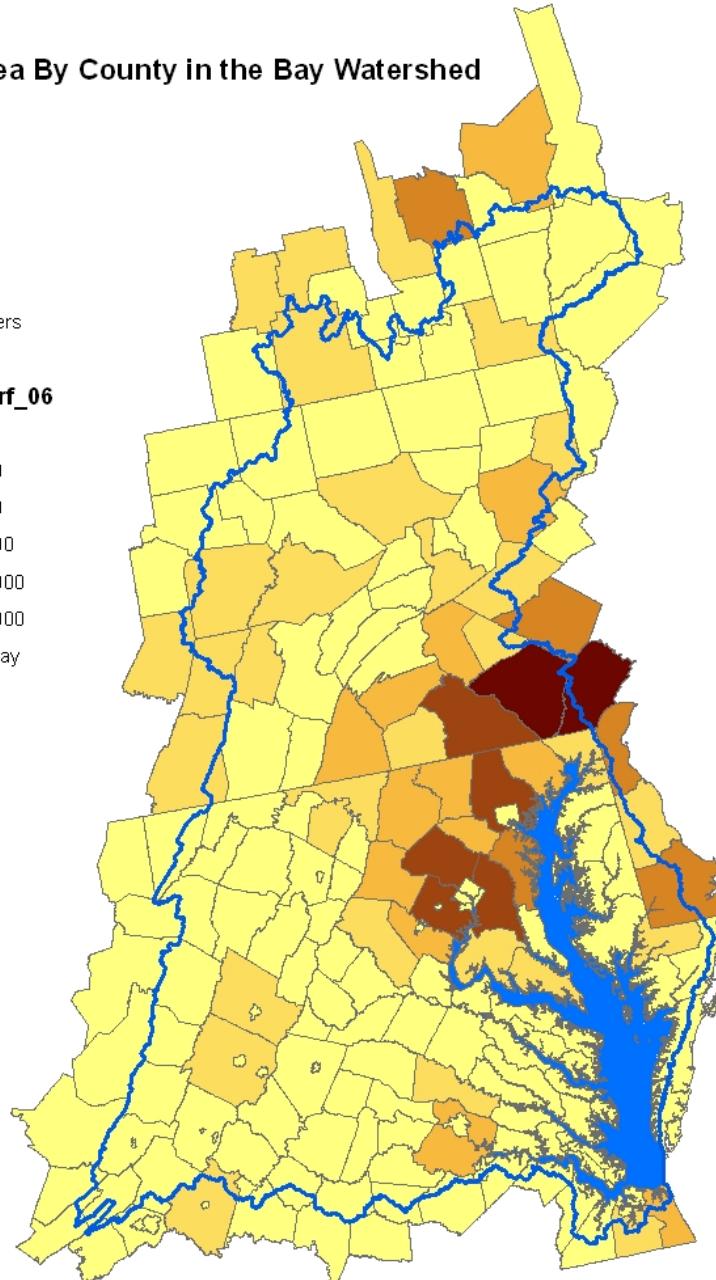
50,001 - 75,000

75,001 - 100,000

100,001 - 125,000

125,001 - 150,000

Chesapeake_Bay





The Chesapeake Bay Land Change Model (CBLCM):

Why was it created?



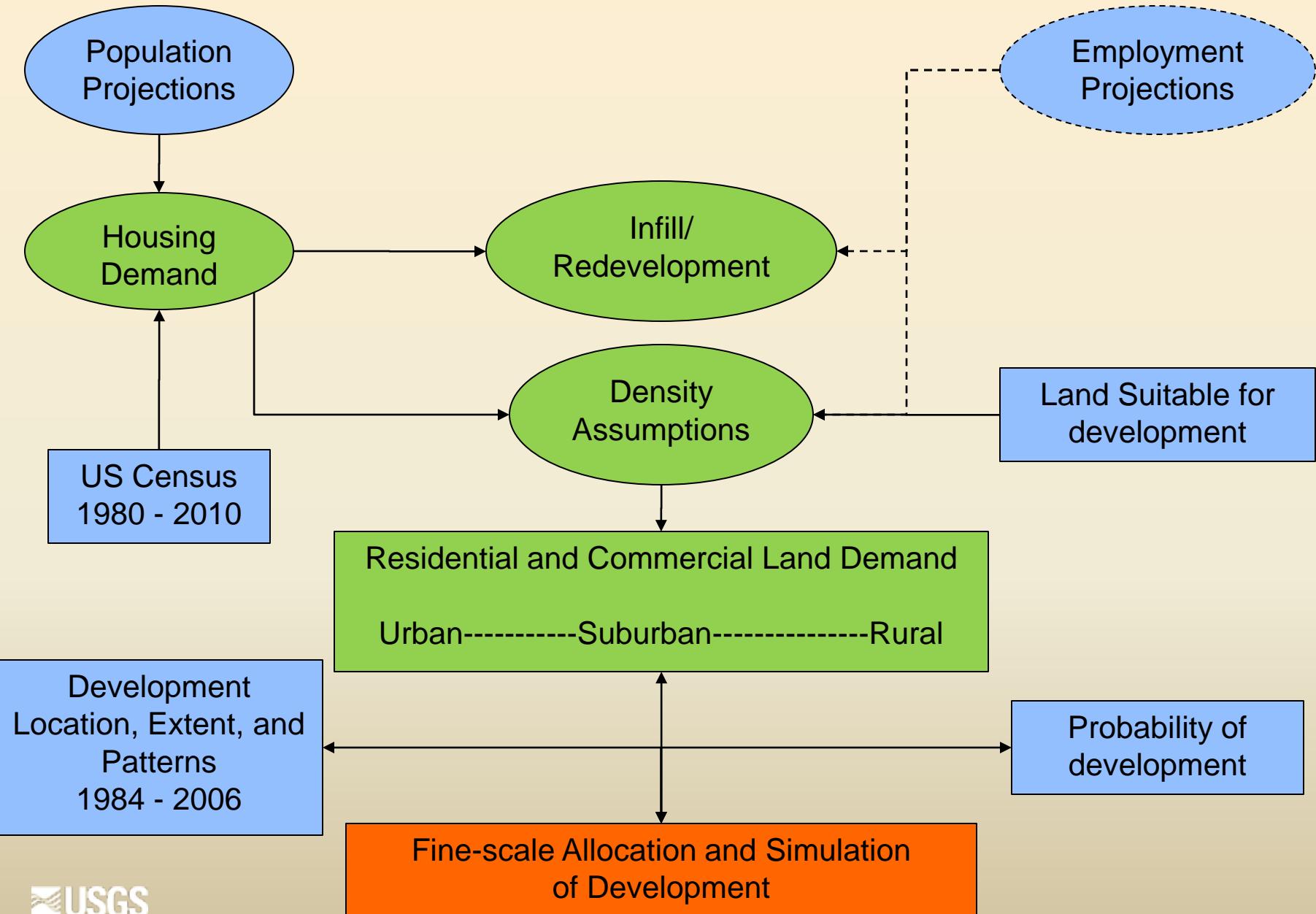
1. To generate spatially and temporally consistent developed land use data for calibrating the Chesapeake Bay watershed model and for simulating alternative future scenarios.
2. A new model needed to be constructed to address the specific data input needs of the Watershed Model and to accommodate the best available regional data.



What does the CBLCM do?

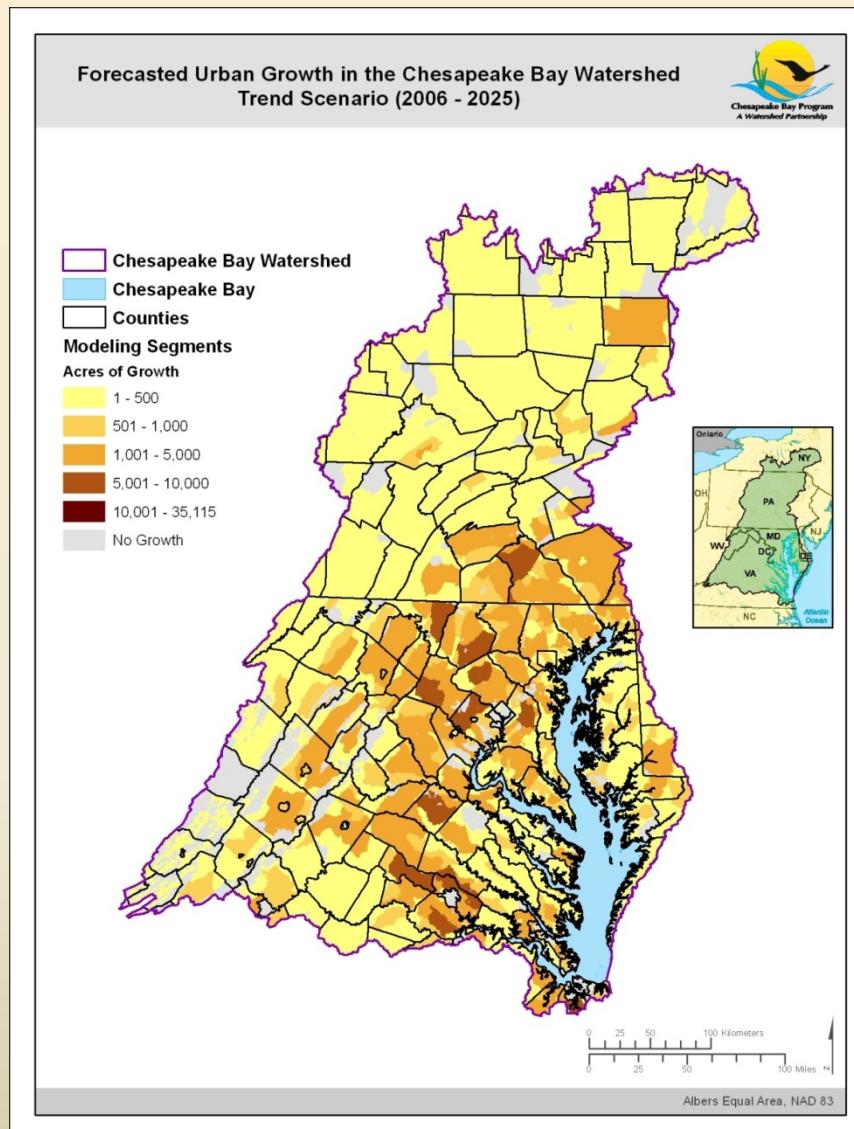
1. Estimates extent of historic and future development in rural, suburban, and urban areas.
2. Estimates historic and future population and households on sewer and septic.
3. Estimates future conversion of forest and farmland.

How does the CBLCM work?

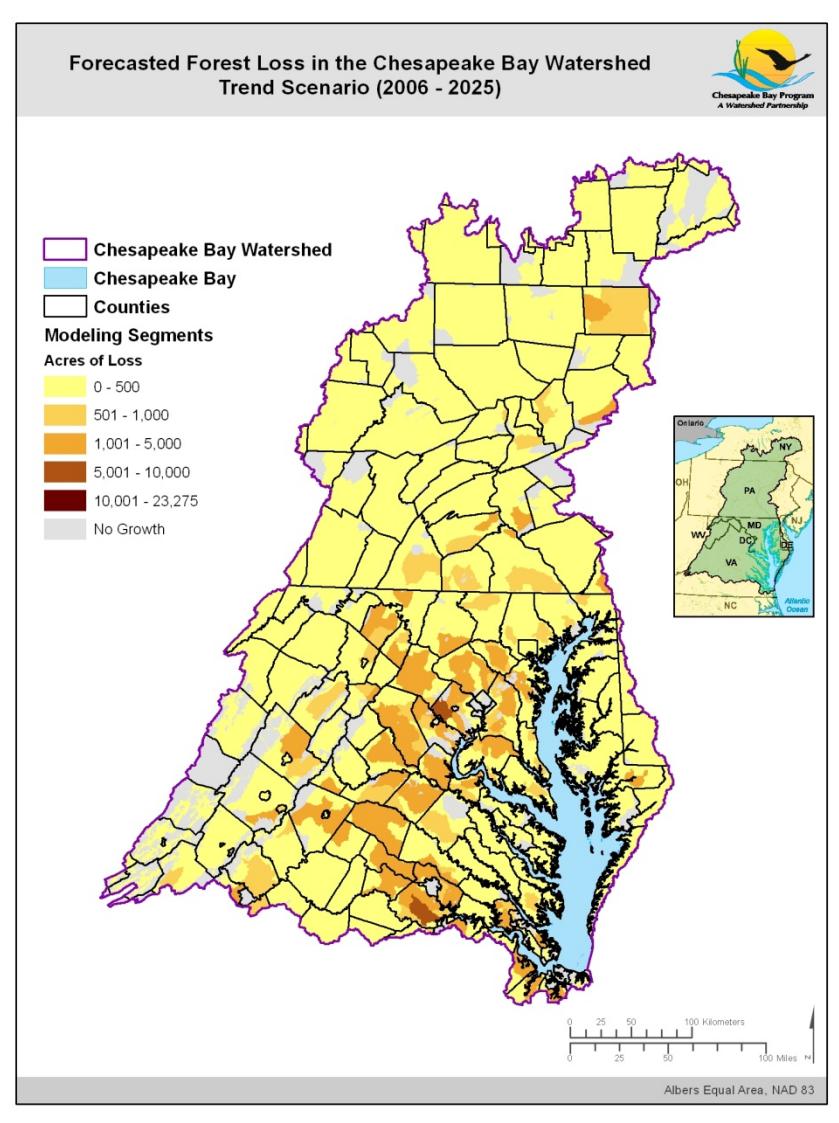


Forecasted Urban Growth in the Chesapeake Bay Watershed

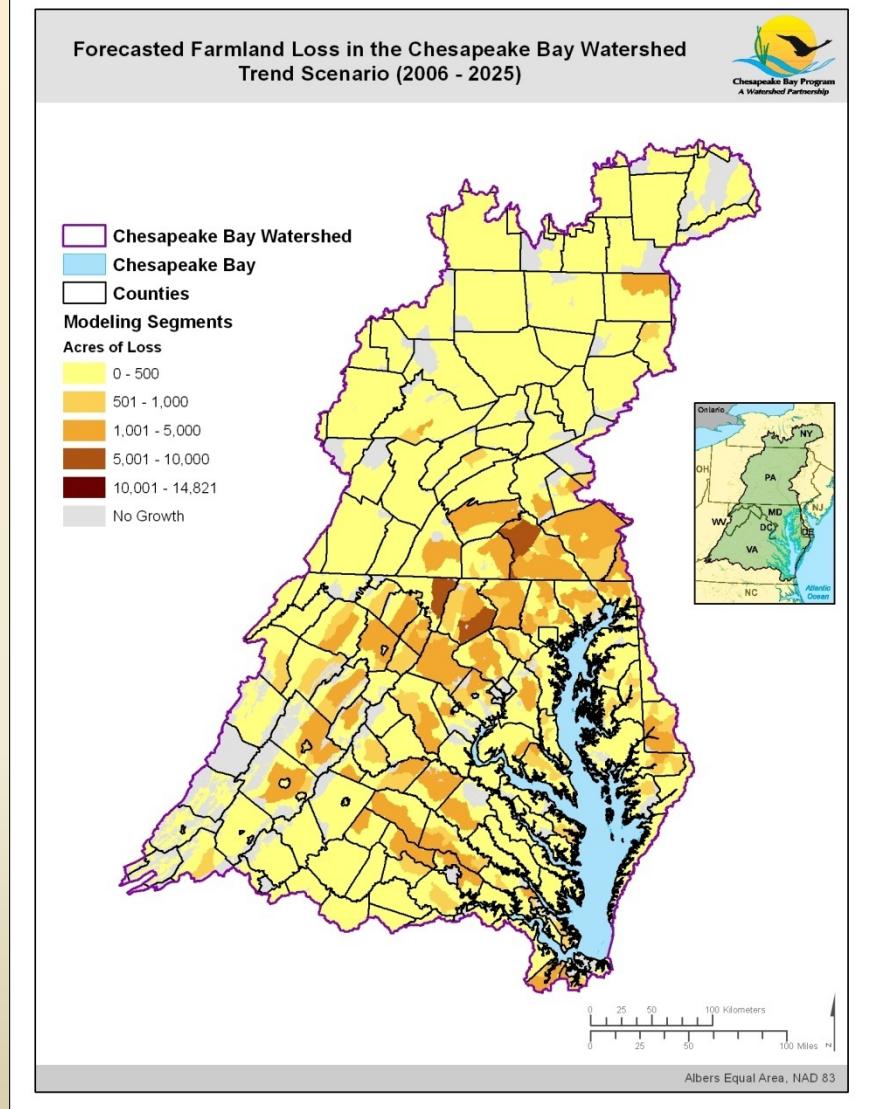
2006 - 2025



Forest Loss (2006 – 2025)



Farmland Loss (2006 – 2025)



Bay Watershed Phase 5.3.2 Trend Scenario

- Developed lands may increase an additional 15% between 2006 and 2025 (~ 37,800 acres per year).
- Impervious surfaces may increase by 122,000 acres.
- Pervious surfaces (lawns) may increase by 596,000 acres.
- 85% of future population growth expected to be on sewer.
- Onsite septic systems may increase by 15% (236,000 systems) and population on sewer may increase by 17% (2,160,000).
- Approximately 328,000 acres of forests (tree canopy) and 390,000 acres of farmland may be converted to development (2006 – 2025).

Nitrogen Loading Coefficients

Phase 5.3.2 Median No Action Edge-Of-Stream Load Coefficients

Impervious **12.5 lbs. TN/acre/yr**

Pervious (lawns) **10.5 lbs. TN/acre/yr**

Septic **4.5 – 11.2 lbs. TN/hh/yr**

Sewer **1.8 - 4.9 lbs. TN/hh/yr**

Changes in Nitrogen Loads, 2006 – 2025 (Trend Scenario)

Impervious surface:

122,000 acres = **1.5 million lbs. TN/yr**

Pervious surfaces (lawns):

596,000 acres = **6.3 million lbs. TN/yr**

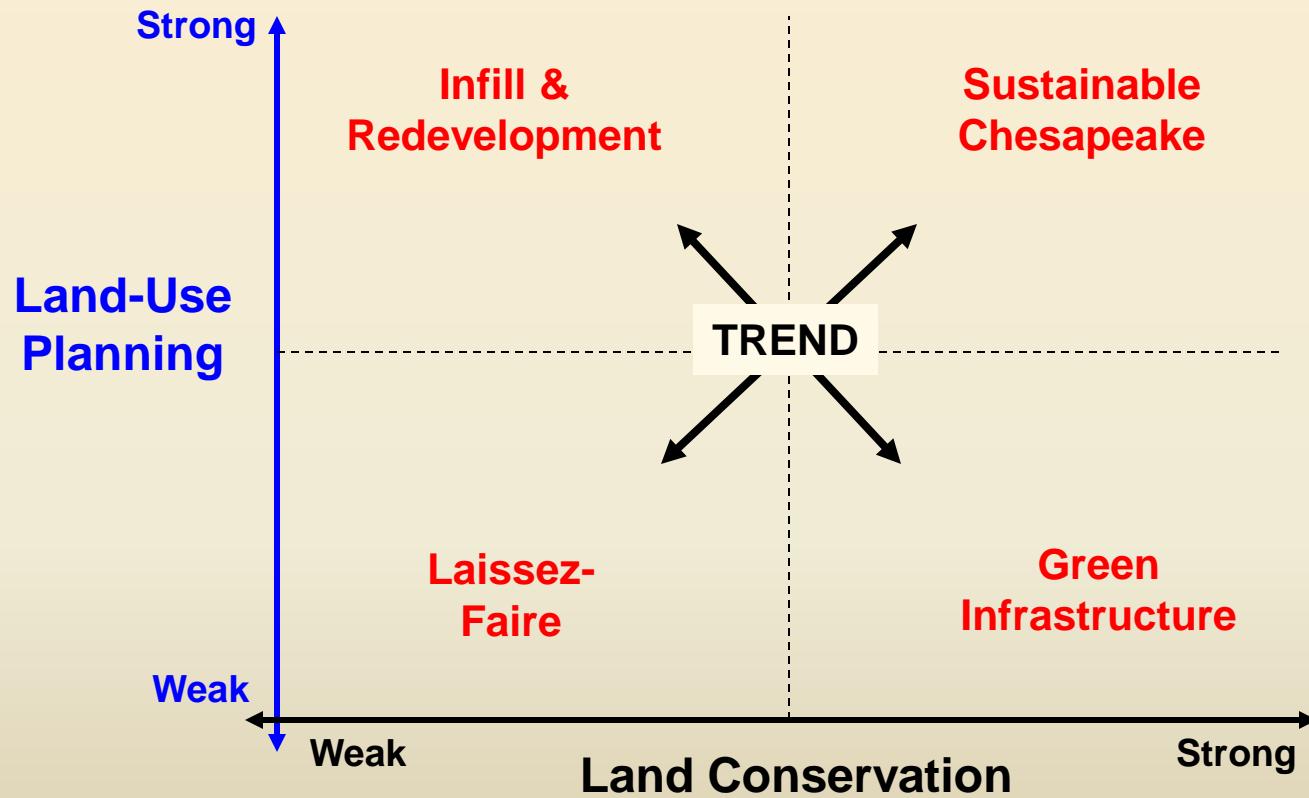
Sewer:

2,160,000 people = **1.5 – 4.2 million lbs. TN/yr**

Septic:

236,000 systems = **0.9 – 2.6 lbs. TN/yr**

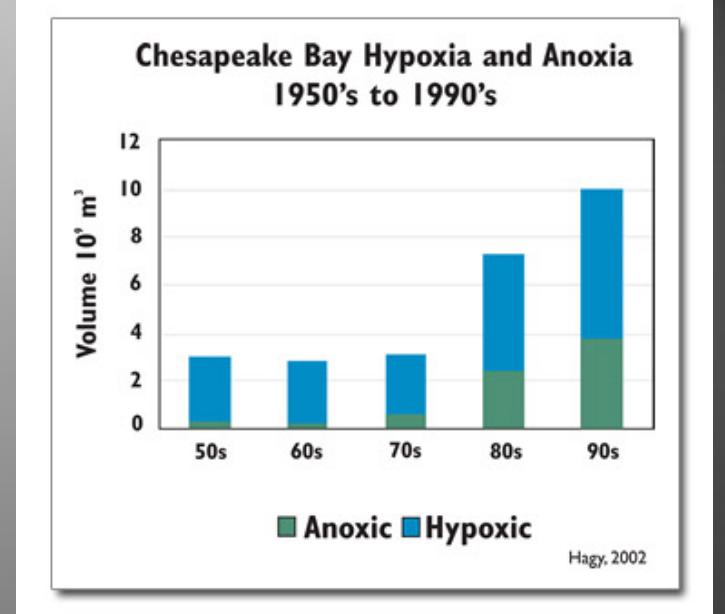
Conceptual Alternative Future Development Scenarios



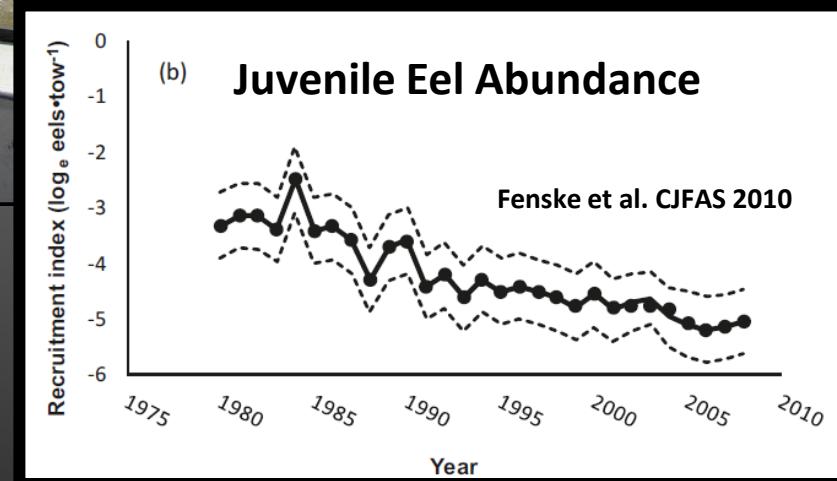
A Central Question: How do we scale nutrient and hypoxic effects, which tend to be “local” to living resource responses, which tend to be “global”?



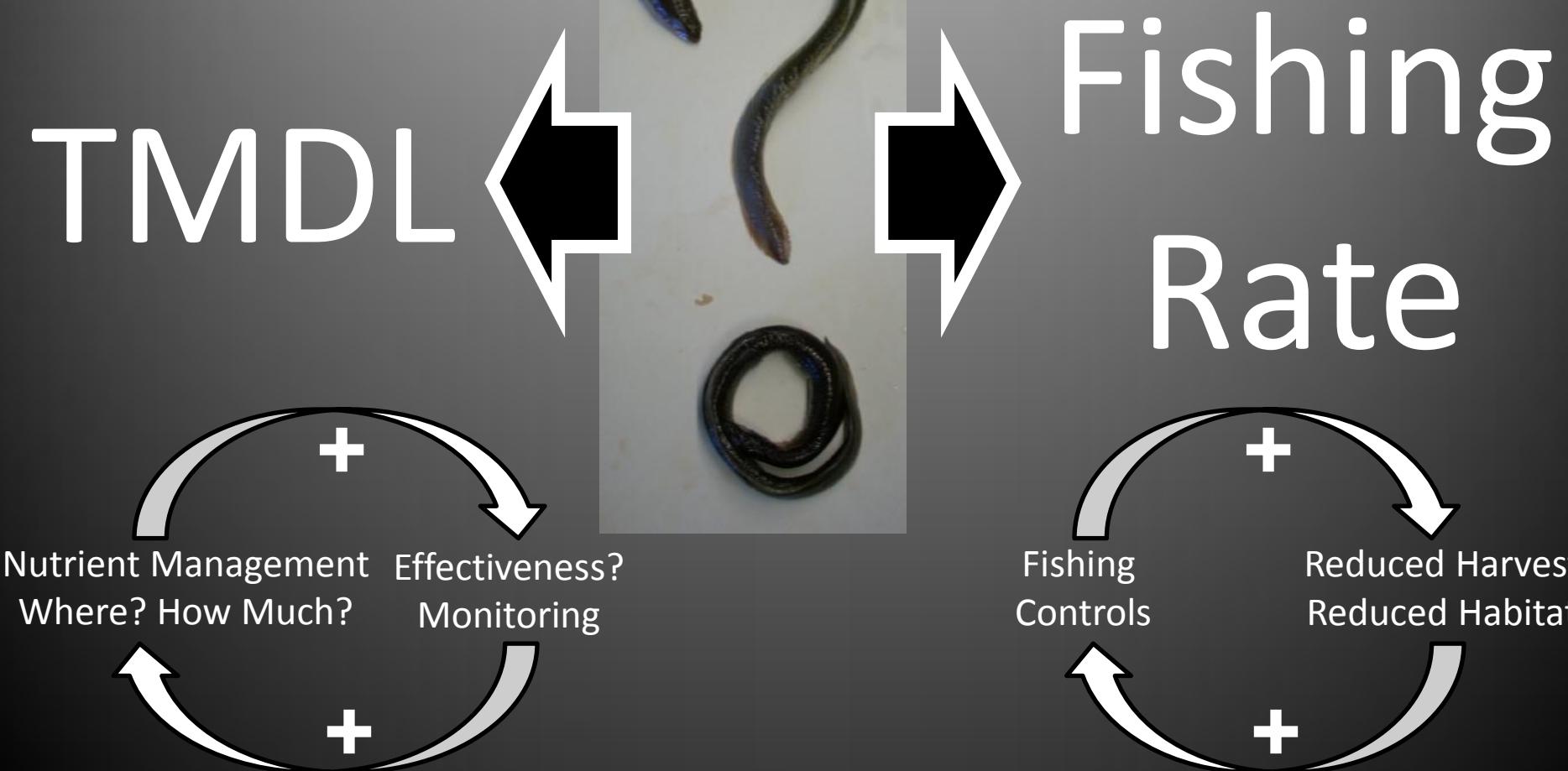
Swan Point, Potomac
River Estuary
Chesapeake Bay



One-way streets related?
Increased Hypoxia ~ depressed
eel production??



How to Align Fisheries and Water Quality Science and Management? A Central Issue in the Chesapeake



Managing Living Resources from an Ecosystem Perspective: The Power Plant Impact Model

Translate Impacts into Living Resource Effects (Same Currency)

Habitat Suitability Models

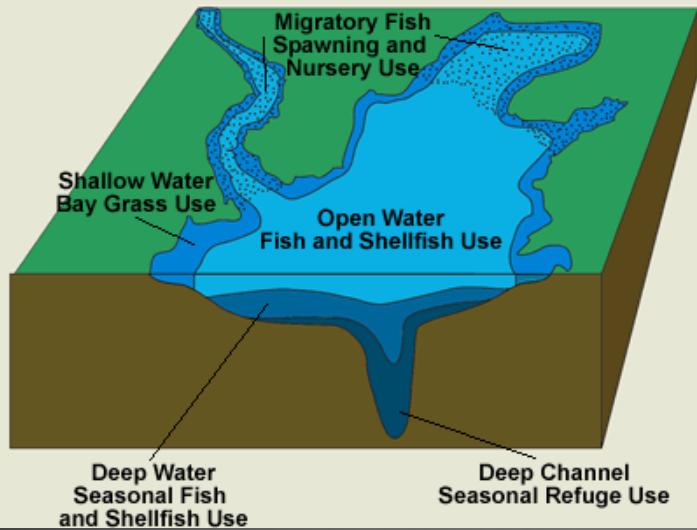


1. Establishing Protective Water Quality Standards – Thresholds Approach
 - Designated Use Habitats
 - Biological Criteria
 - Monitoring
 - Biological Reference Points (thresholds, attainment)
 - Assumptions
2. Translate water quality into fisheries production – Habitat Suitability
 - Experimentally derive production responses to Chesapeake conditions
 - Develop and calibrate model
 - Input water quality data – map distributions of suitable habitat
 - Calibrate against field preference data
 - Assumptions
3. Future challenges and opportunities
 - Climate
 - Better observing systems for living resources and water quality
 - Improved Habitat and Ecosystem models
 - Forecasting

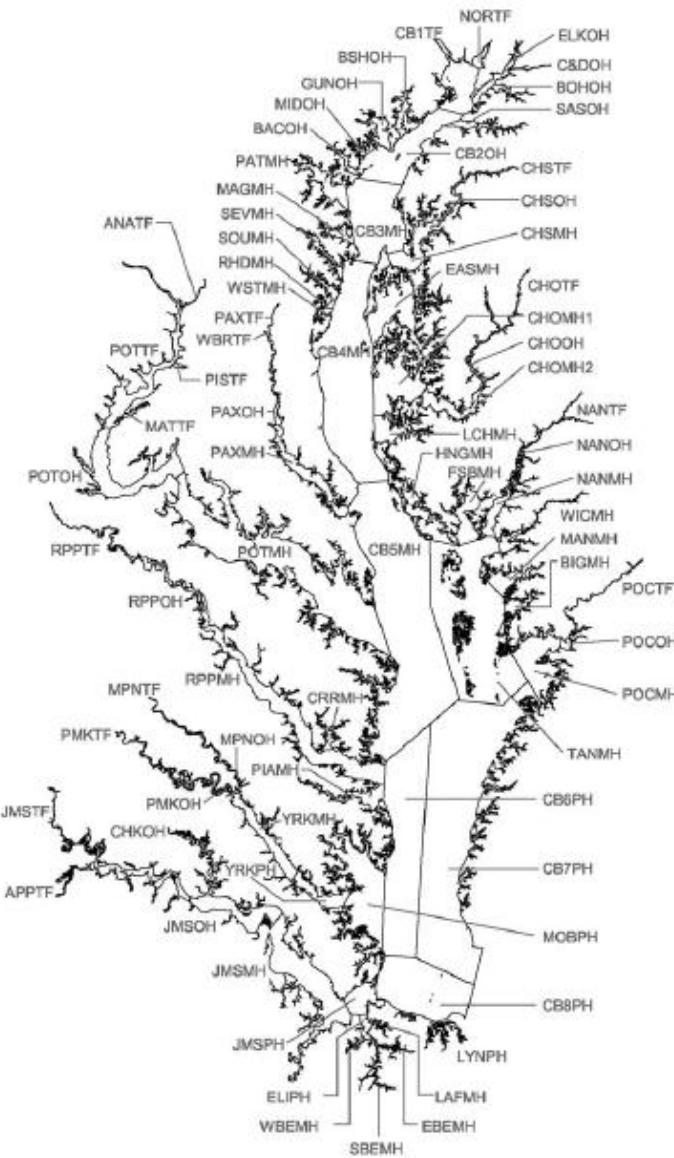
Ambient Water Quality Criteria

Designated Uses

Oblique View of the Chesapeake Bay and Its Tidal Tributaries



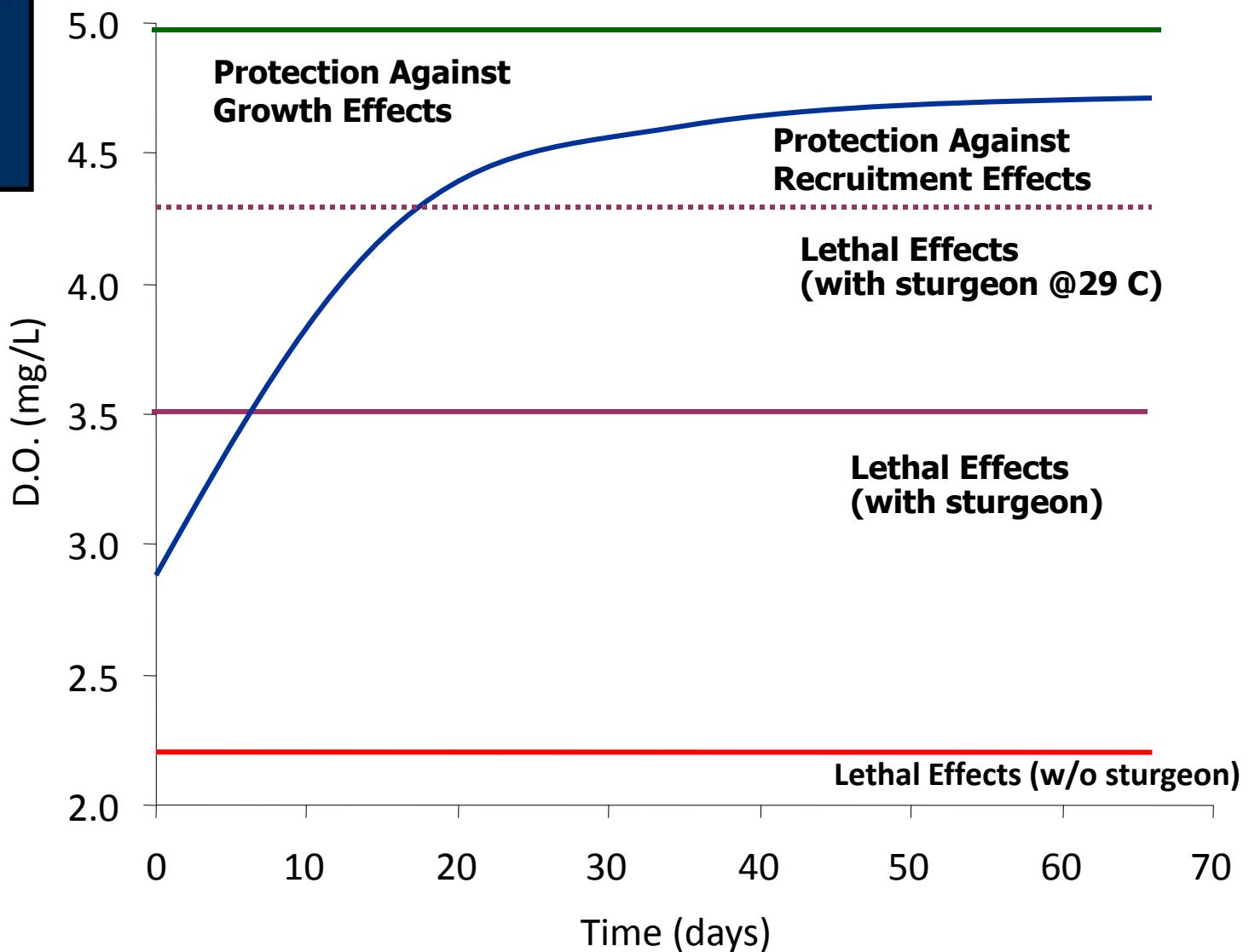
Segment Monitoring



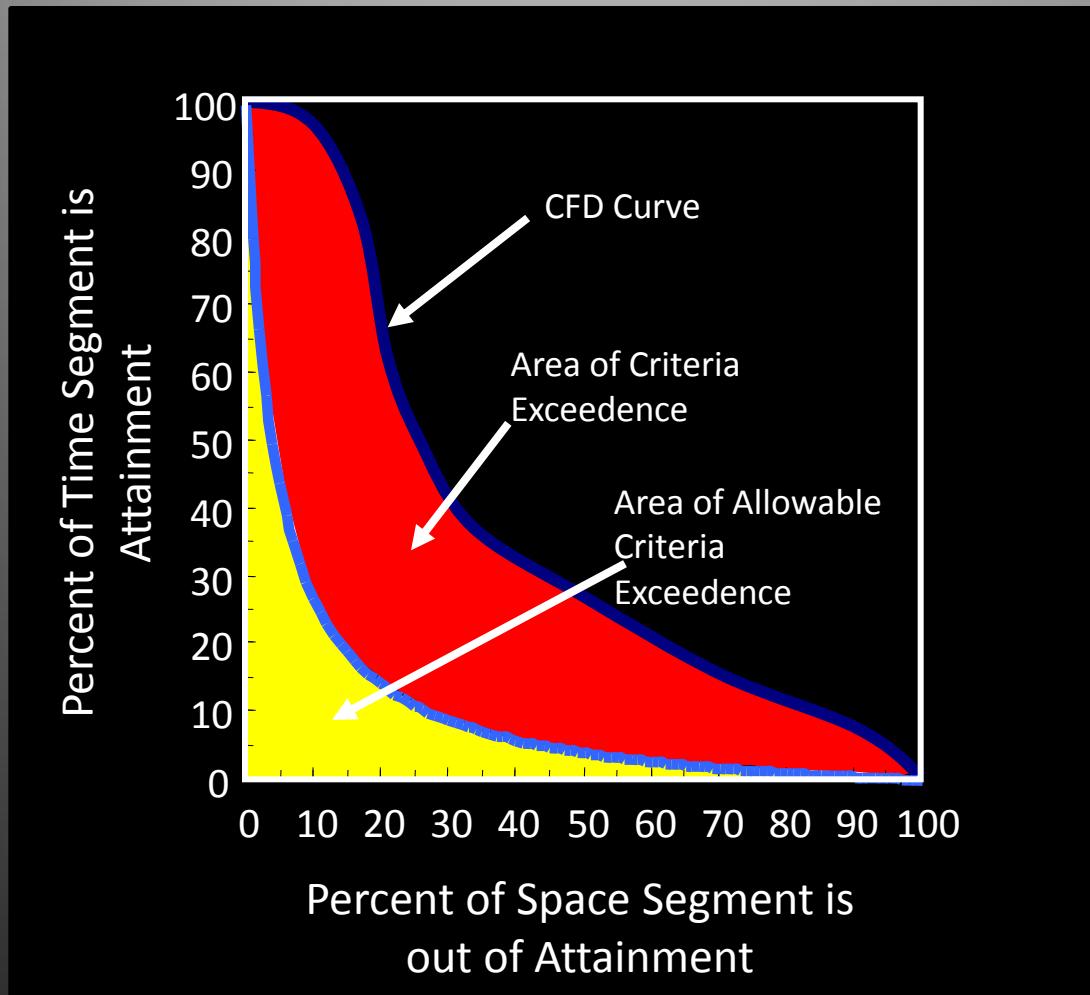
Biological Criteria (EPA 2003)

	6	5	4	3	2	1	0
Migratory Spawning and Nursery Habitats							
Striped Bass: 5-6							
Shallow-Water and Open-Water Habitats							
American Shad: 5							
White Perch: 5							
Deep-Water Habitats							
Yellow Perch: 5							
Hard Clams: 5							
Alewife: 3.6							
Deep-Channel Habitats							
Bay Anchovy: 3							
Crabs: 3							
Spot: 2							
Worms: 1							

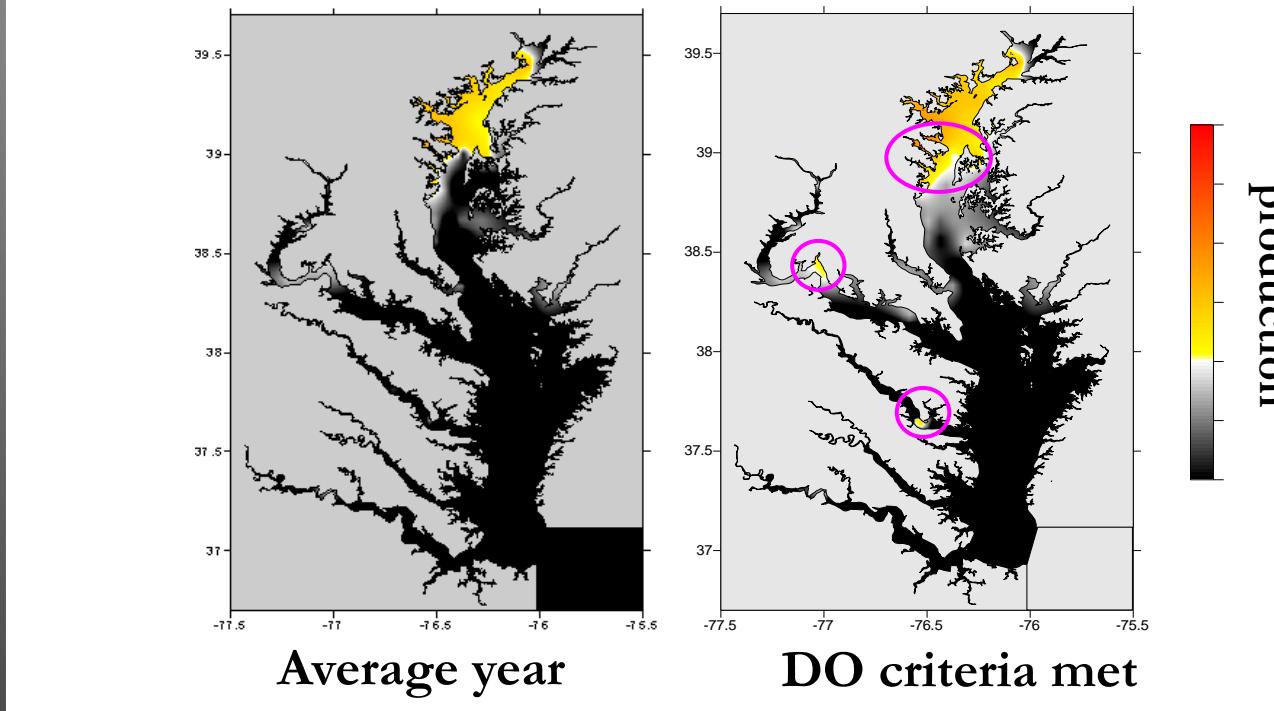
EPA Chesapeake Bay Program
Proposed Open water & Spawning/Nursery Habitat Criteria



Uncertainty and Risk Measures: Cumulative Frequency Approach

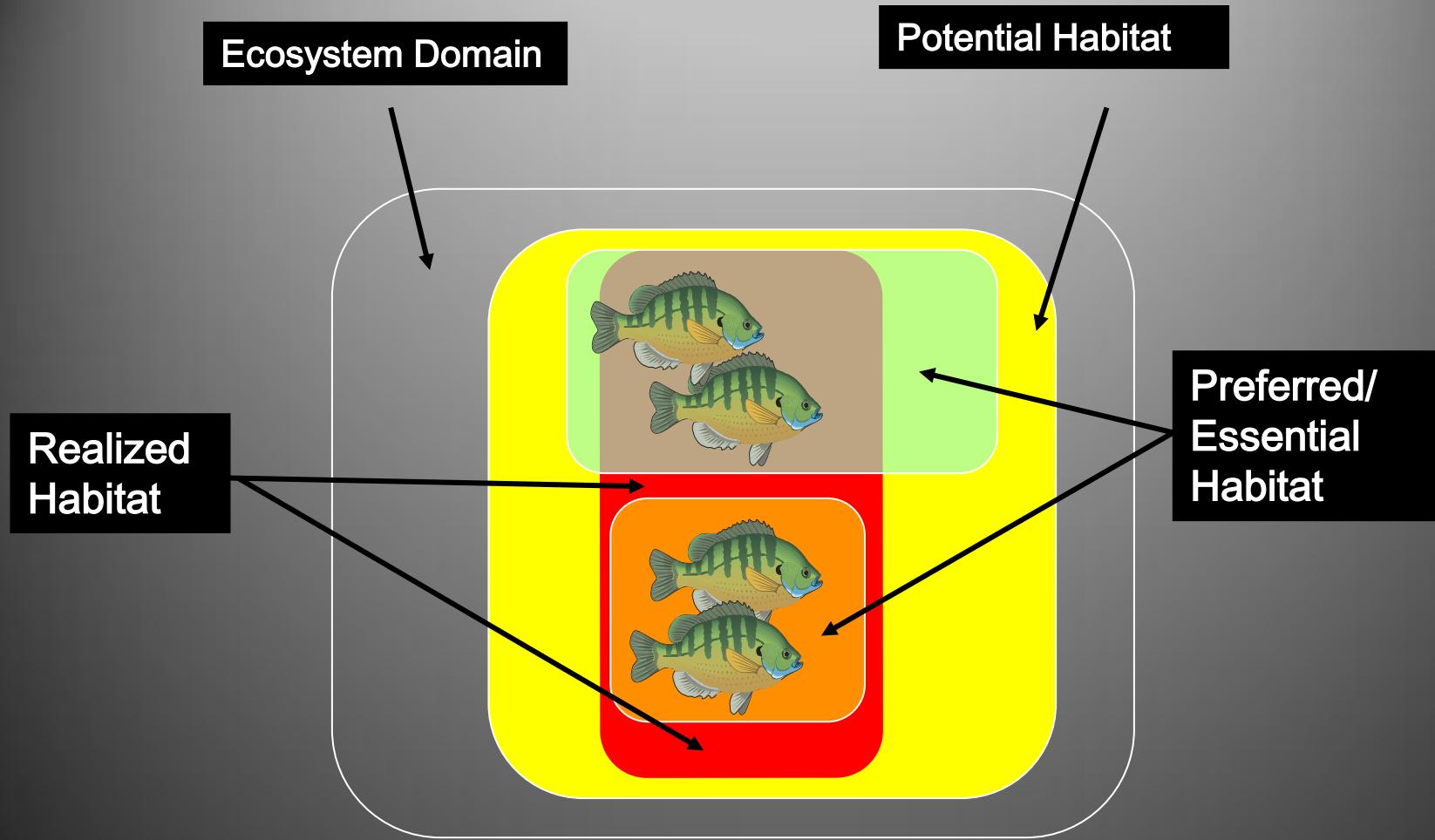


Meeting the Chesapeake Bay Program for sturgeon New DO Criteria - July



Ches Bay Program Attainment Approach - Limitations

1. Thresholds designed as protective binary measures, improving water quality further will continue to contribute to fisheries production.
2. Highly dependent on monitoring intensity and stable ecosystem conditions (climate)
3. Does not include synchronous monitoring of living resources (fisheries).
4. Does not consider changes to living resource status.



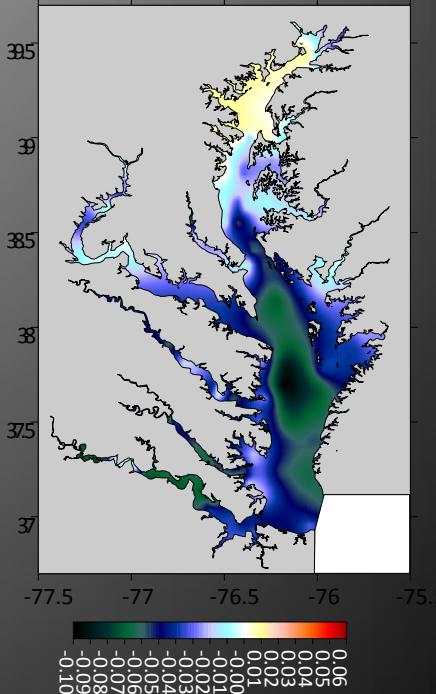
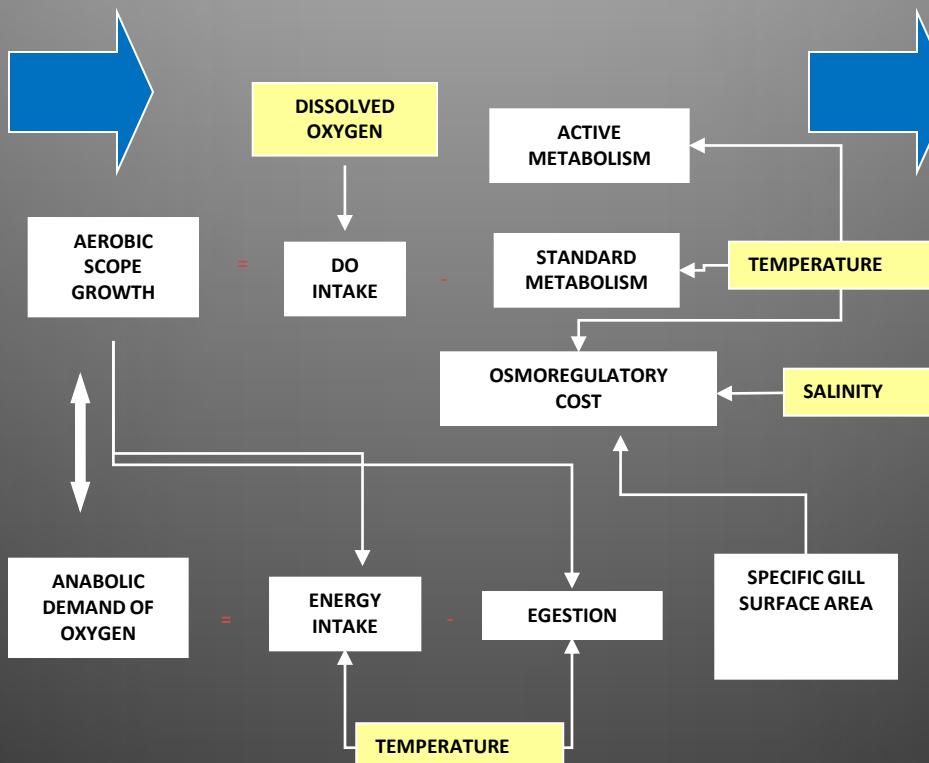
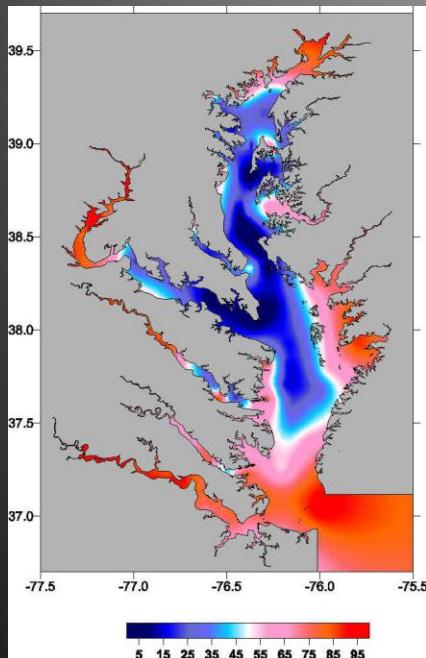
Habitat classifications for living resources. Note that potential and realized habitats nest in an ordered manner within the ecosystem, yet preferred and essential habitat volumes are dependent upon population status and behavior. For instance, preferred habitat may exist but remain uncolonized due to behavioral constraints (orange area). In contrast, realized habitat may represent only a subset of essential or preferred habitat (green area) at abundances below carrying capacity.

Potential Habitat Modeling, An example for juvenile sturgeon

Issue: Nursery Production of Sturgeons

Resource variable (Stressor): dissolved oxygen

Currency Use: potential production (carrying capacity)

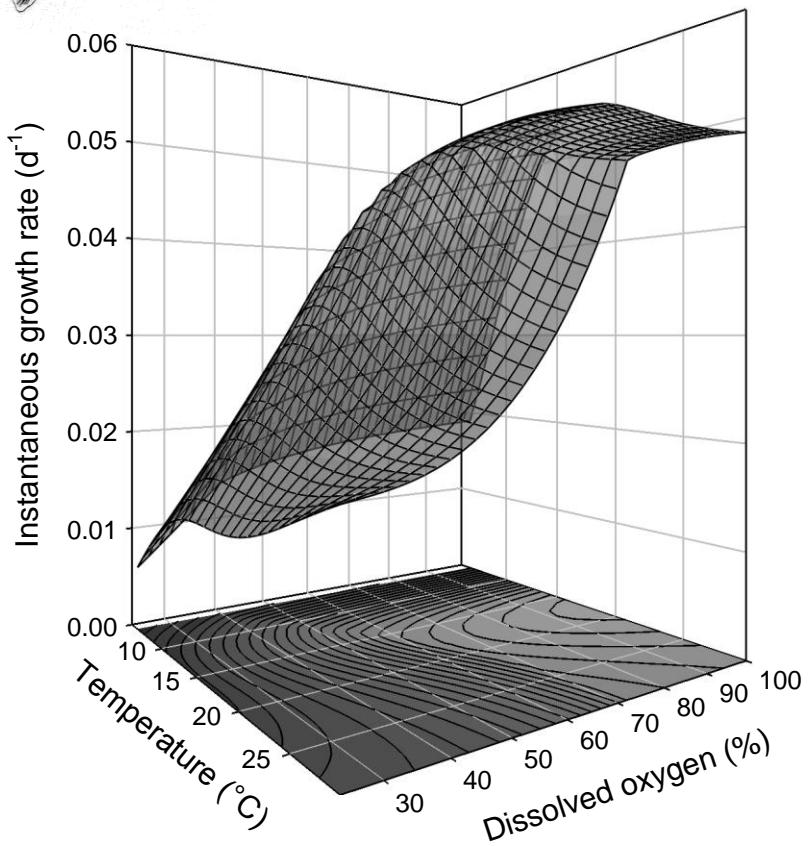
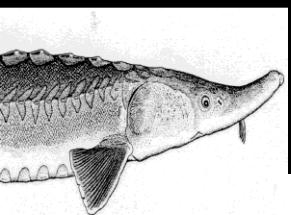


Bottom
DO saturation
July '90-'99

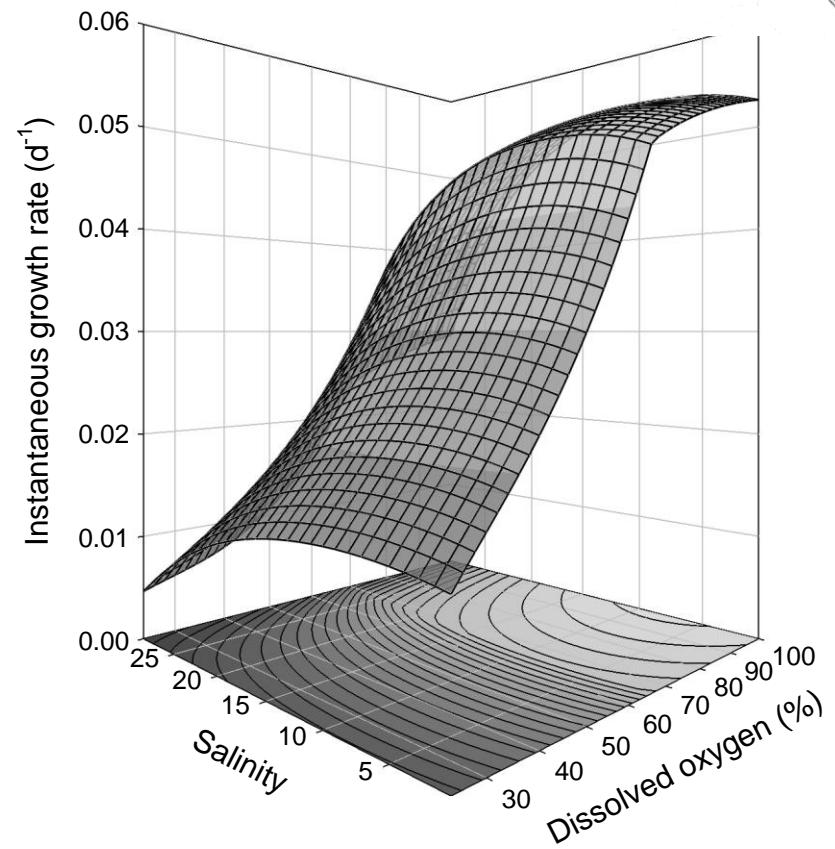
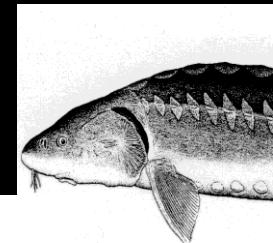
Bioenergetics Model

Atl. Sturgeon Potential Production '90-'99

Growth and survival strongly affected by temperature, hypoxia and salinity



Atlantic sturgeon

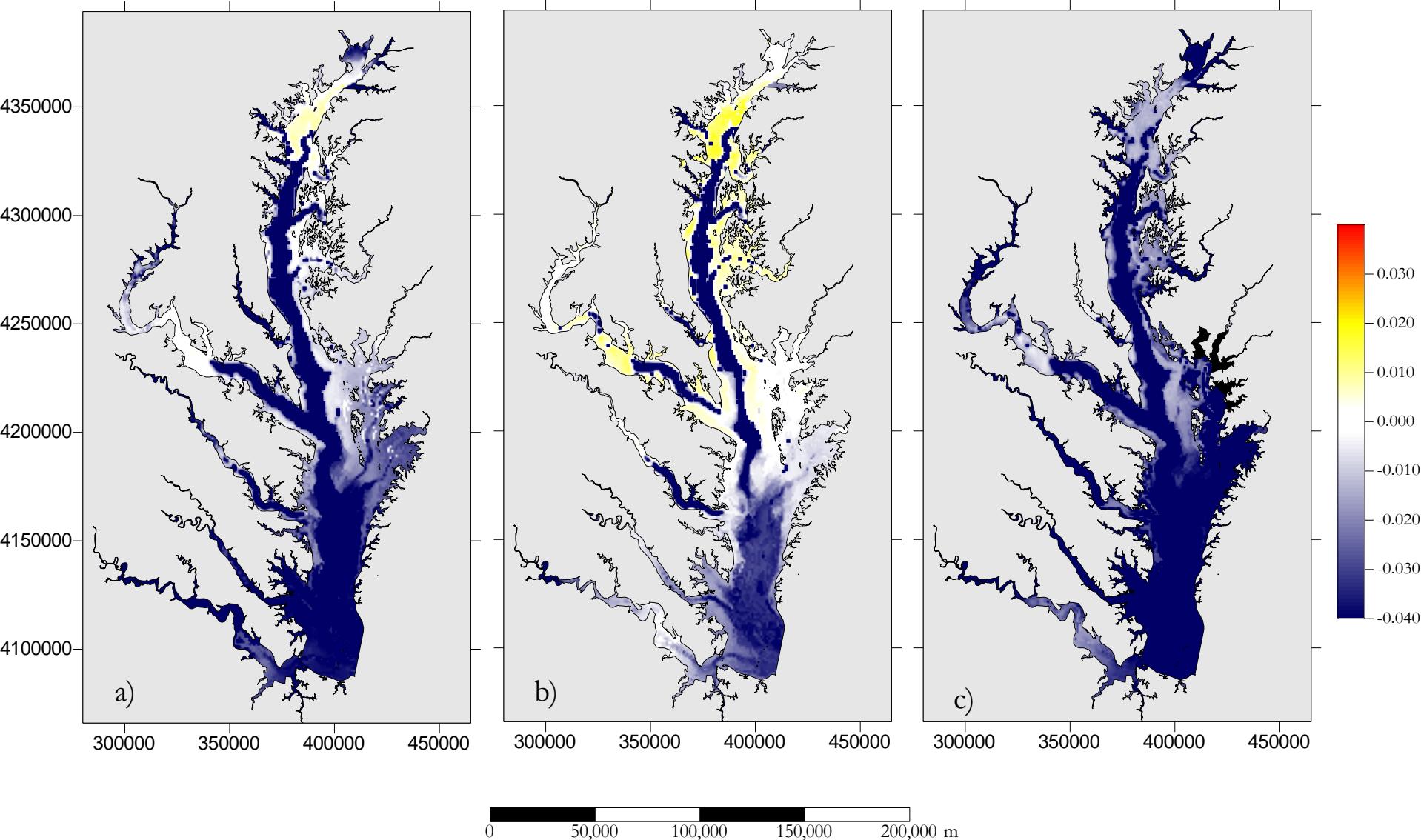


Shortnose sturgeon

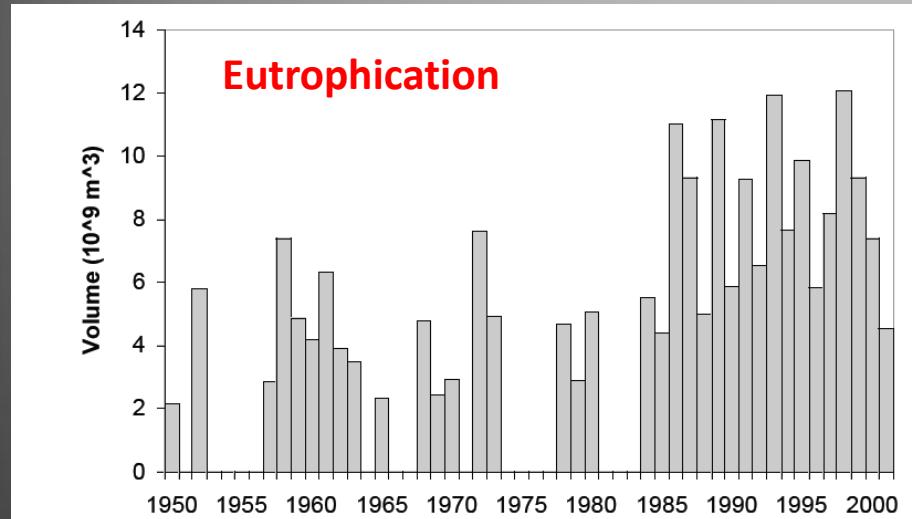
10-Yr Mean

1996

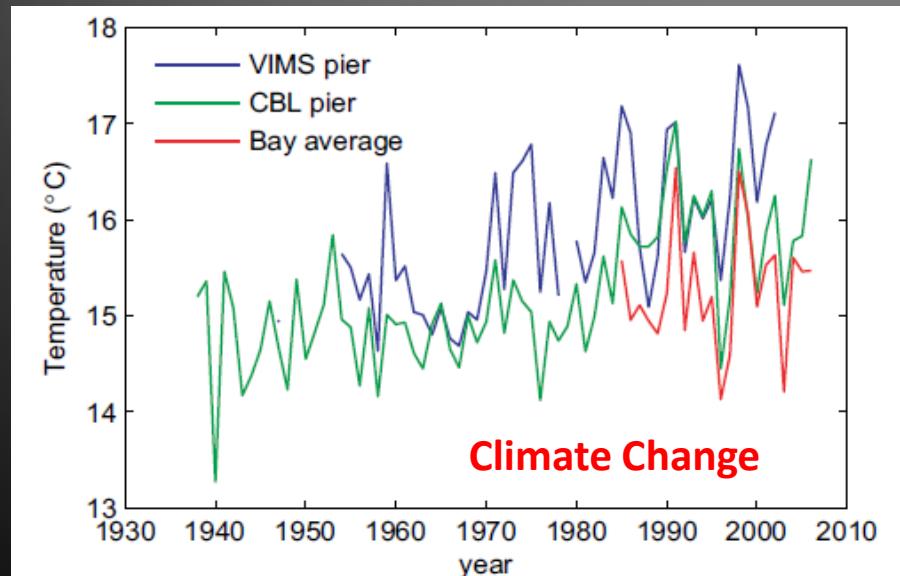
1999



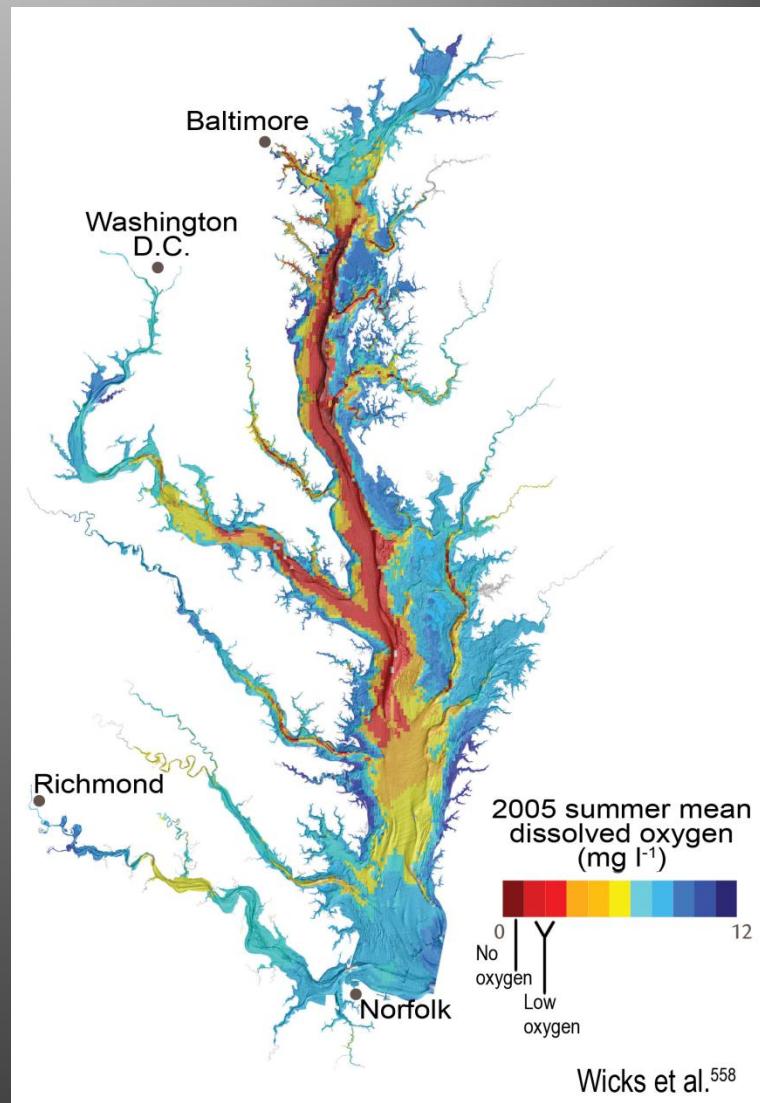
Complex Challenges Facing Fisheries Management



Hagy et al. (2004)

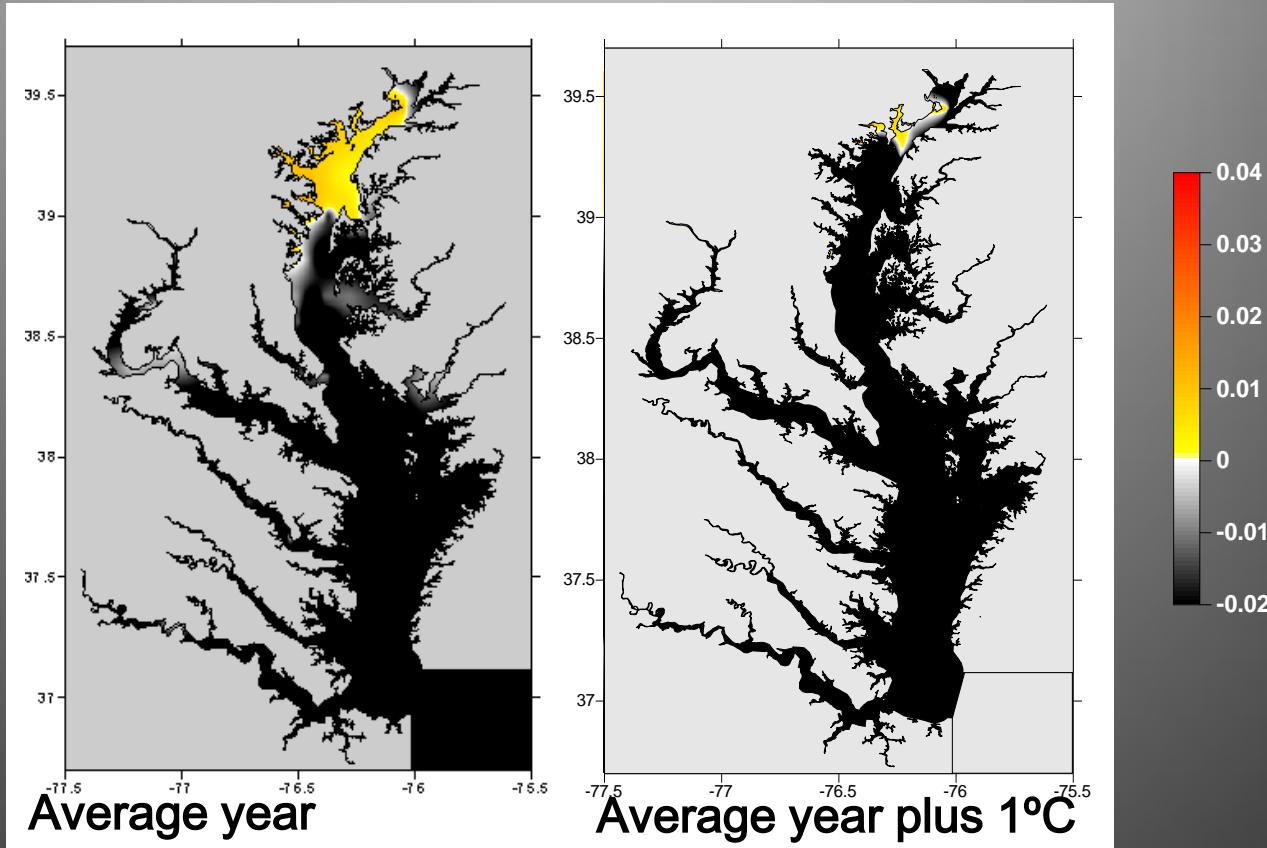


Najjar et al. (2009)



http://www.eco-check.org/pdfs/do_letter.pdf

Climate – A tipping point?

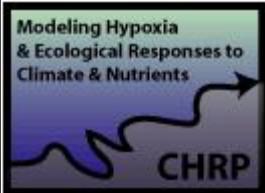


“Static” Habitat Suitability Models - Limitations

1. Estimates production associated with potential habitat rather than preferred or realized habitat. Doesn't allow fish to move. Does not include forage resources.
2. Does not involve synchronous observations of water quality and living resources (fisheries).
3. Does not consider changes to living resource status.

Still, a very powerful approach for projecting historical and future ecosystem changes

Modeling Hypoxia and Ecological Responses to Climate and Nutrients



**Past and Future Predictions of Distributions of Hypoxia
(nutrient and climate scenarios)**

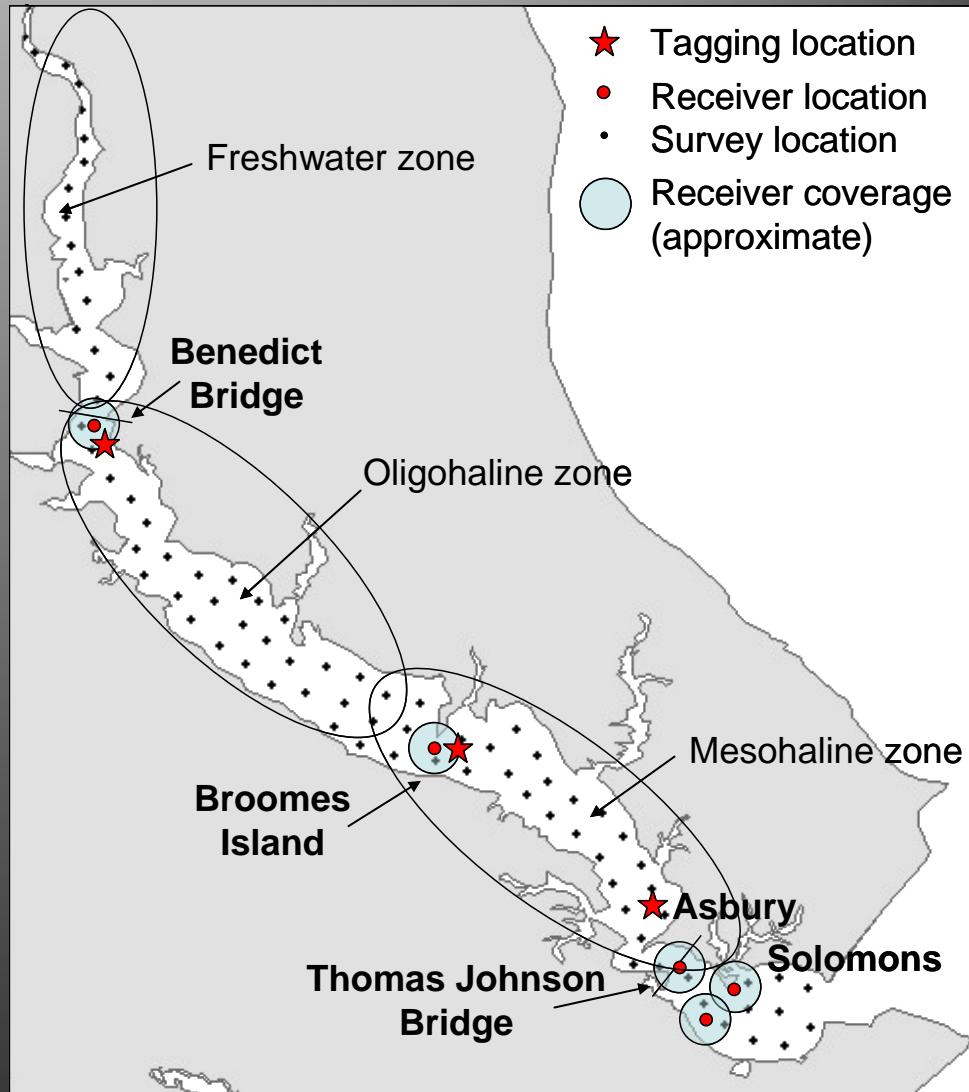
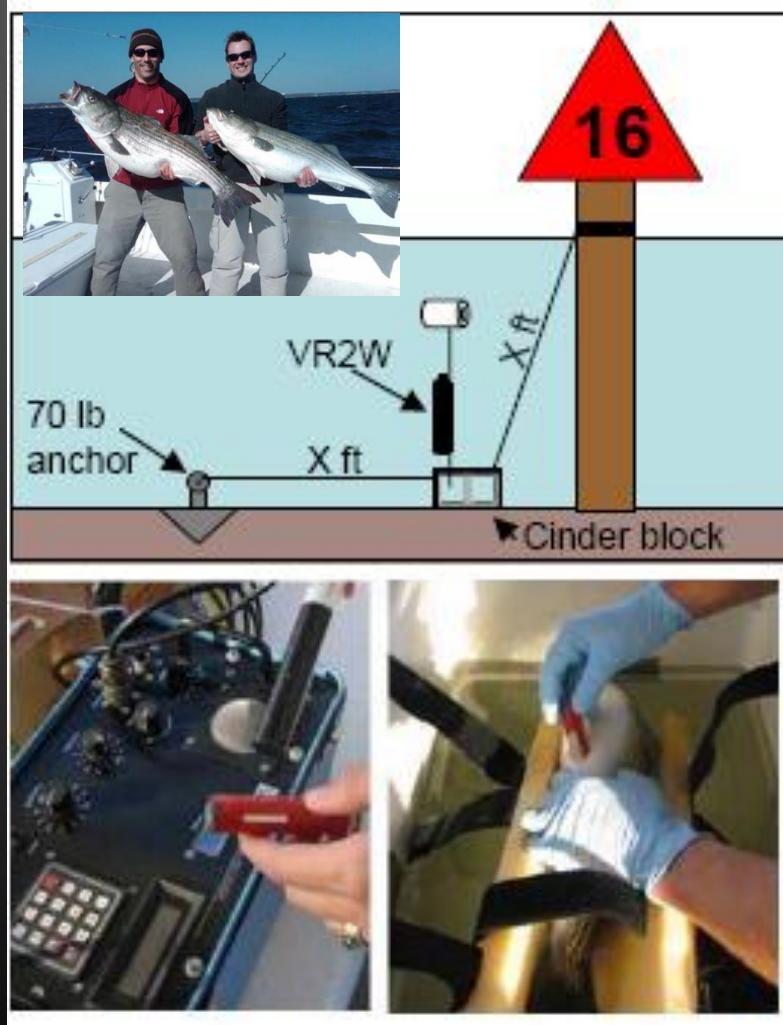


Essential Habitat Model

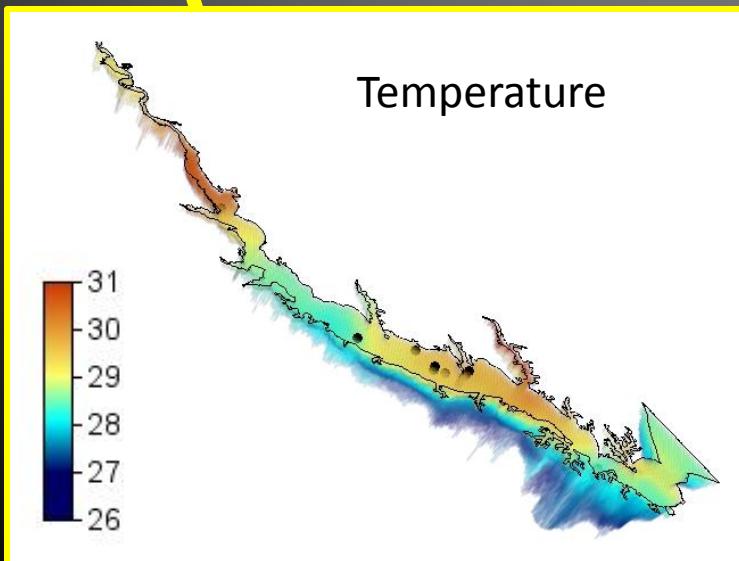
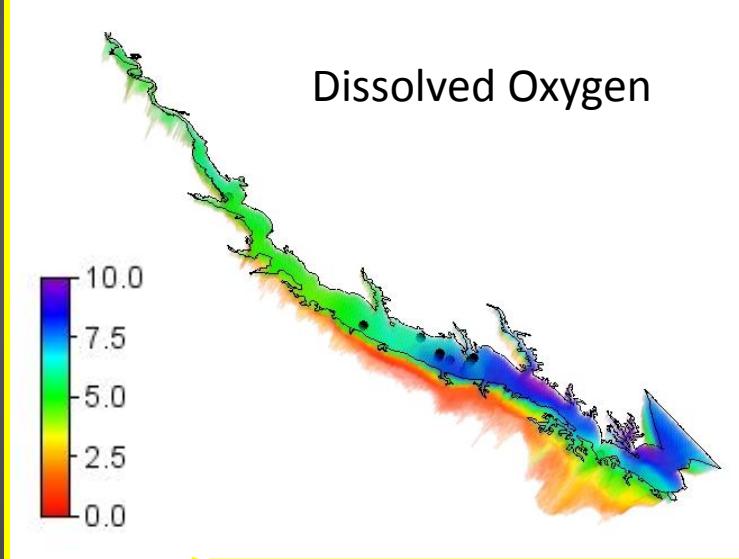


Habitat Size and Quality

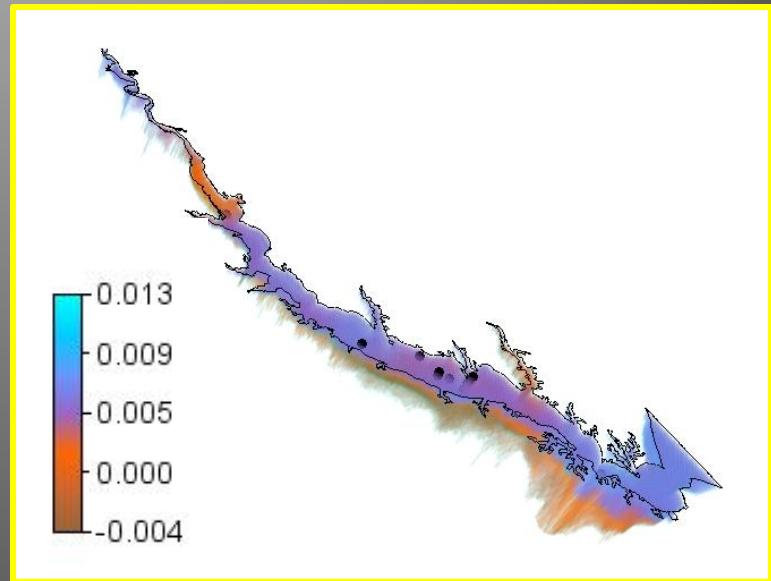
Dynamic Habitat Suitability Modeling: Simultaneous models of habitat and living resources



3D Interpolations and Spatial Growth Rate Potential Model

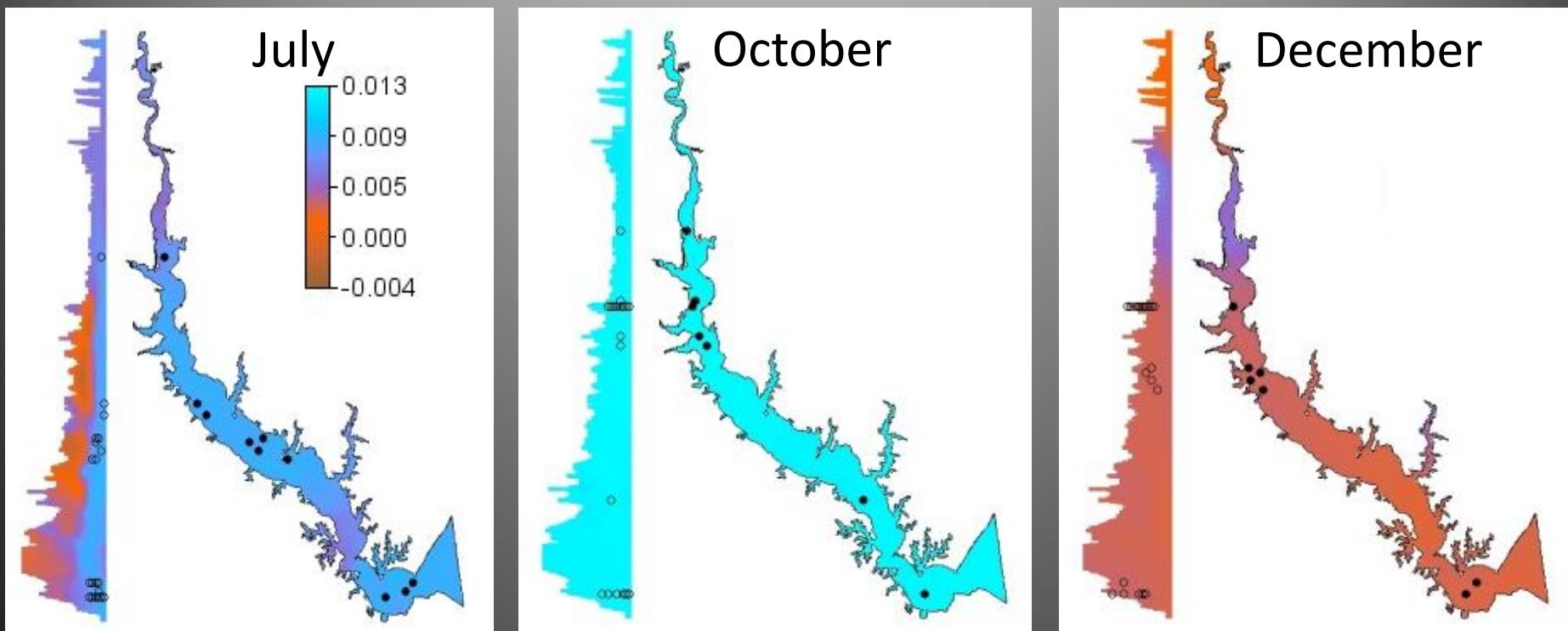


$$(C_{\max}/2) - (R + S + F + U) =$$

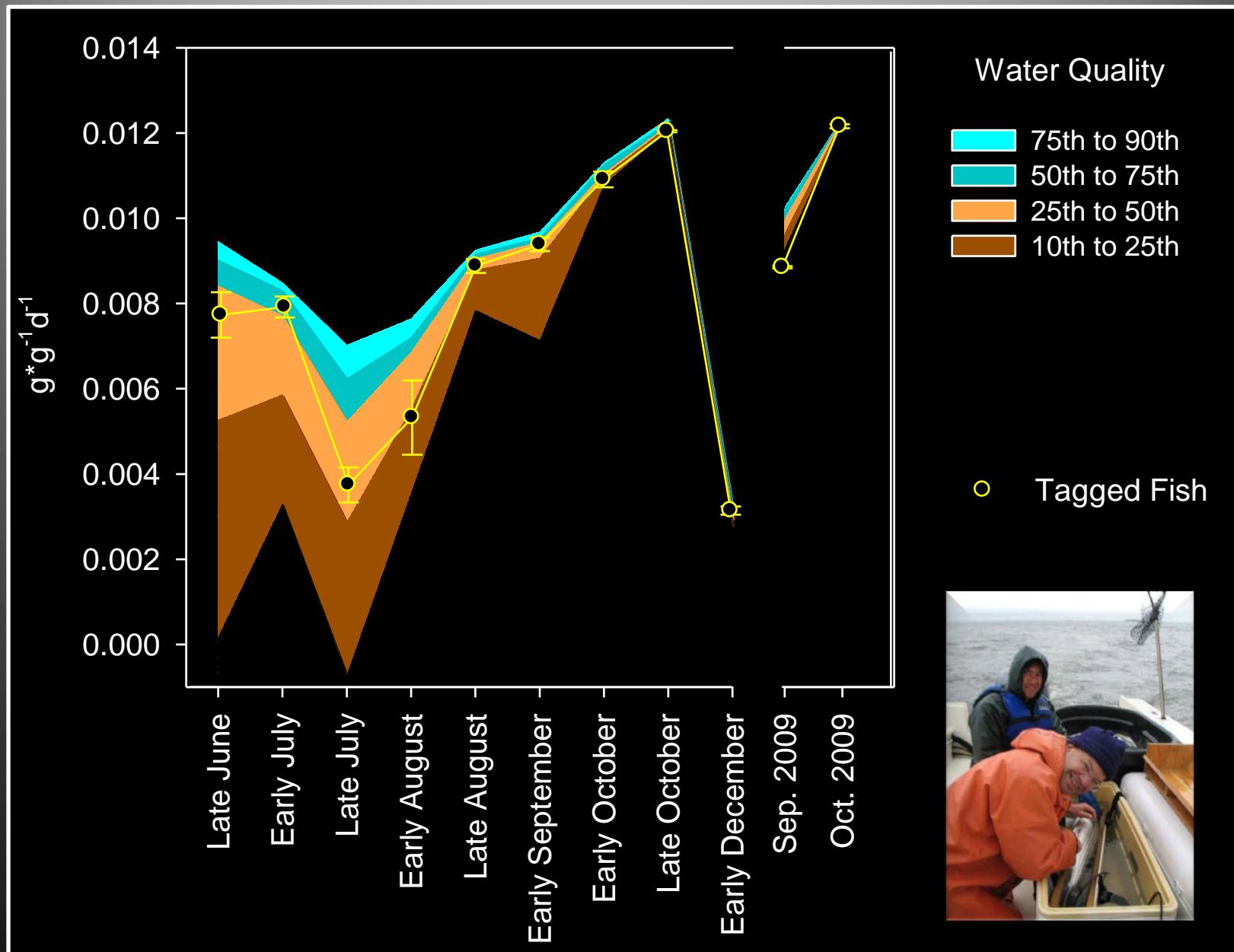


Where:
 $C_{\max} = f(T) f(DO),$
 $R = f(T)$

Seasonal Changes in Growth Rate Potential and Striped Bass locations



Predicted Growth Rate Potential



Linking water quality with Chesapeake Bay living resources

- Better monitoring of water quality
 - Most monitoring is high in watershed with limited relevance to estuarine fisheries
 - Monitoring inadequately covers designated uses, particularly open water habitat
 - Monitoring is not designed around climate change
- Align fisheries monitoring with water quality monitoring
 - CBIBS, telemetry, VIMS trawl survey, gliders, etc.
- Develop habitat suitability models
 - Adaptive management: Concept → actions → monitor → assessment/model → repeat!
 - Stakeholder engagement
 - Historical perspectives and forecasts
- Still haven't solved scale issue
 - Management of water quality is local but living resources integrate water quality over their life cycles – their responses and management is more global
 - Pick targets – critical nursery habitats, oysters, sea grasses
 - Partition potential carrying capacity by regions and watersheds
- Continue to move towards dynamic habitat models
 - Improved observing platforms – real time observations on fish distributions and behaviors linked with water quality and other resources (forage)
 - Continued Chesapeake Bay ecosystem modeling efforts

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Policy Implementation Analysis Perspective: Why isn't my policy working as intended?

Public policy & administration

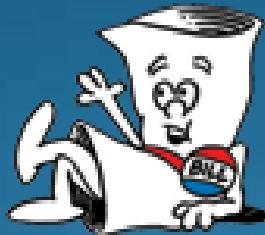
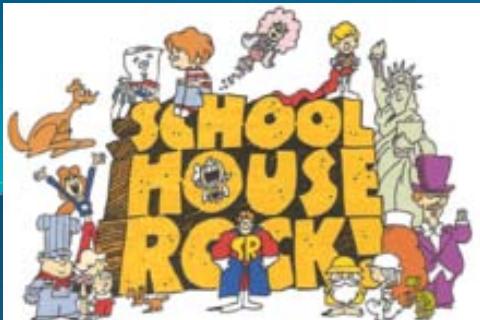
Policy implementation analysis
framework

What should I ask about local
implementation?

Mini-example

Troy W. Hartley

Research Associate Professor of
Marine Science & Public Policy



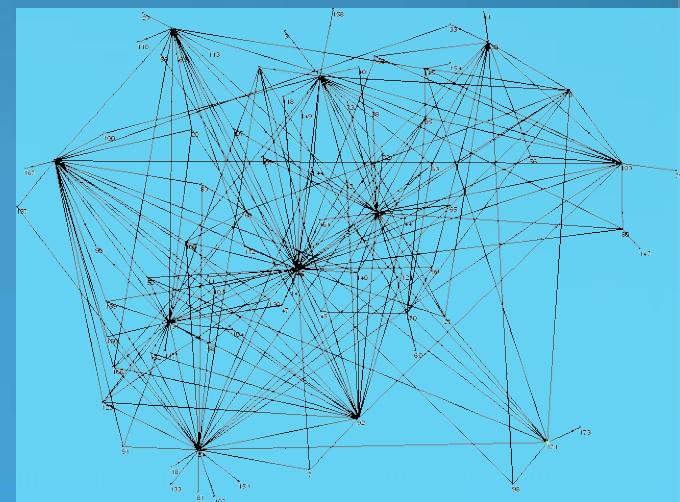
Implementing Public Policy:

Top-Down

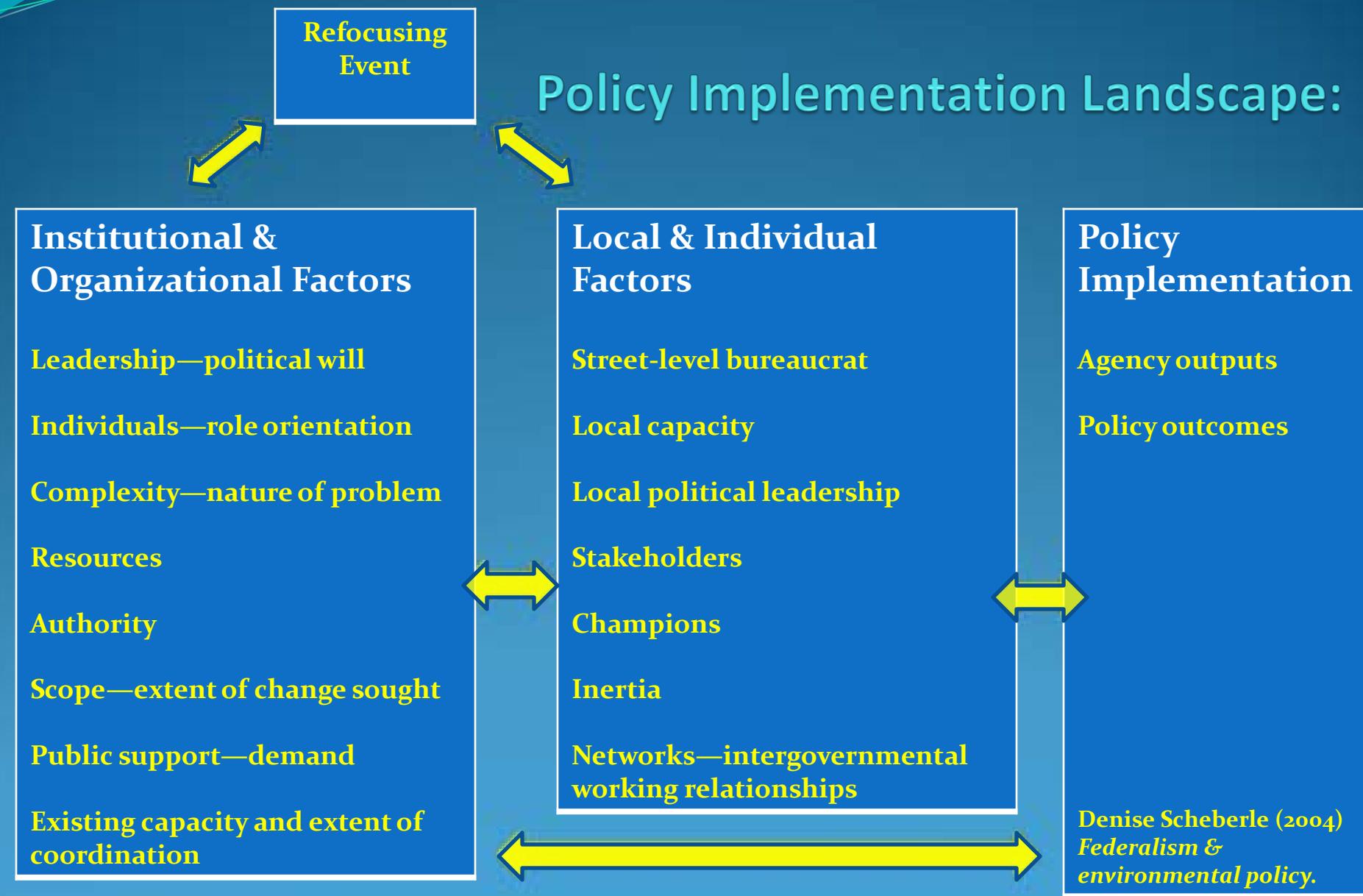
Assumption: Can control implementation behavior
Authority and resources

Bottom-Up—response to top-down Street-level realities

Both....

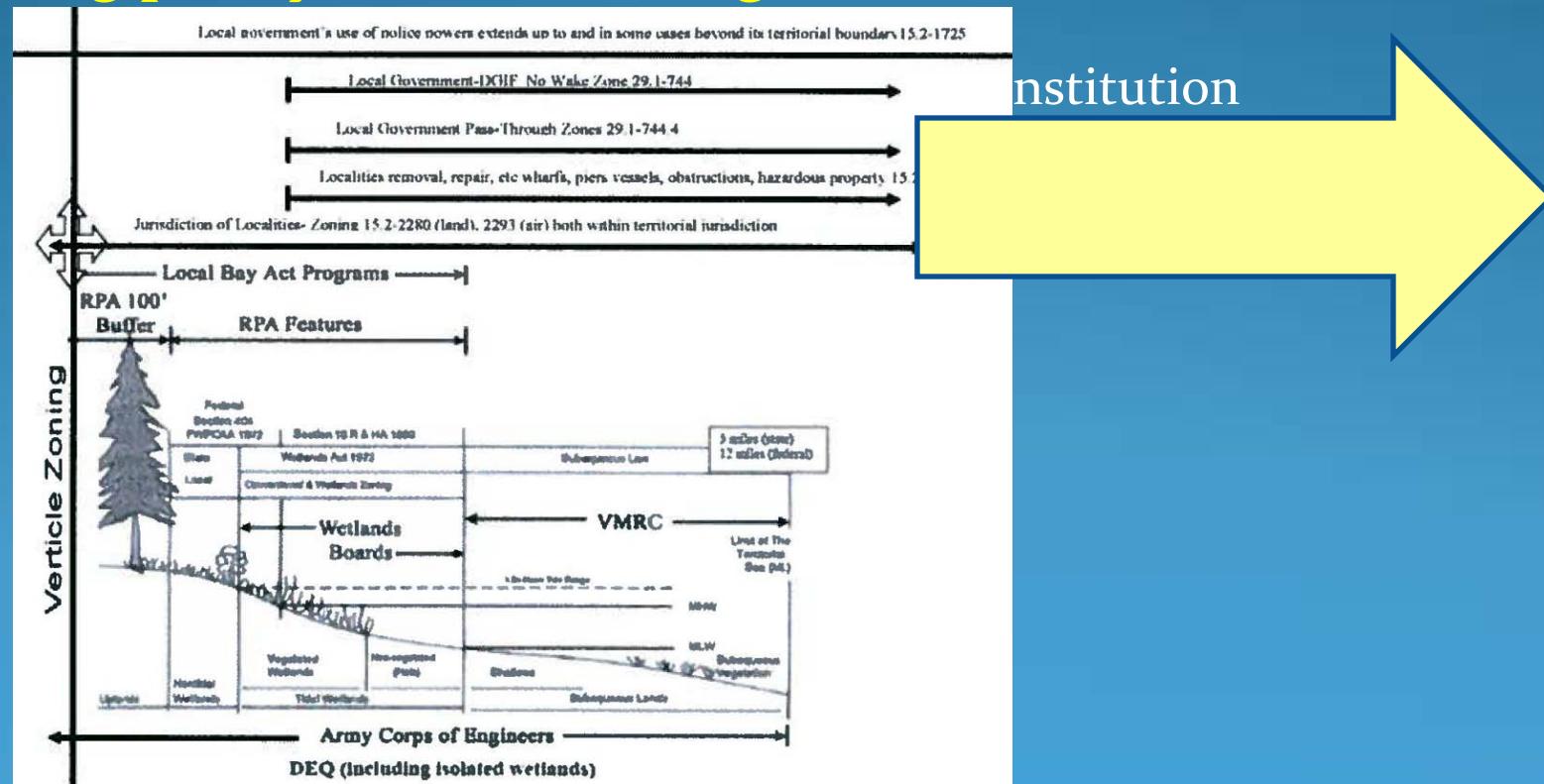


Policy Implementation Landscape:



Policy Implementation Landscape: Virginia mini-example

Big policy context in Virginia



Policy Implementation Landscape: Virginia mini-example

An aquaculture story—sub-plots & multiple story lines

Well known, local real estate broker

Special use permit to unload and process oysters

Neighbor opposes

County denies

Richmond, General Assembly Senator introduces Right-to-Farm bill

Local govt has no authority to restrict aquaculture

Passes Senate, died in House

County proposes a zoning ordinance change

Special use permit had been re-submitted

Policy Implementation Landscape: Virginia mini-example

An aquaculture story—sub-plots & multiple story lines

Sub-plots—complicated landscape

House Bill on Aquaculture Opportunity Zones—zoning, fair competition
Baylor ground study

York Tea Party and Daily Press Editorials...more broadly:

Tea Party—“next intrusion by state government...”
Editorial: Decision a job-killer; choose suburbanites over waterman

Policy Implementation Landscape: Virginia mini-example

An aquaculture story—sub-plots & multiple story lines

Back in York County

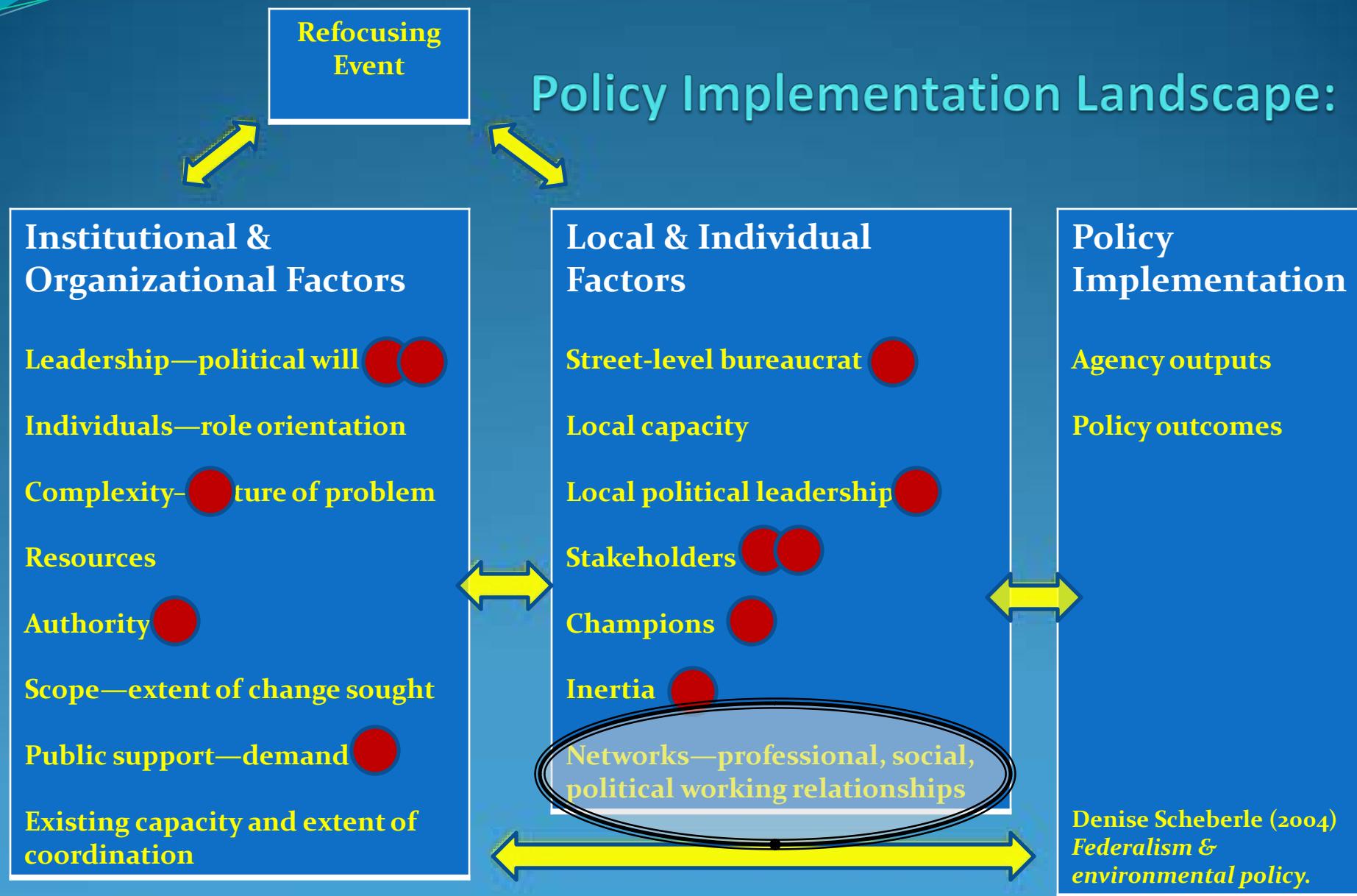
On-line petitions

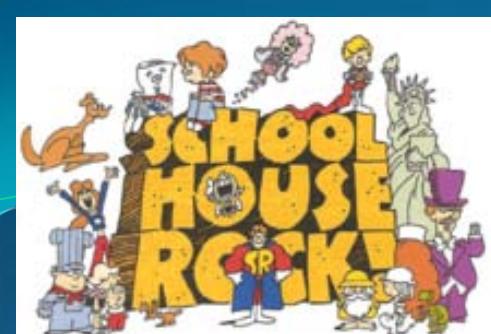
Aquaculture, agriculture, and backyard chickens

Delegate Brenda Pogge, York resident

“I can’t believe we’re having this conversation in York County, the place where liberty was won and the right of the tyrannical government was defeated.”

Policy Implementation Landscape:





Implementation Landscape:

Policy Implementation: Top-Down *and* Bottom-Up

Not straightforward, no single silver bullet.

But we know the questions to ask

Who do we talk to?

Policy Implementation Analysis Perspective: Why isn't my policy working as intended?



Troy W. Hartley: thartley@vims.edu

Research Associate Professor of
Marine Science & Public Policy

Thank you



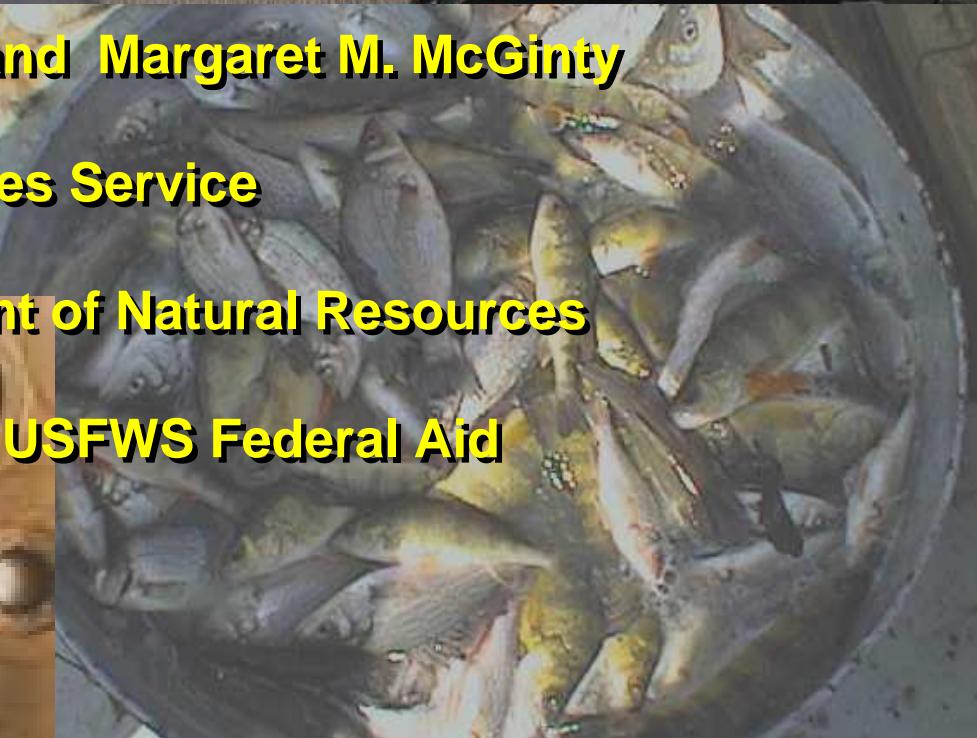
Managing Chesapeake Bay's Land Use, Fish Habitat, and Fisheries: Positive and Negative Case Studies



James H. Uphoff Jr. and Margaret M. McGinty



Fisheries Service



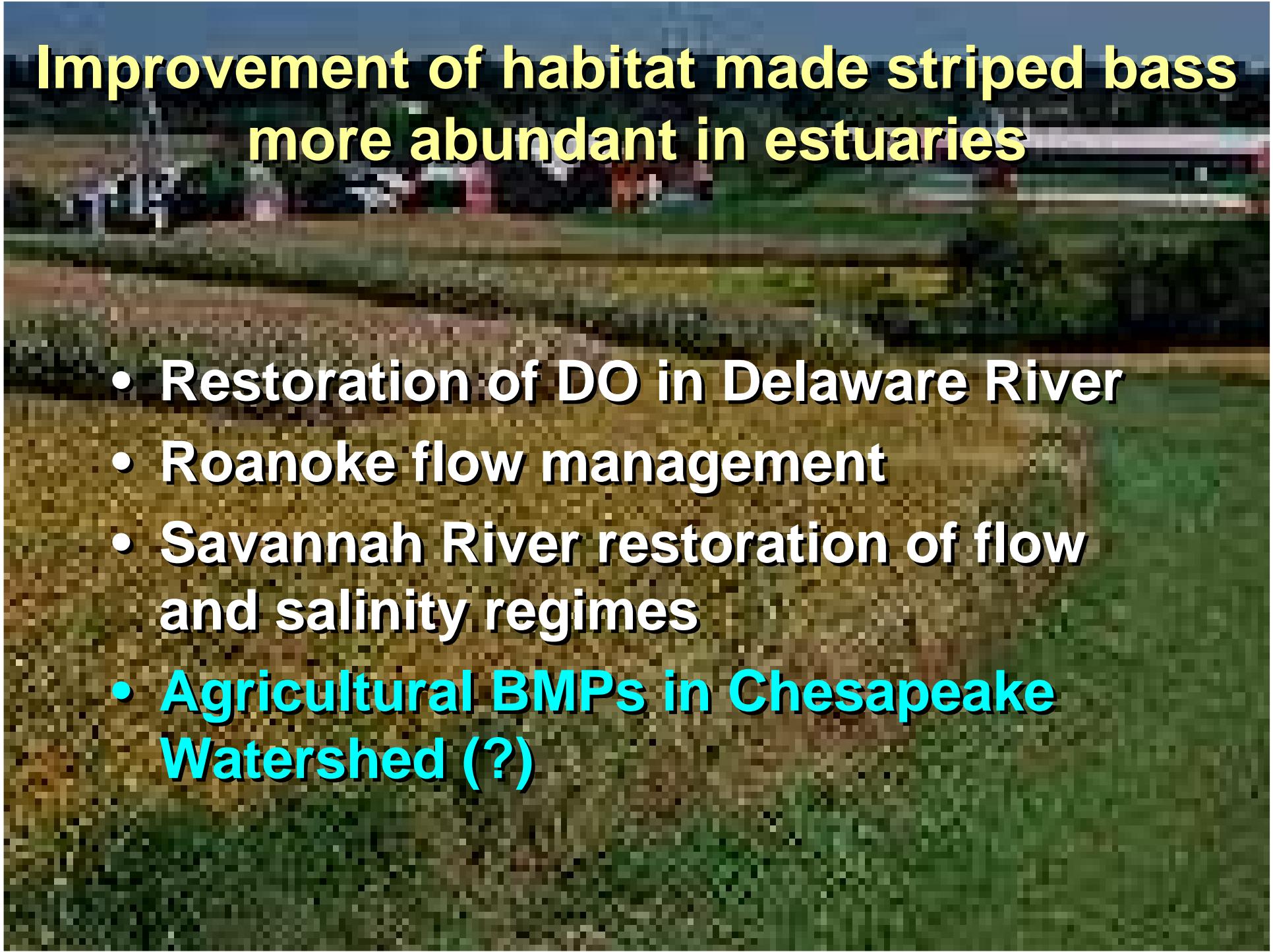
Maryland Department of Natural Resources

Funded through USFWS Federal Aid

Crash and recovery of Chesapeake Bay striped bass has become part of fisheries management mythology.



Overfishing and habitat conditions were leading hypotheses.
A strong stock increase followed after reducing F.
Habitat hypothesis was not pursued further.



Improvement of habitat made striped bass more abundant in estuaries

- Restoration of DO in Delaware River
- Roanoke flow management
- Savannah River restoration of flow and salinity regimes
- Agricultural BMPs in Chesapeake Watershed (?)

Why would agricultural conservation matter?

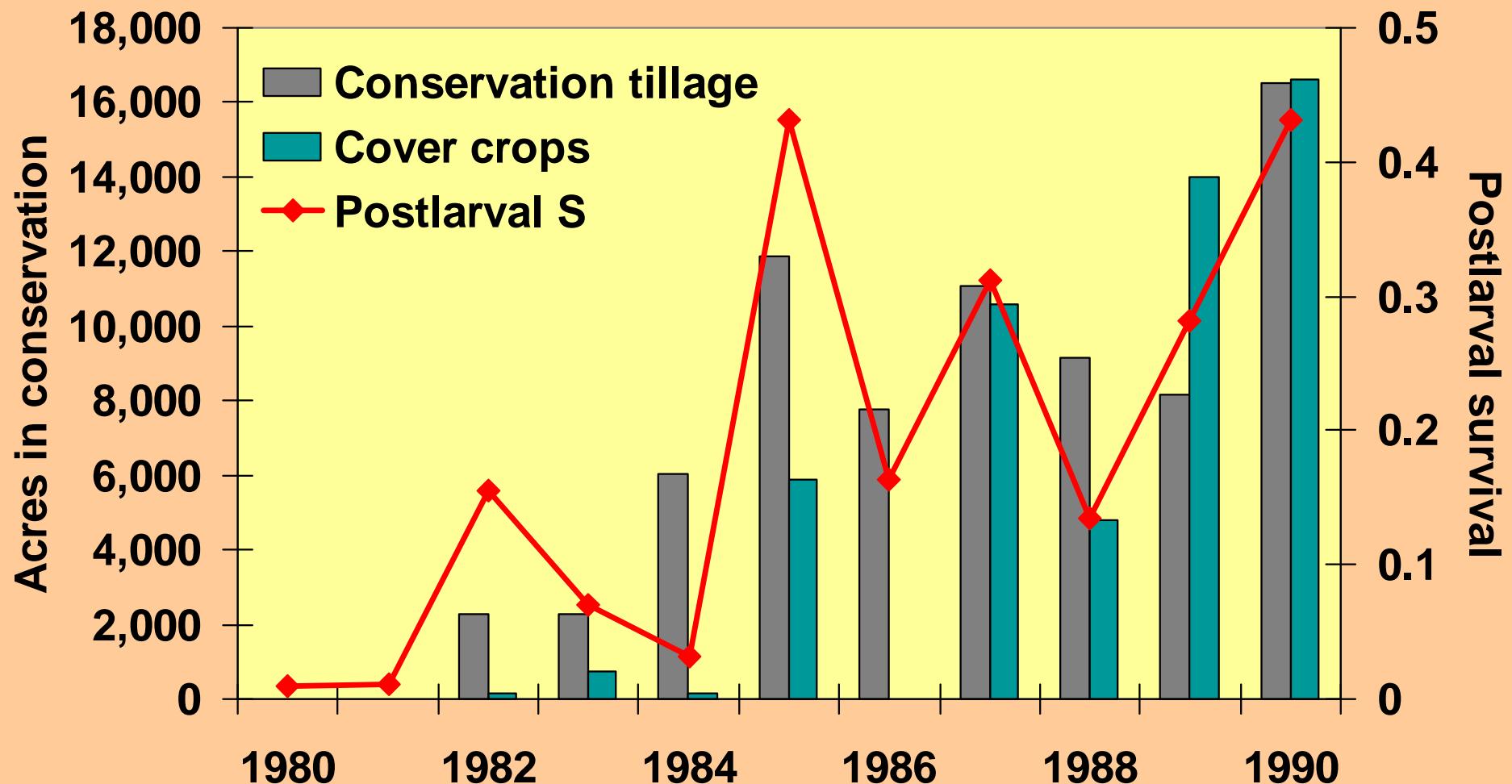
1. Spawning areas & nurseries aren't big (MD major ones plotted).
2. They receive nearly all watershed drainage.
3. Agriculture is the largest human land use (acreage).



Bay Watershed	
Land-use	Percent
Developed	3.6%
Agriculture	28.5%
Forest	60.0%
Other	7.8%

Choptank River postlarval survival follows Caroline County BMPs (minimize erosion, pesticides, fertilizer).

Caroline County, MD, borders most of the nursery and had very good records.

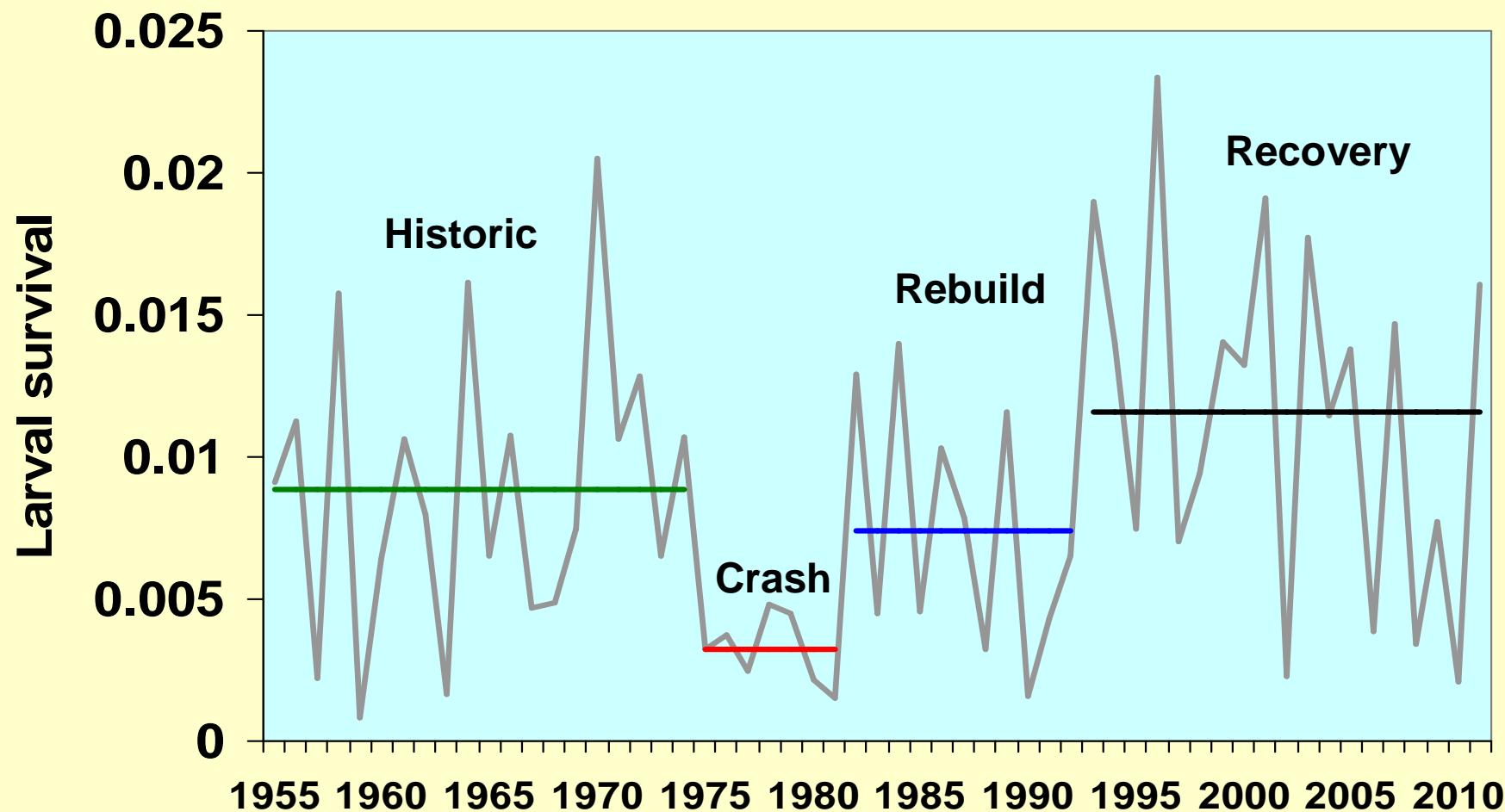


1955-2011 Index of Larval Survival for Maryland' major spawning rivers

- Recruits per egg scaled into survival
- Egg production indicated by egg-
presence absence
- Recruits = juvenile indices for 4 major
spawning tributaries

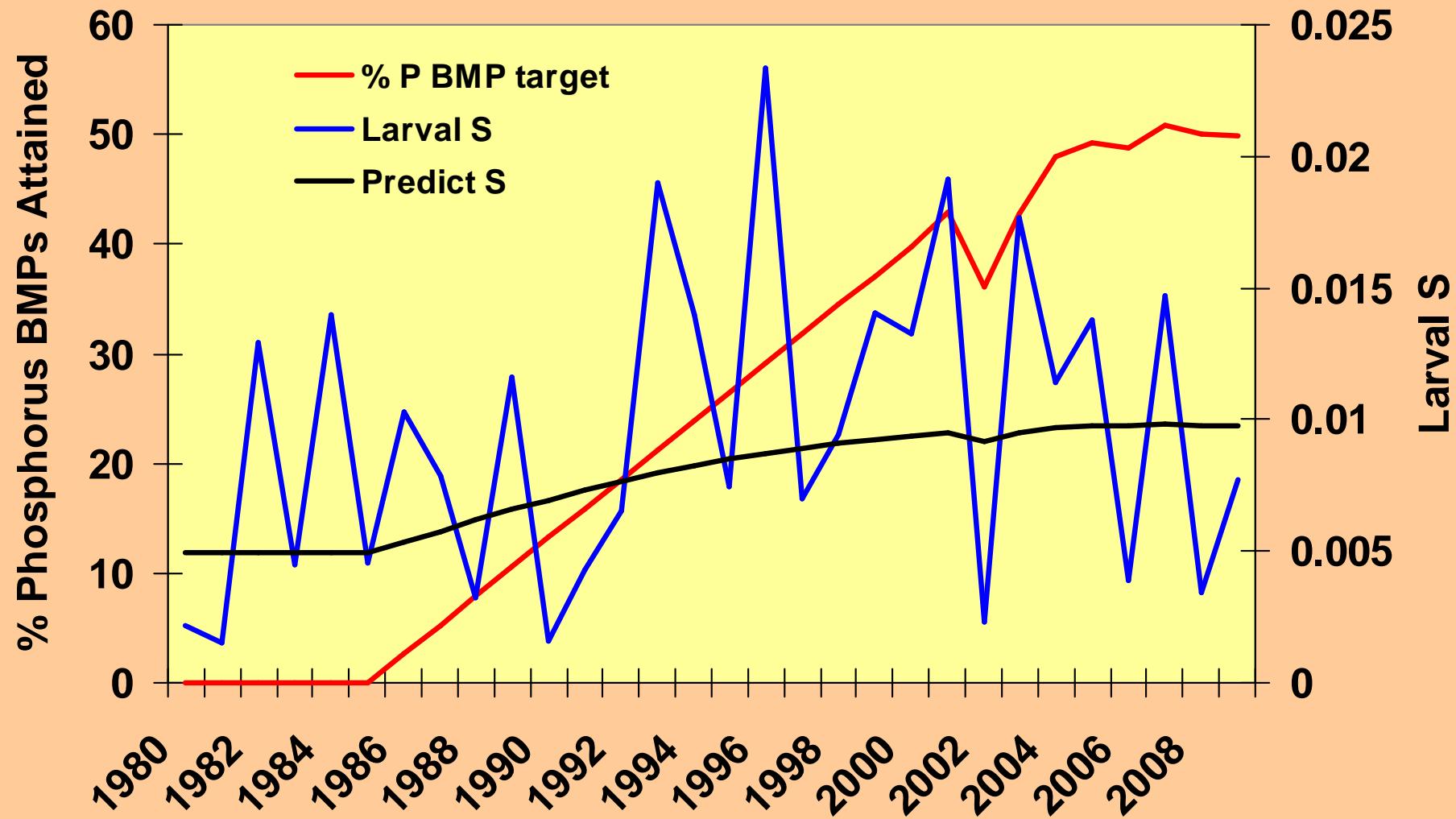
Bay wide larval survival (mean of spawning area estimates) and time period averages.

Time period averages qualitatively follow abundance.



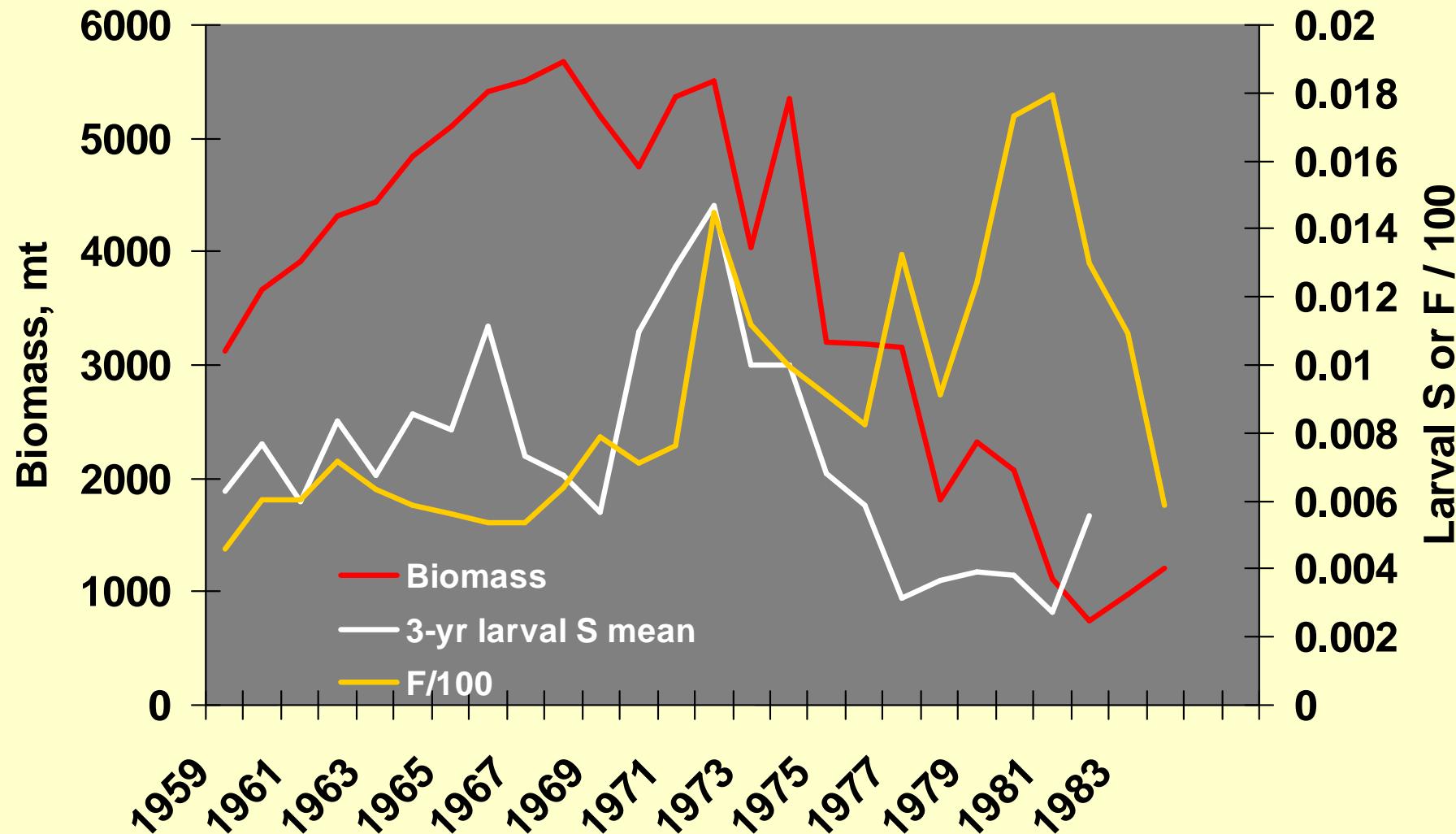
Trends in larval survival and estimated attainment of phosphorus BMPs

%BMP estimates from Bay Program



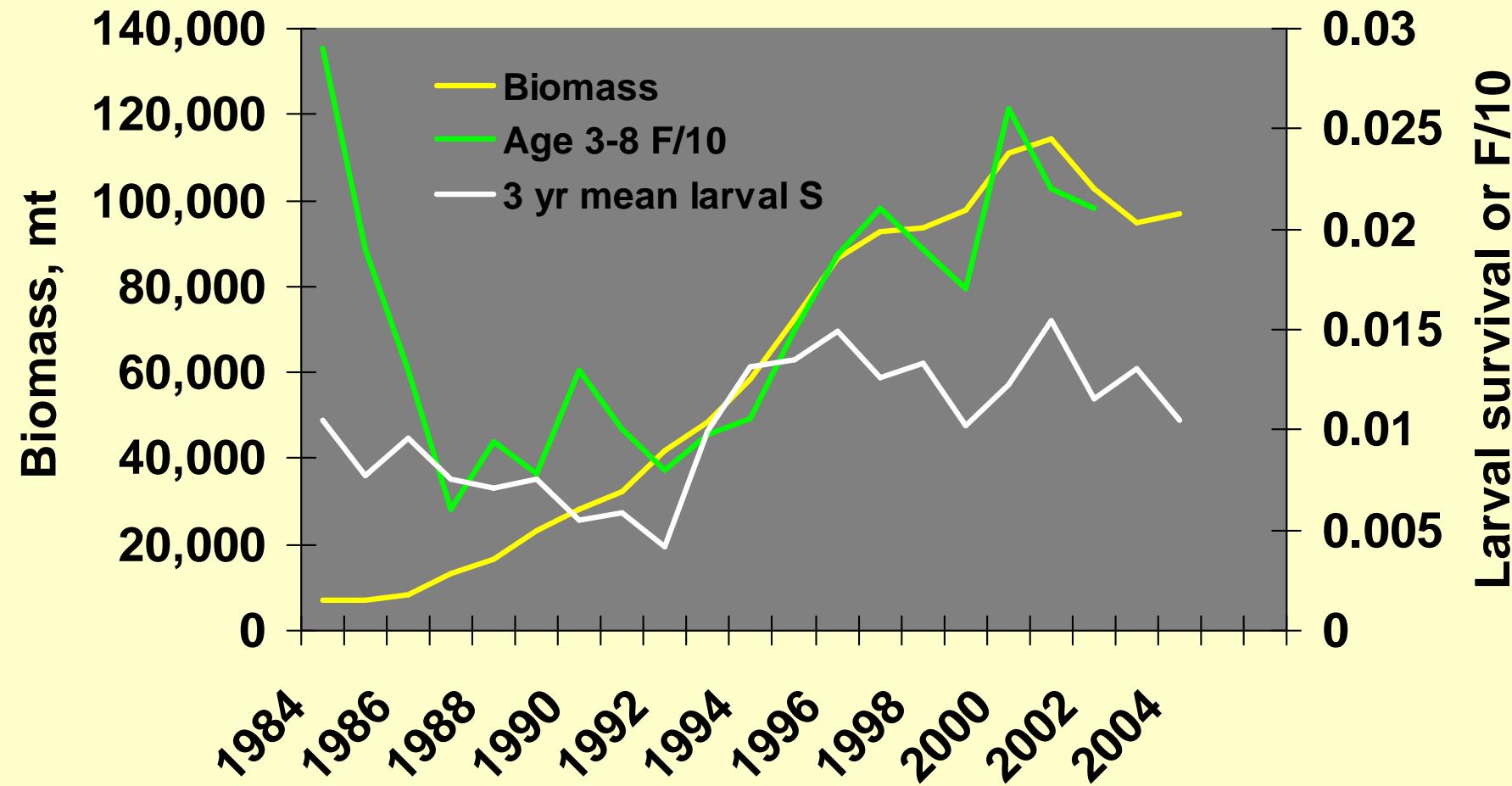
Trends in larval survival precede F and biomass

Chesapeake F & biomass from Gibson (1993) VPA



Rebuilding of biomass with low F was complemented by increased larval survival

Atlantic coast F & biomass from ASMFC (2006)





Maryland Fisheries Service has been looking at development and fish habitat dynamics in Chesapeake Bay

- **Goals:**
 - Fish management strategies that reflect development's impact
 - Guidance for planning agencies
 - Public support for watershed conservation

**Focus is on “iconic” managed species
i.e., keep the common species common**

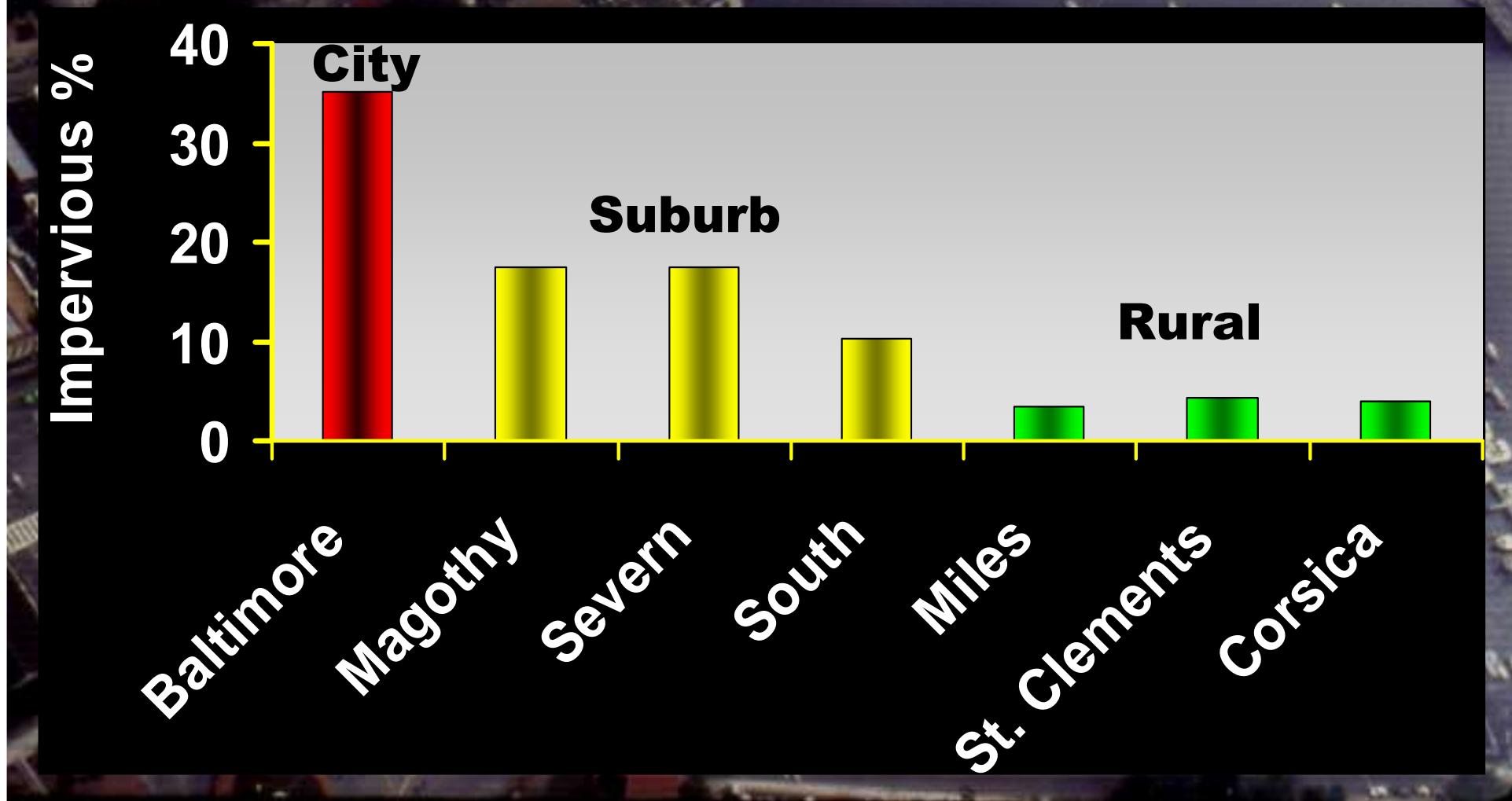




Presence-absence is main measure of fish response to development

- **Ecologically meaningful**
- **Statistically robust**
- **Understandable**
- **Cost-effective**

Impervious surface measures intensity of development

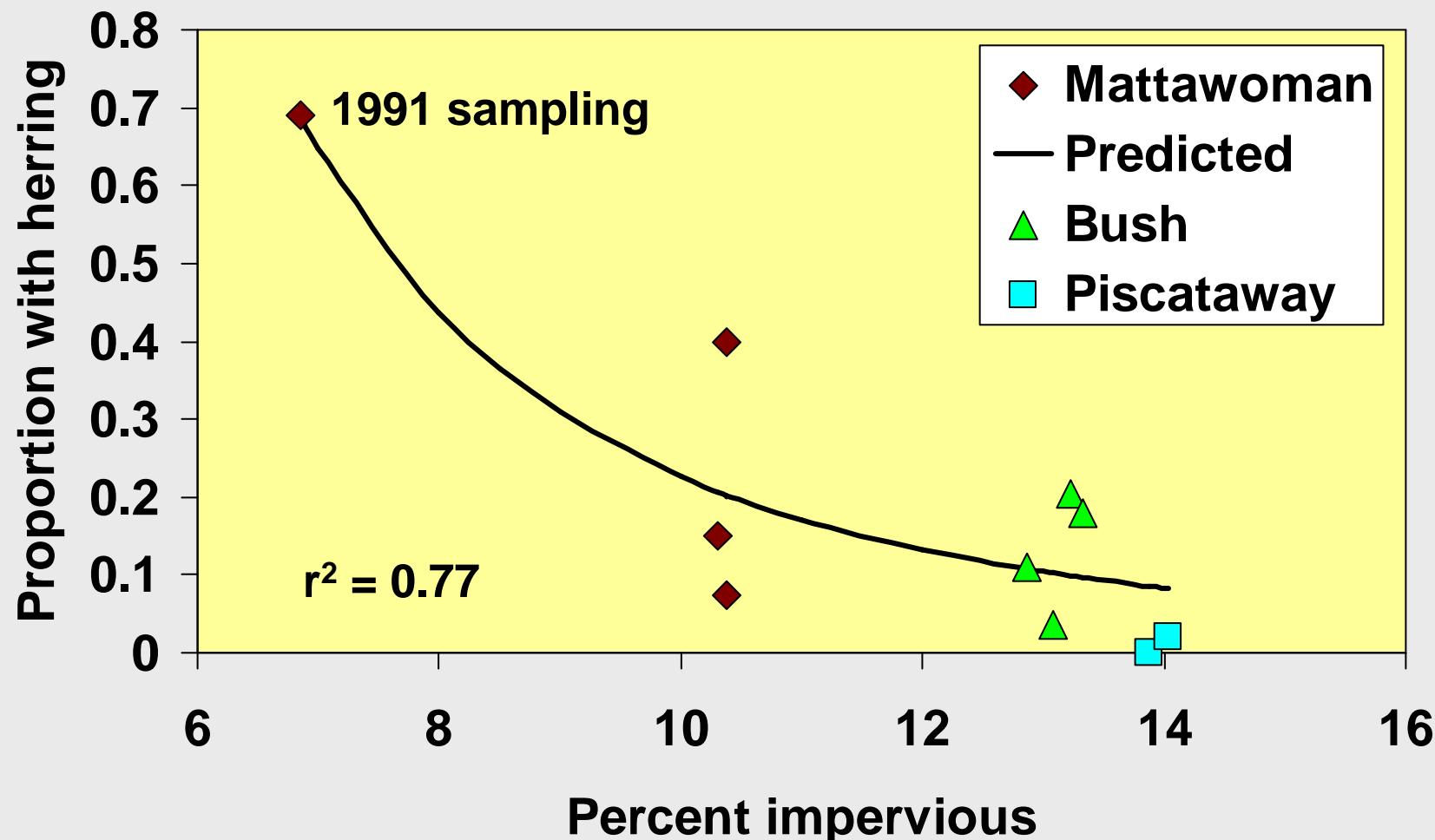




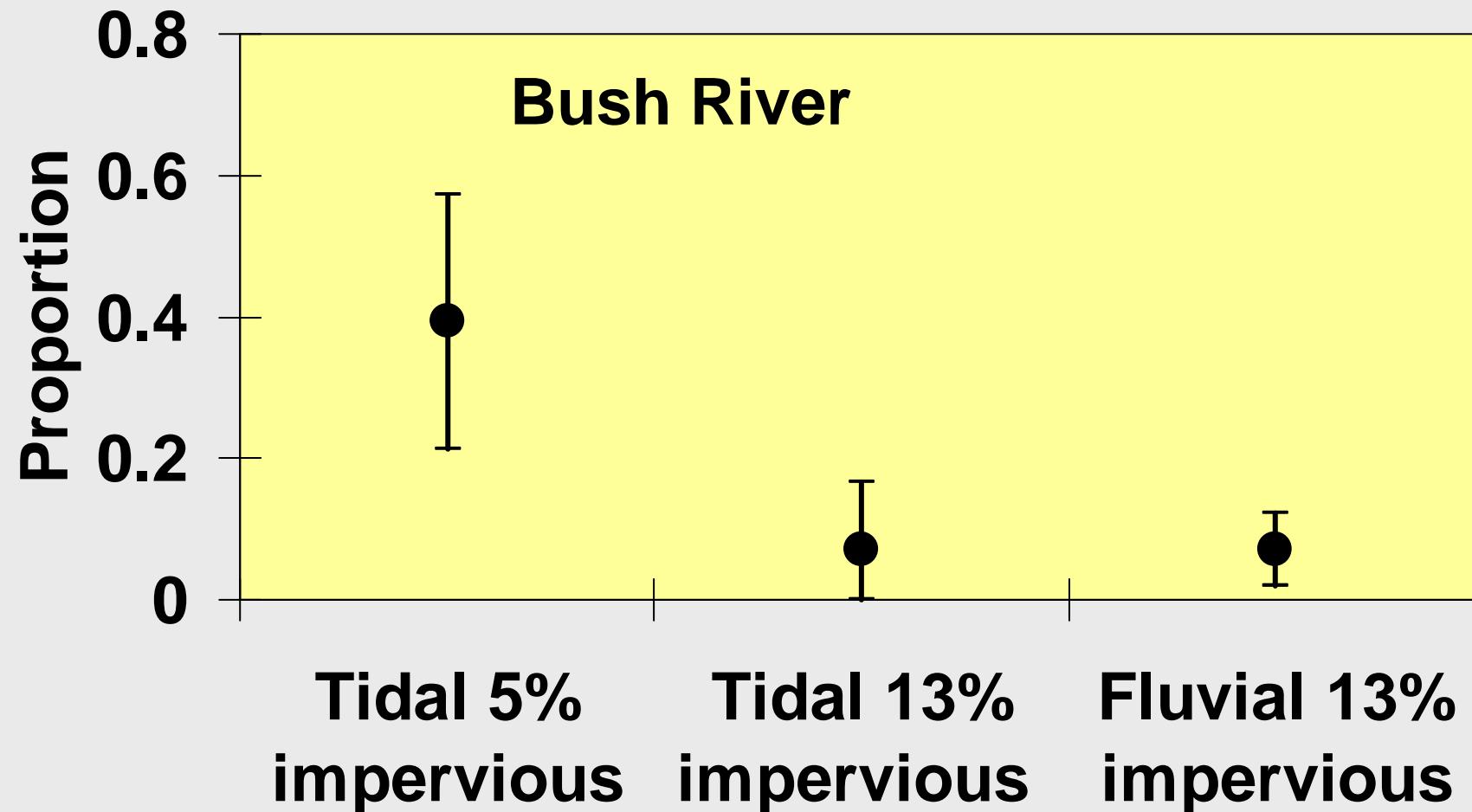
Volunteers conducted anadromous fish stream surveys during 2005-2010 to explore development's effect.

Three watersheds were sampled.

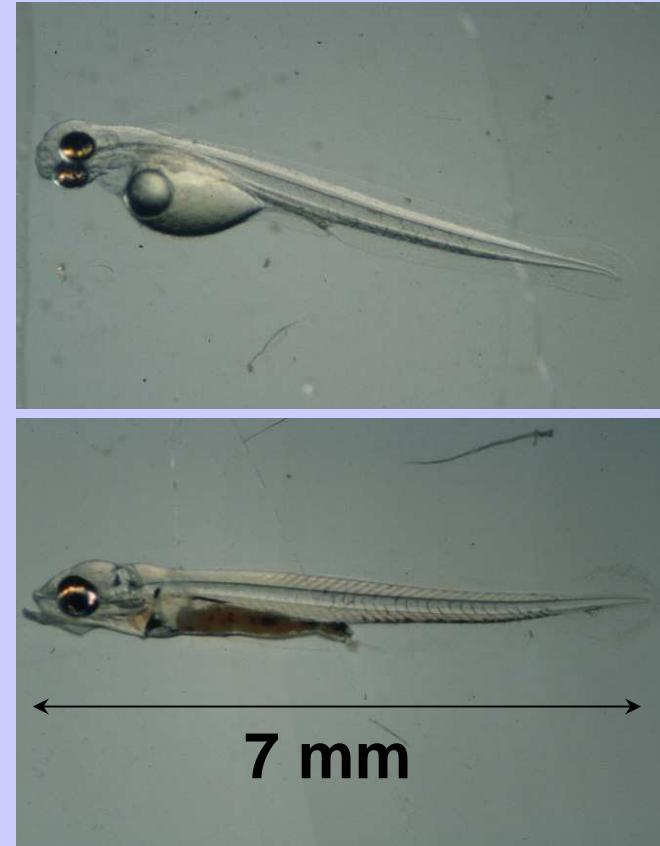
Proportion of stream samples with herring eggs or larvae versus impervious surface



Proportion of samples (95% CI) with anadromous fish eggs or larvae in developed and undeveloped portions of watershed

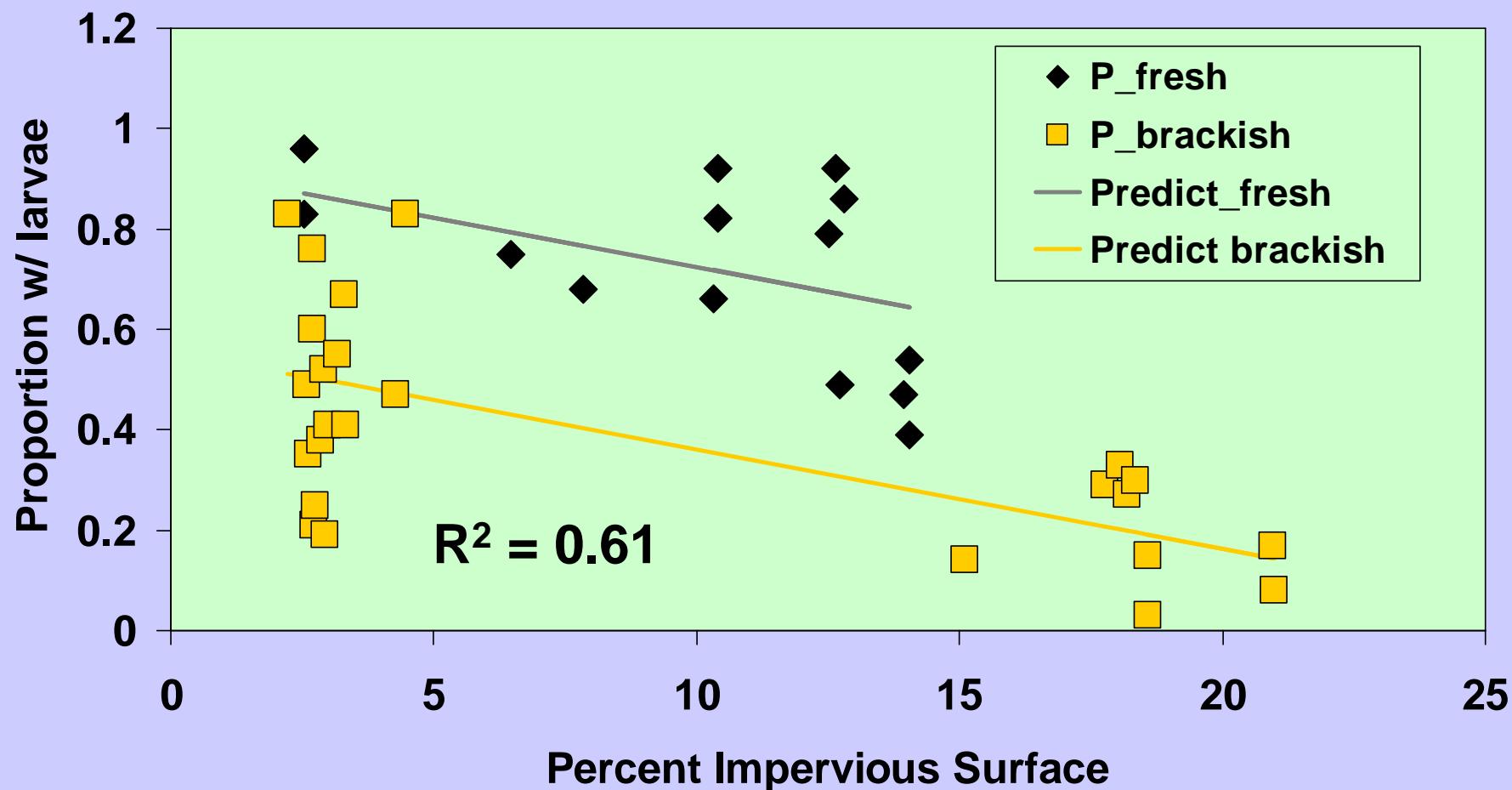


Estuarine yellow perch larvae were sampled with plankton nets towed from boats

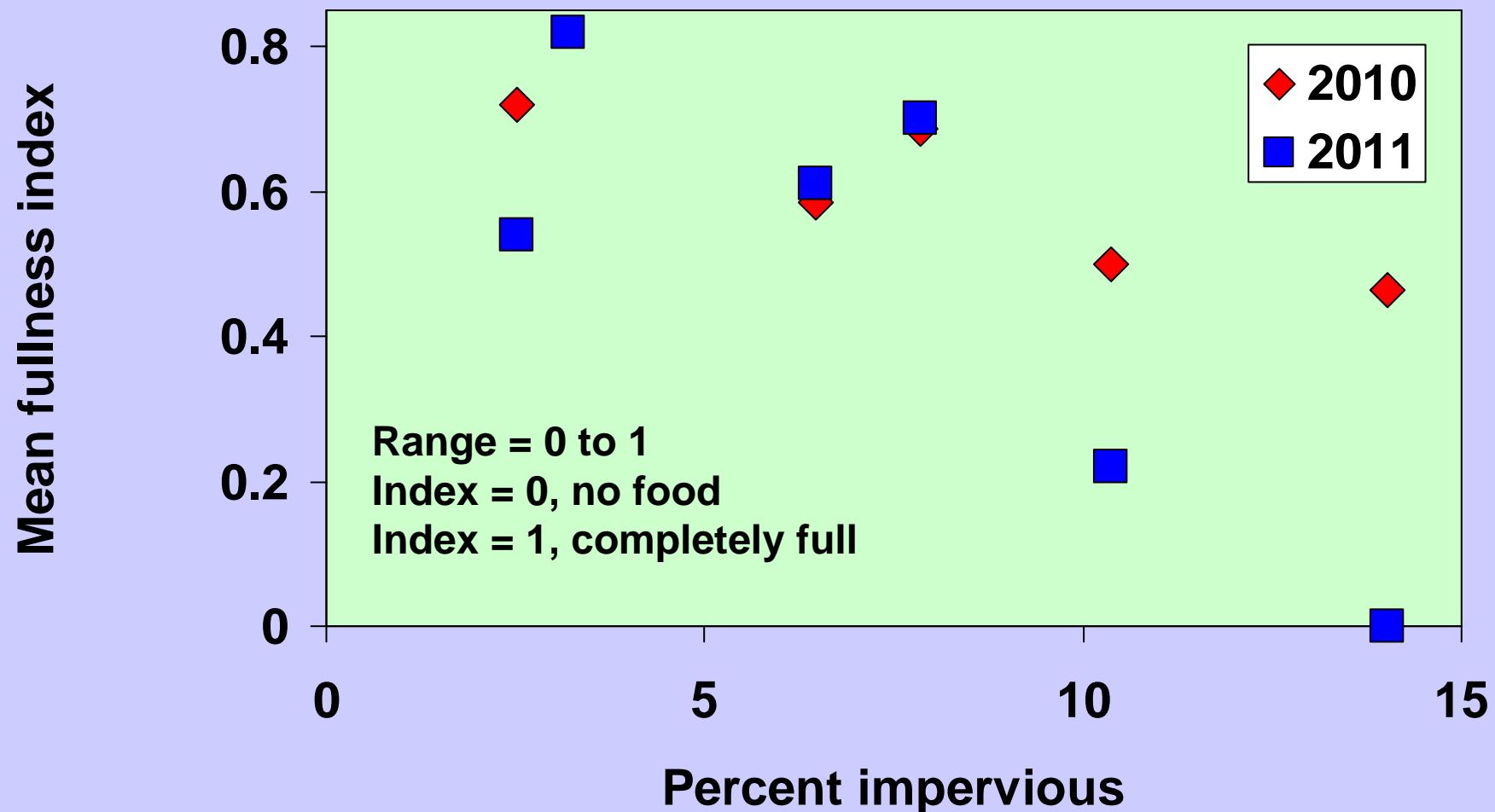


Proportion of tows with yellow perch larvae declines with development in tidal-fresh and brackish subestuaries

(fresh and brackish as categories in regression)



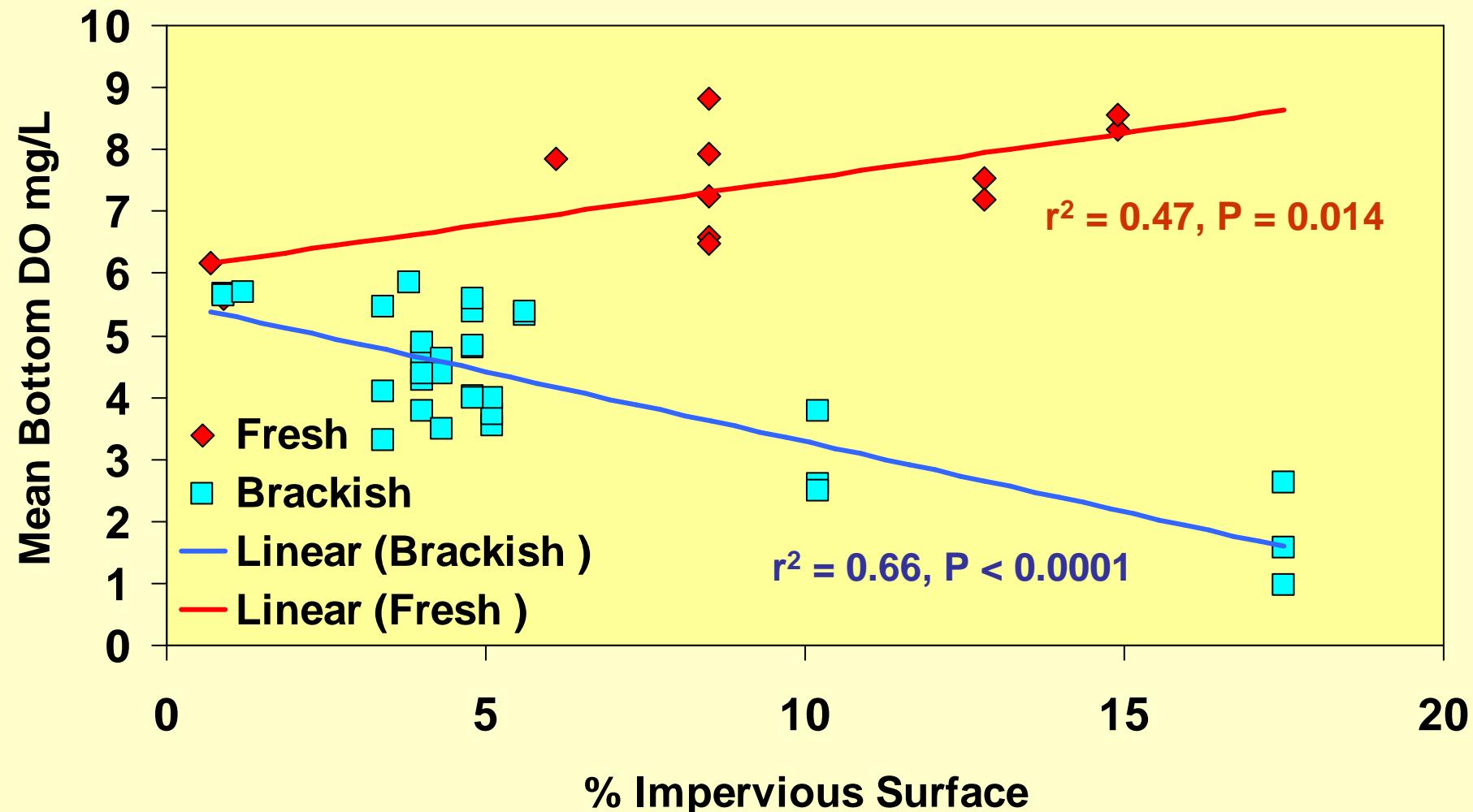
Early larvae feeding success on zooplankton in 2010 & 2011 declines with development



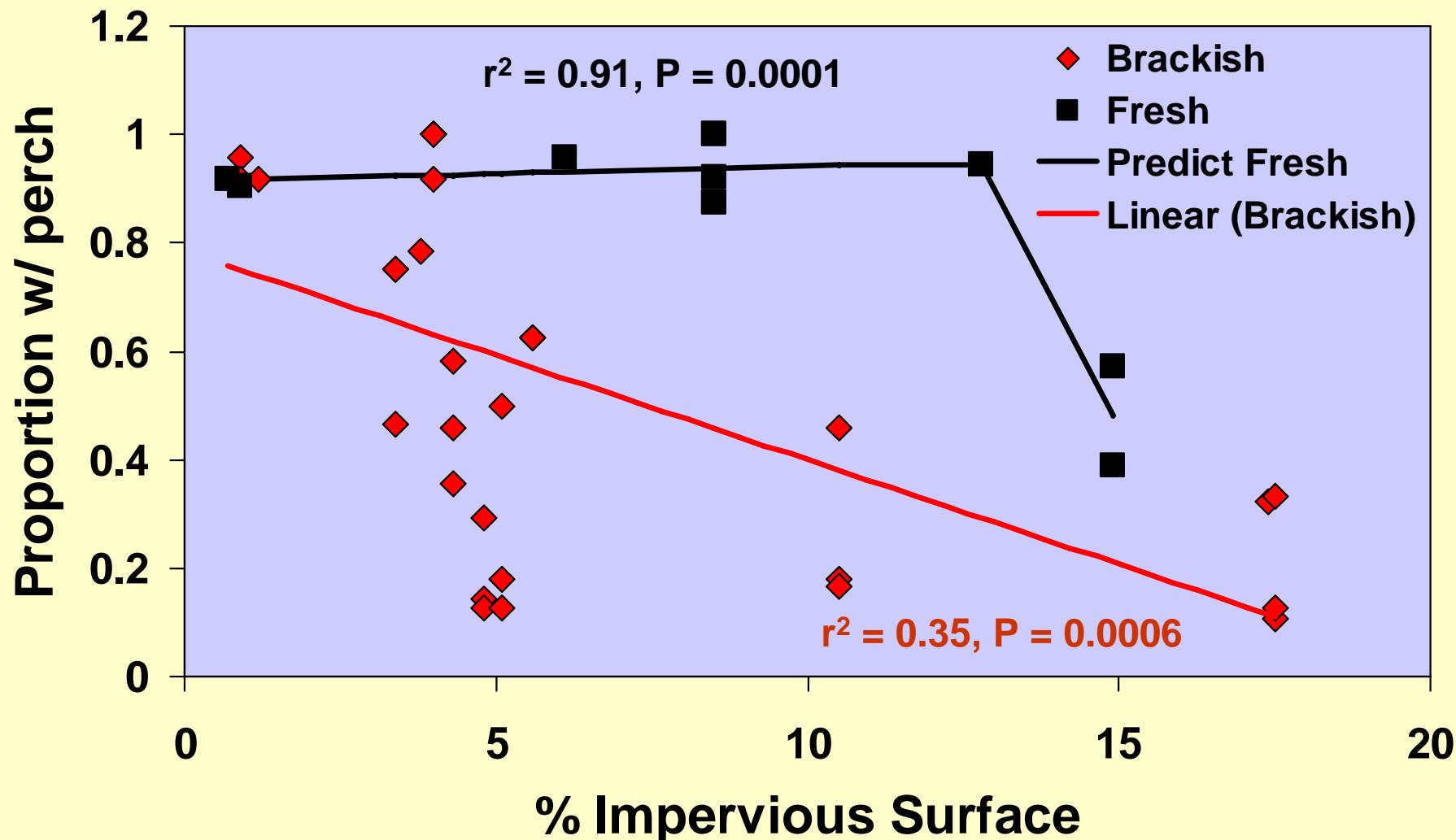
Summer estuarine habitat: habitat occupation and dissolved oxygen



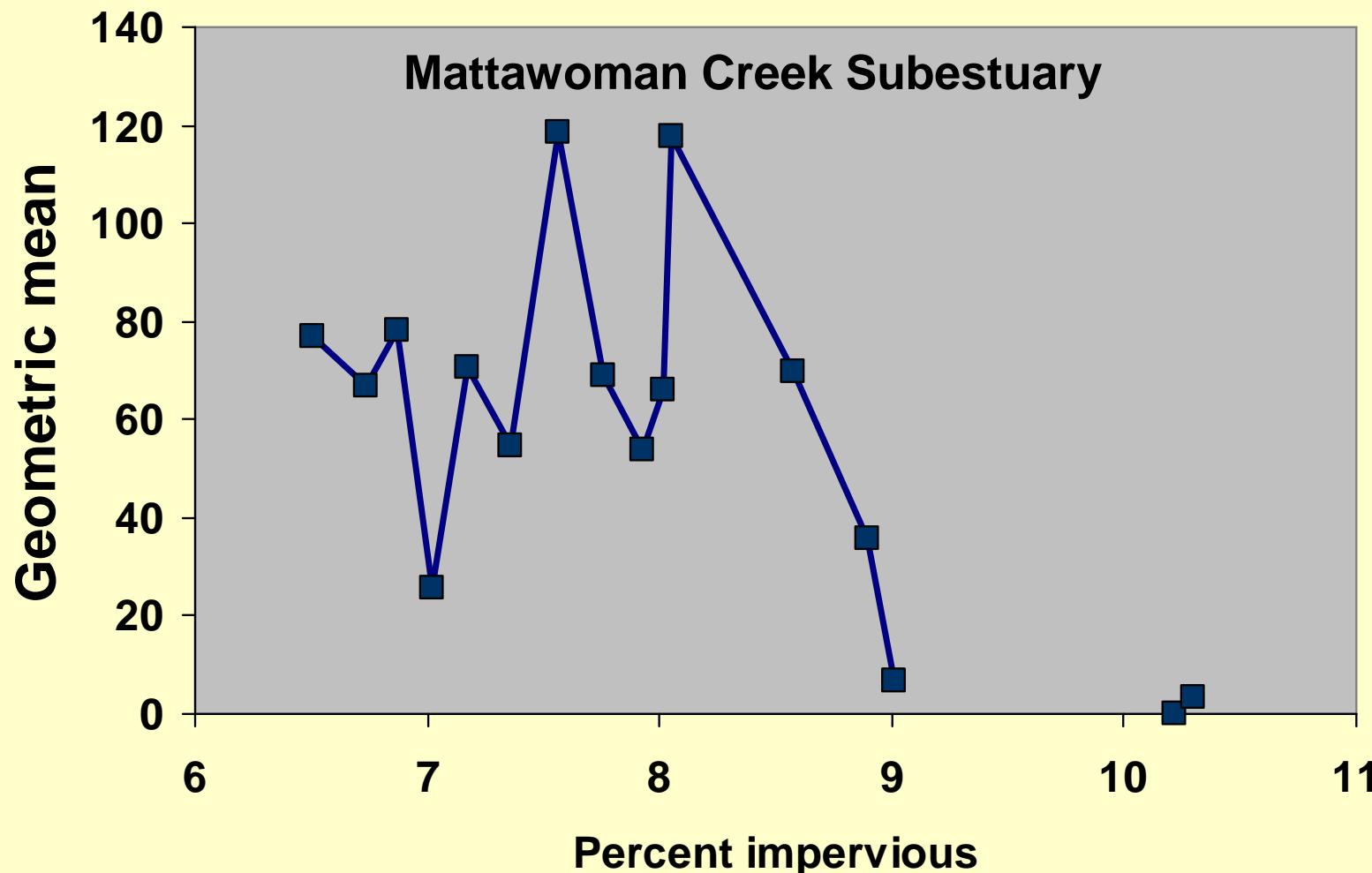
Mean summer bottom DO and percent impervious for fresh and brackish tributaries.



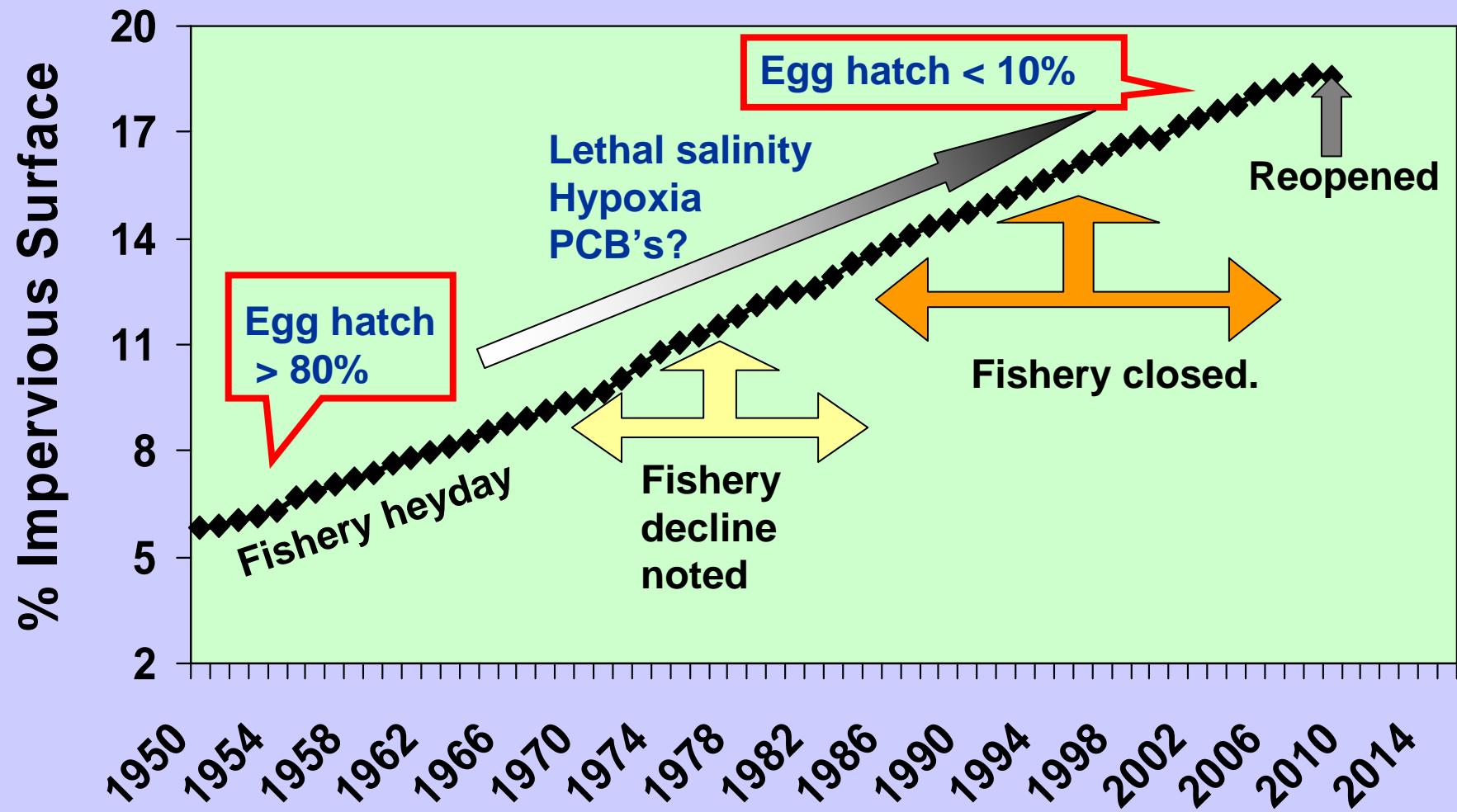
Proportion of bottom trawls with adult white perch degrades by 15% impervious in fresh-tidal or brackish, but how you get there differs.

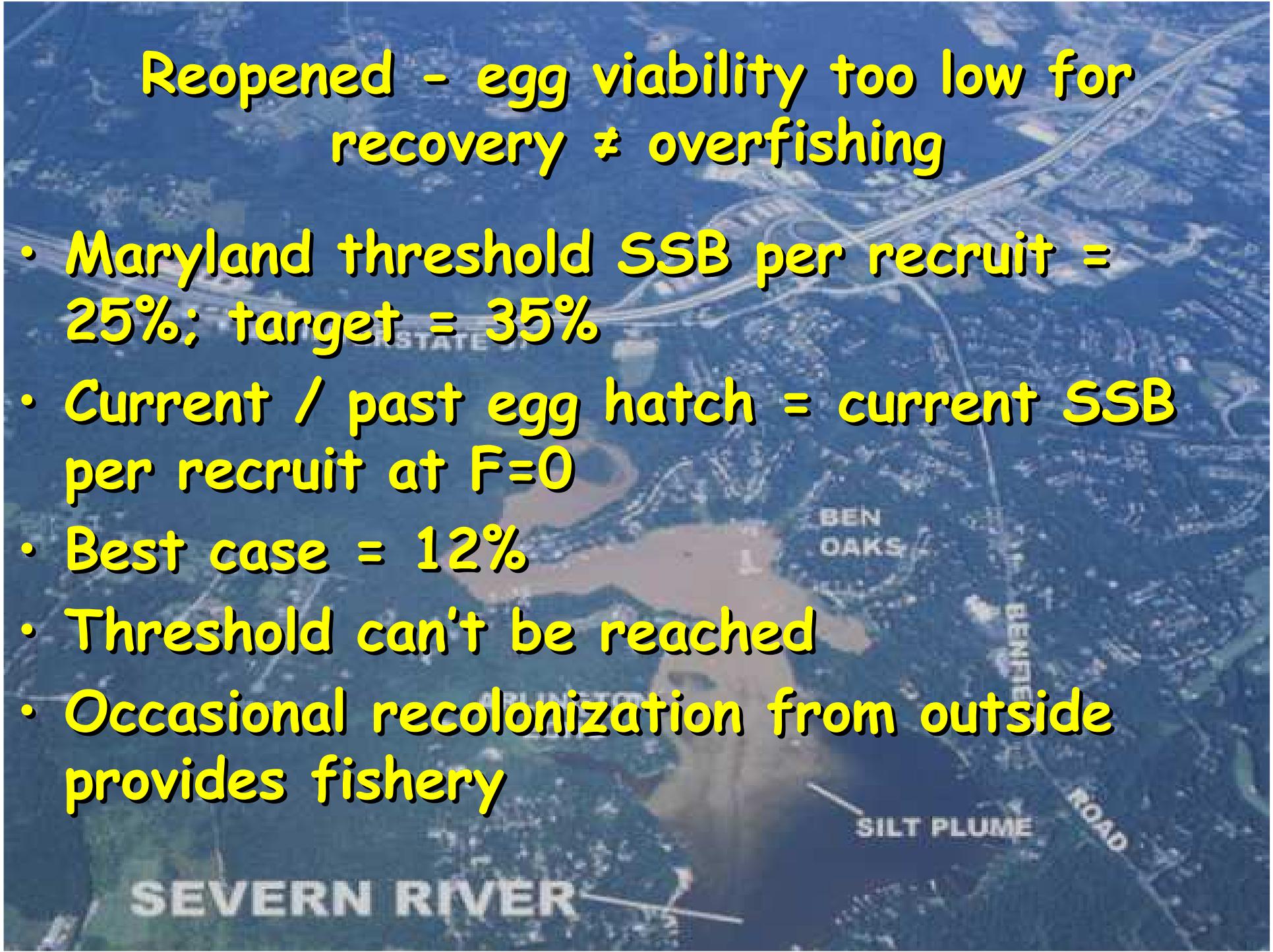


Case study (1989-2002 & 2009-2010) suggests fresh-tidal fish community threshold. Abundance of all species in summer trawl samples collapses.



Severn River yellow perch fishery & development, 1950-2009

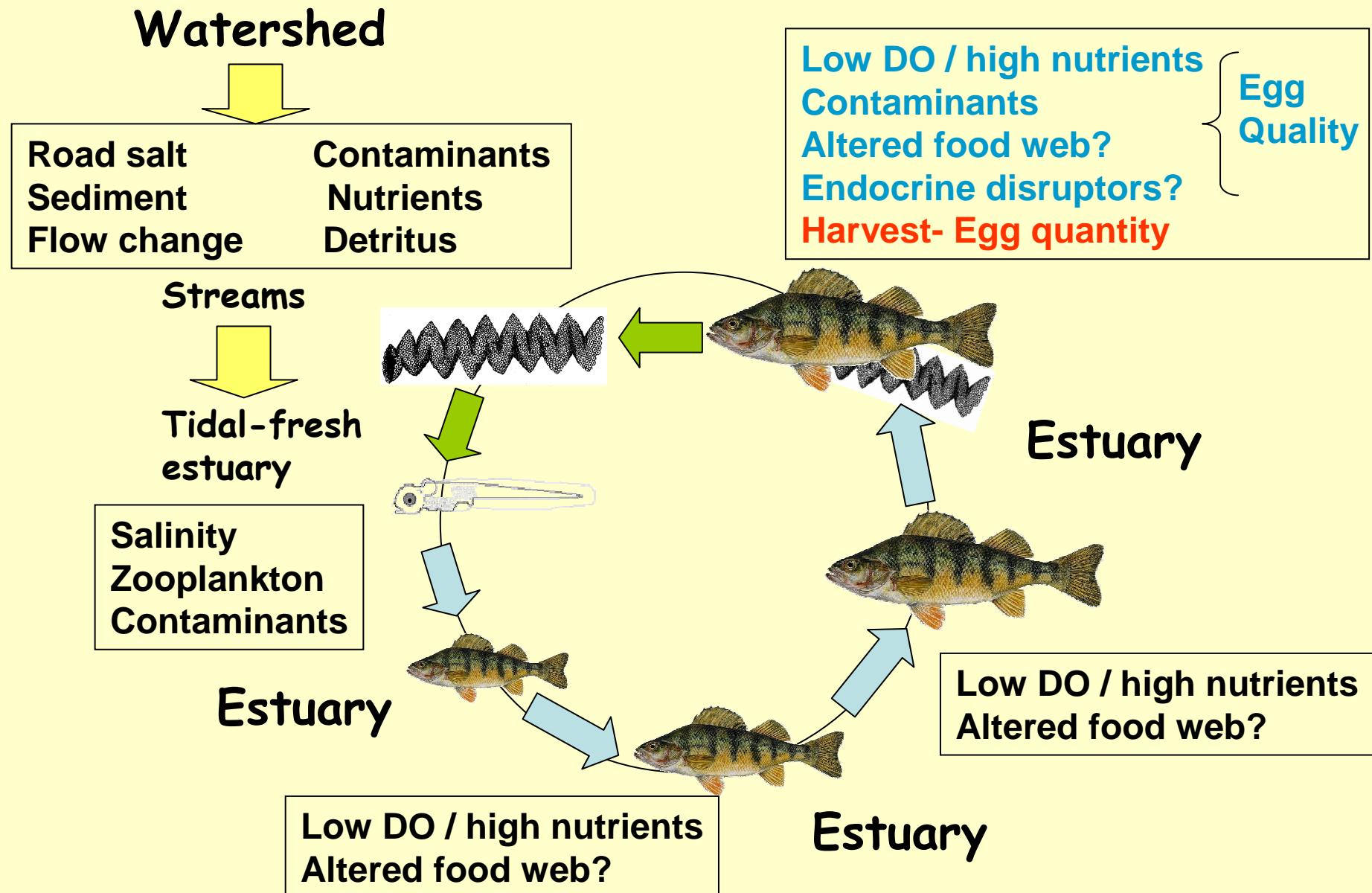




Reopened - egg viability too low for recovery ≠ overfishing

- Maryland threshold SSB per recruit = 25%; target = 35%
- Current / past egg hatch = current SSB per recruit at $F=0$
- Best case = 12%
- Threshold can't be reached
- Occasional recolonization from outside provides fishery

Perch encounter multiple development-related stressors (Wheel of Misfortune)

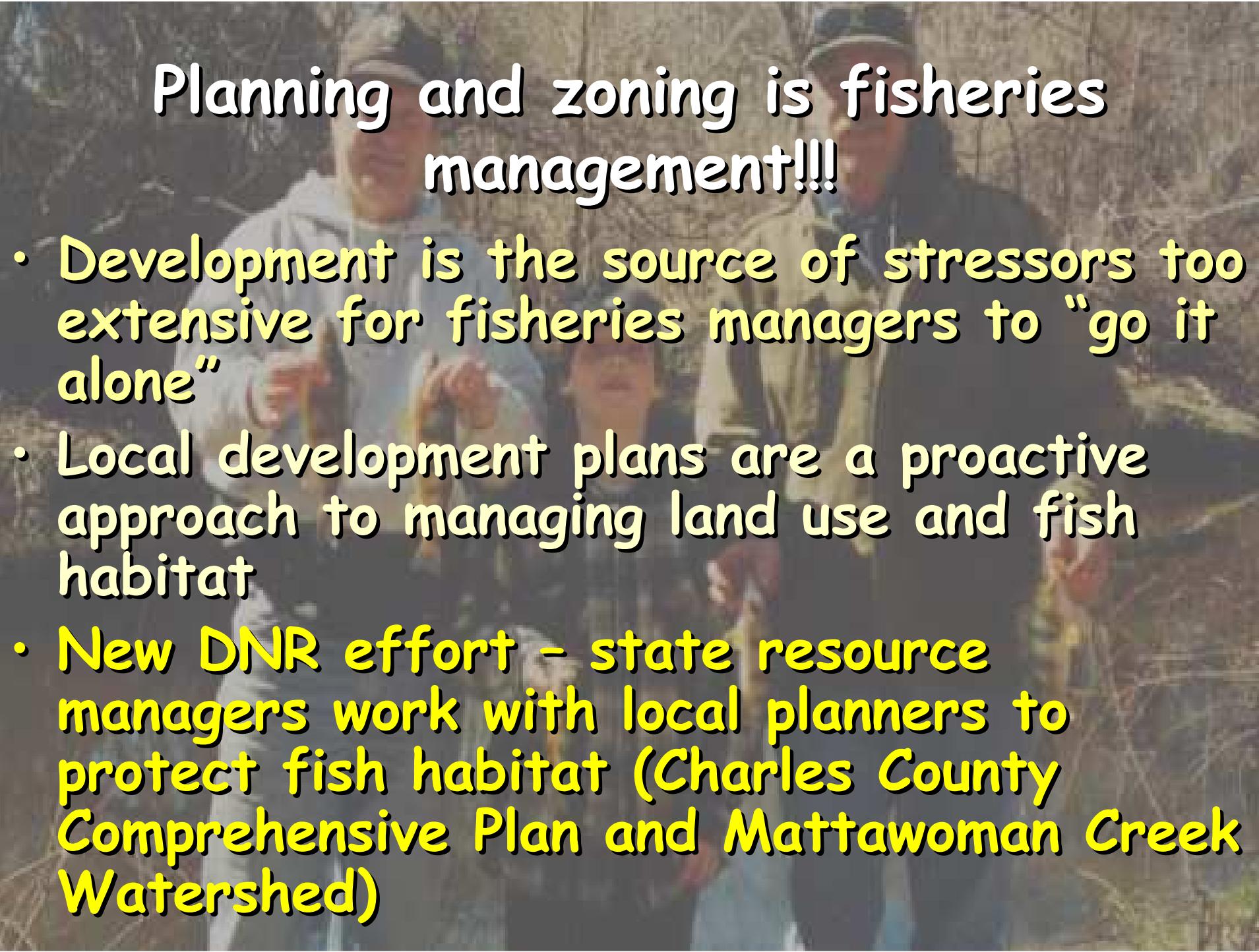


Impervious surface reference points

- < 5% impervious - harvest restrictions & stocking; preserve watershed
- 5-10% - option to decrease harvest & stocking to compensate. Preserve & fix watershed
- >10% - preserve & fix watershed.

Managing harvest & stocking not sustainable strategies.

- >15% - watershed & fishery solutions limited



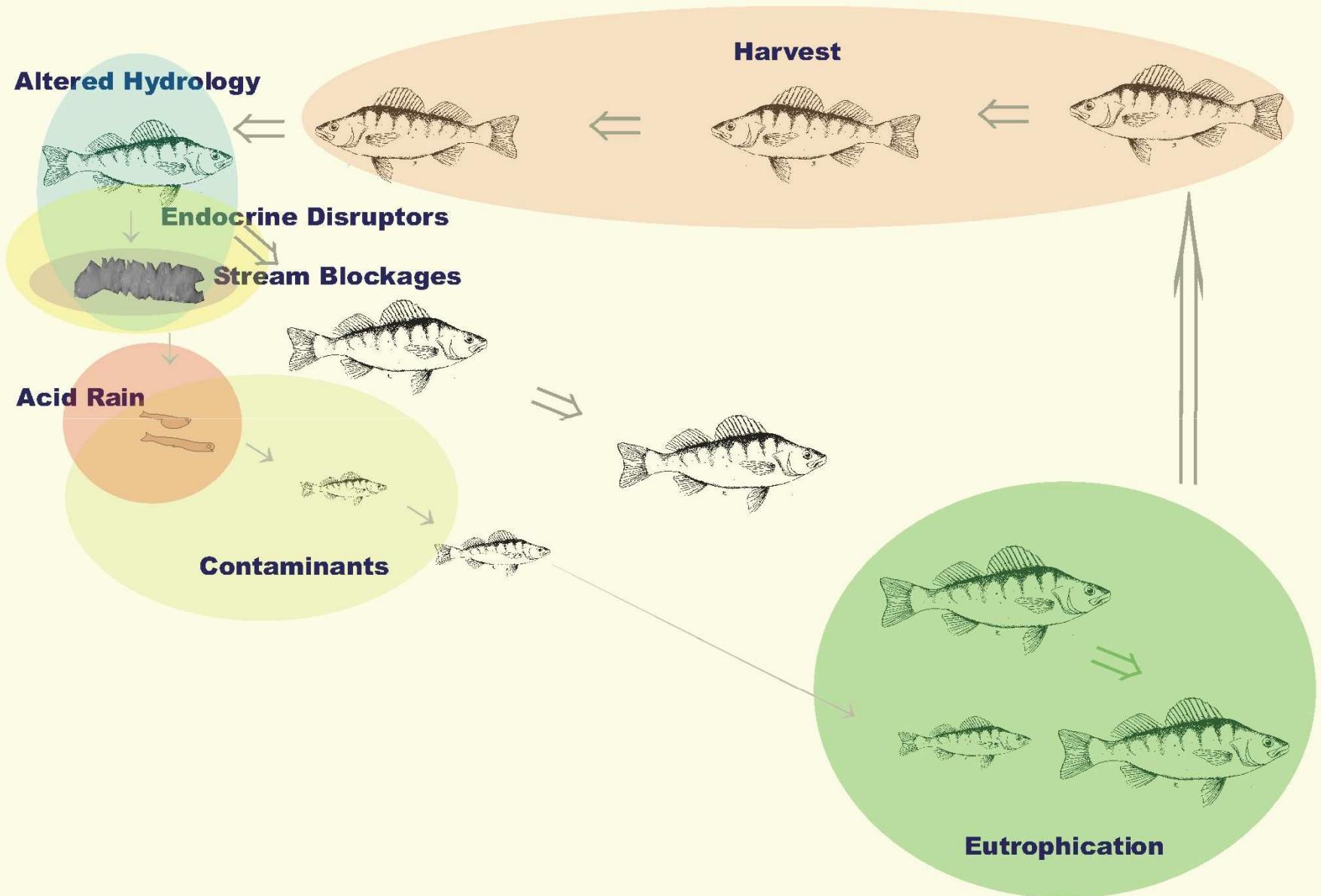
Planning and zoning is fisheries management!!!!

- Development is the source of stressors too extensive for fisheries managers to “go it alone”
- Local development plans are a proactive approach to managing land use and fish habitat
- New DNR effort – state resource managers work with local planners to protect fish habitat (**Charles County Comprehensive Plan and Mattawoman Creek Watershed**)



Applying Impervious Thresholds to Develop Management Priorities

MD DNR Fisheries Service
Fisheries Habitat and Ecosystem Program
Margaret McGinty and Jim Uphoff





**LANDSCAPE MANAGEMENT
IS FISHERIES MANAGEMENT**

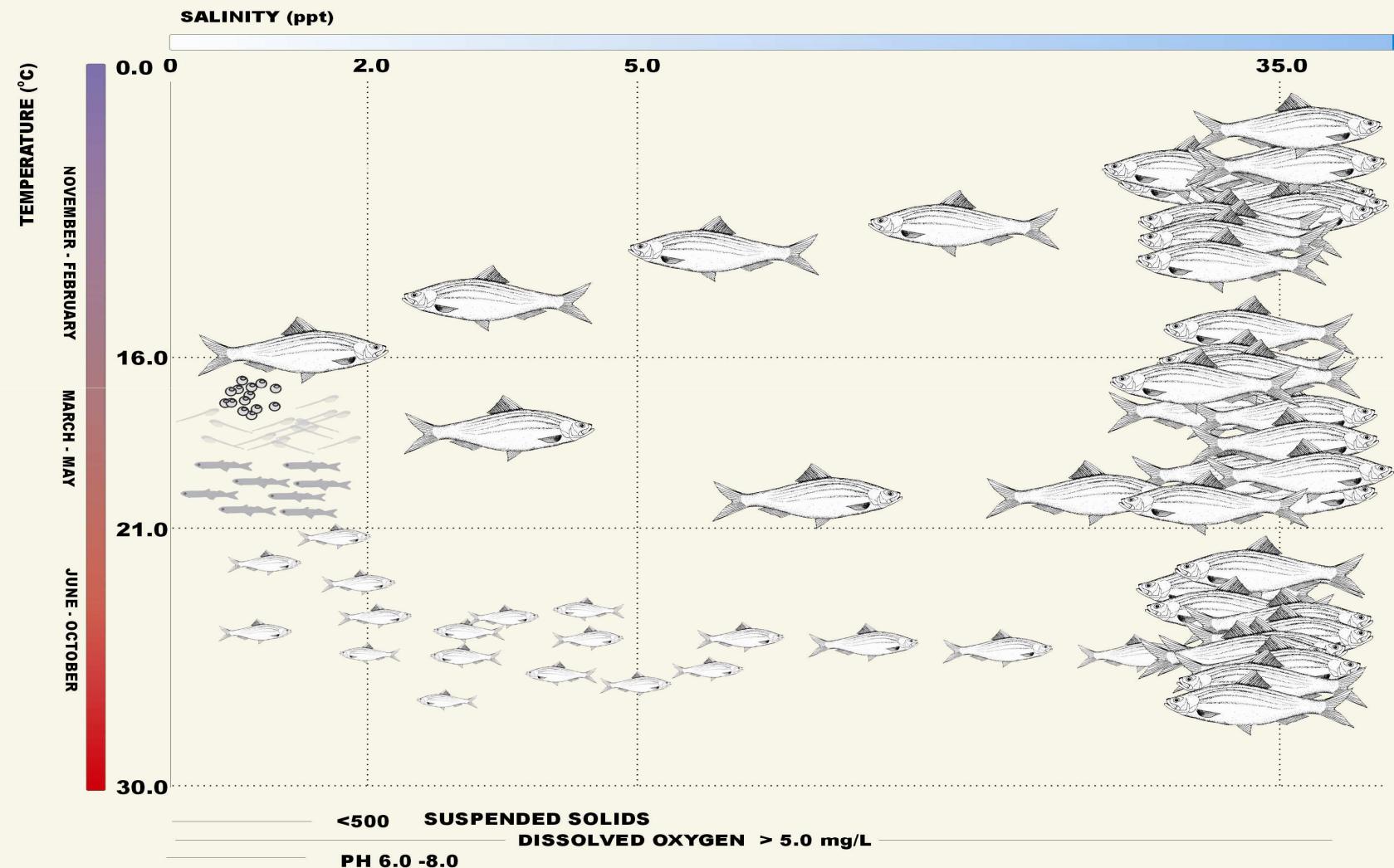


Goal: Identify and prioritize fish habitat areas.

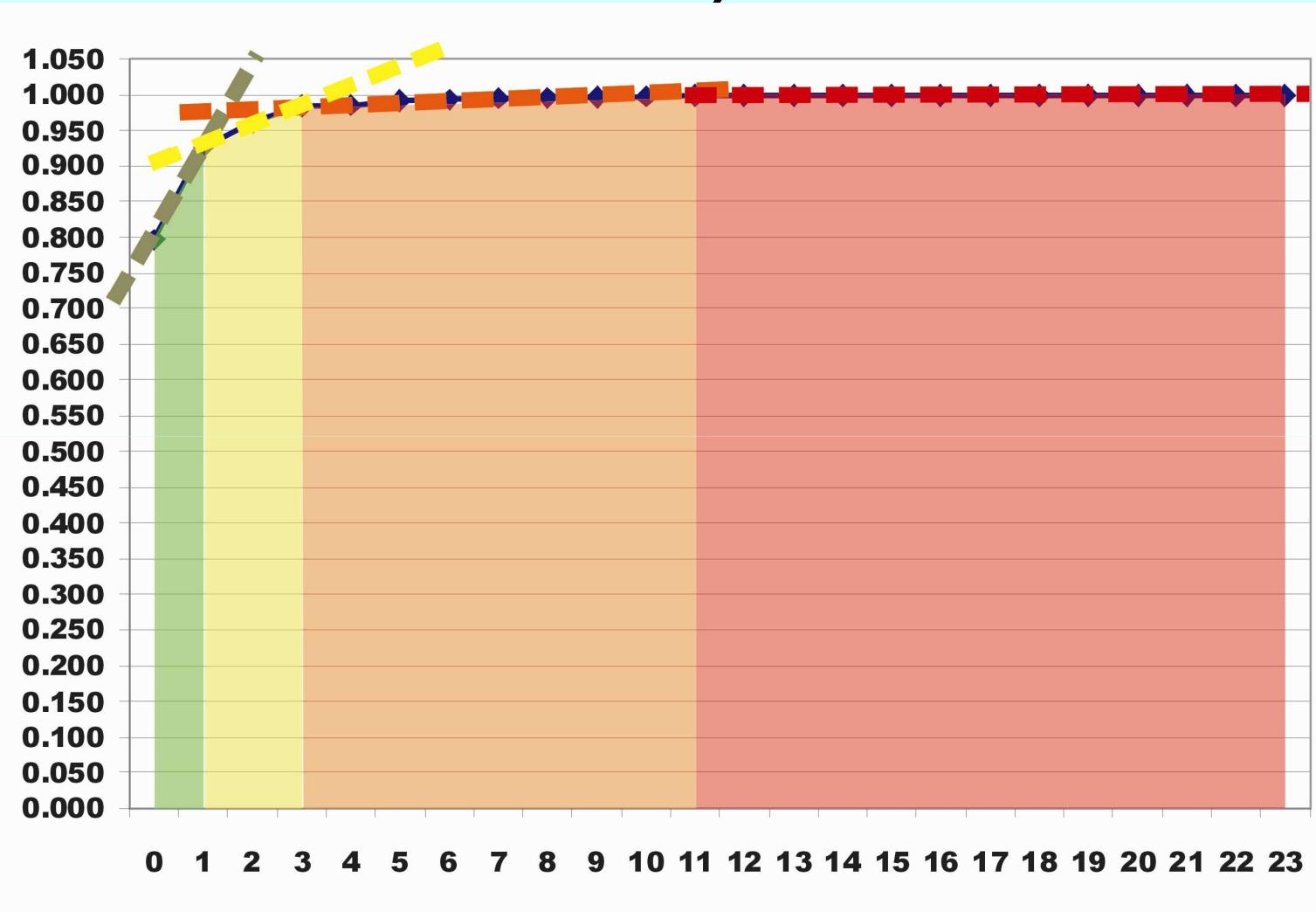


Approach: Develop digitized maps representing sensitive fish habitats to communicate Fisheries Service priorities to land managers.

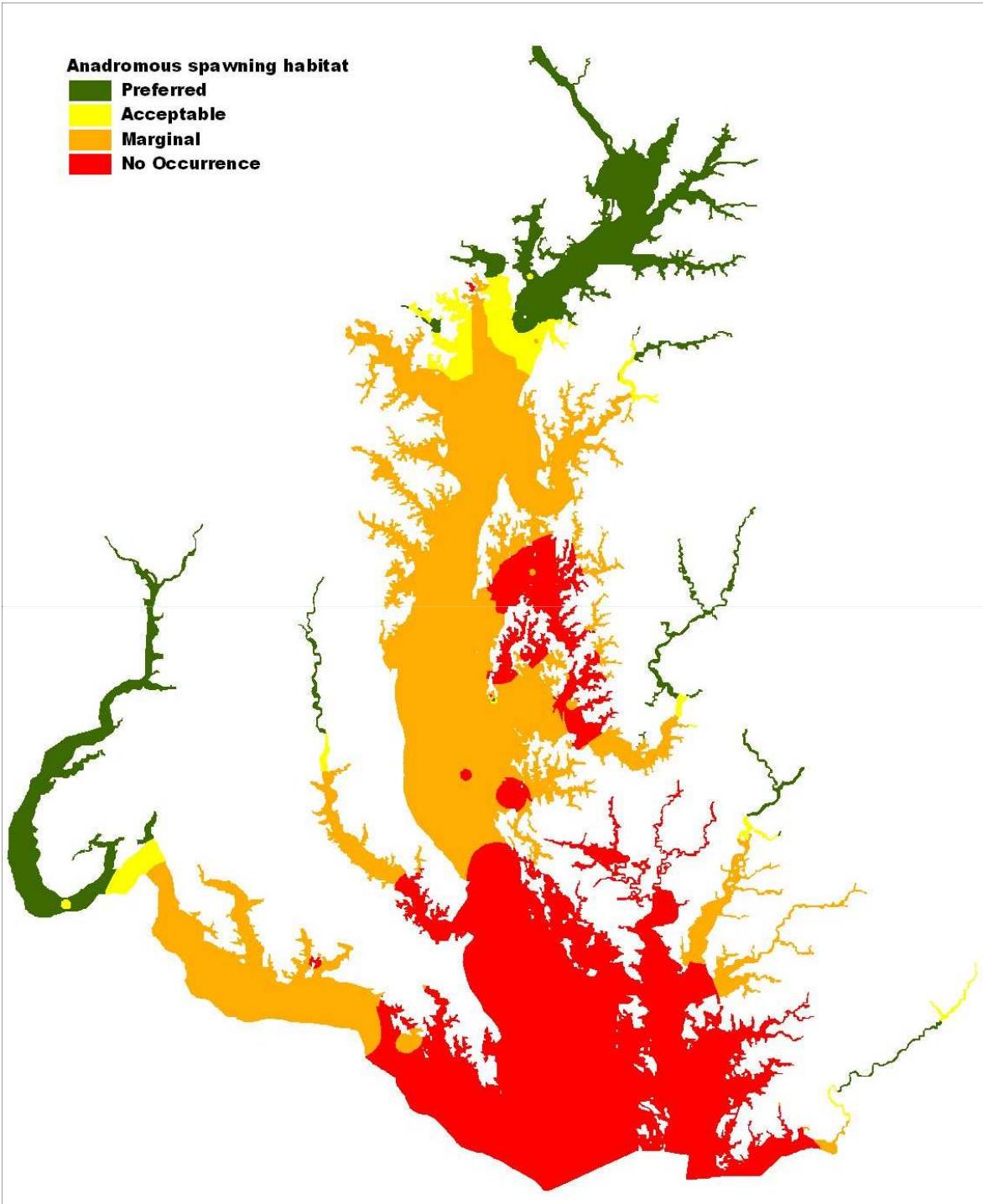
Evaluate species' life history



Define habitat categories (based on data distributions or literature)

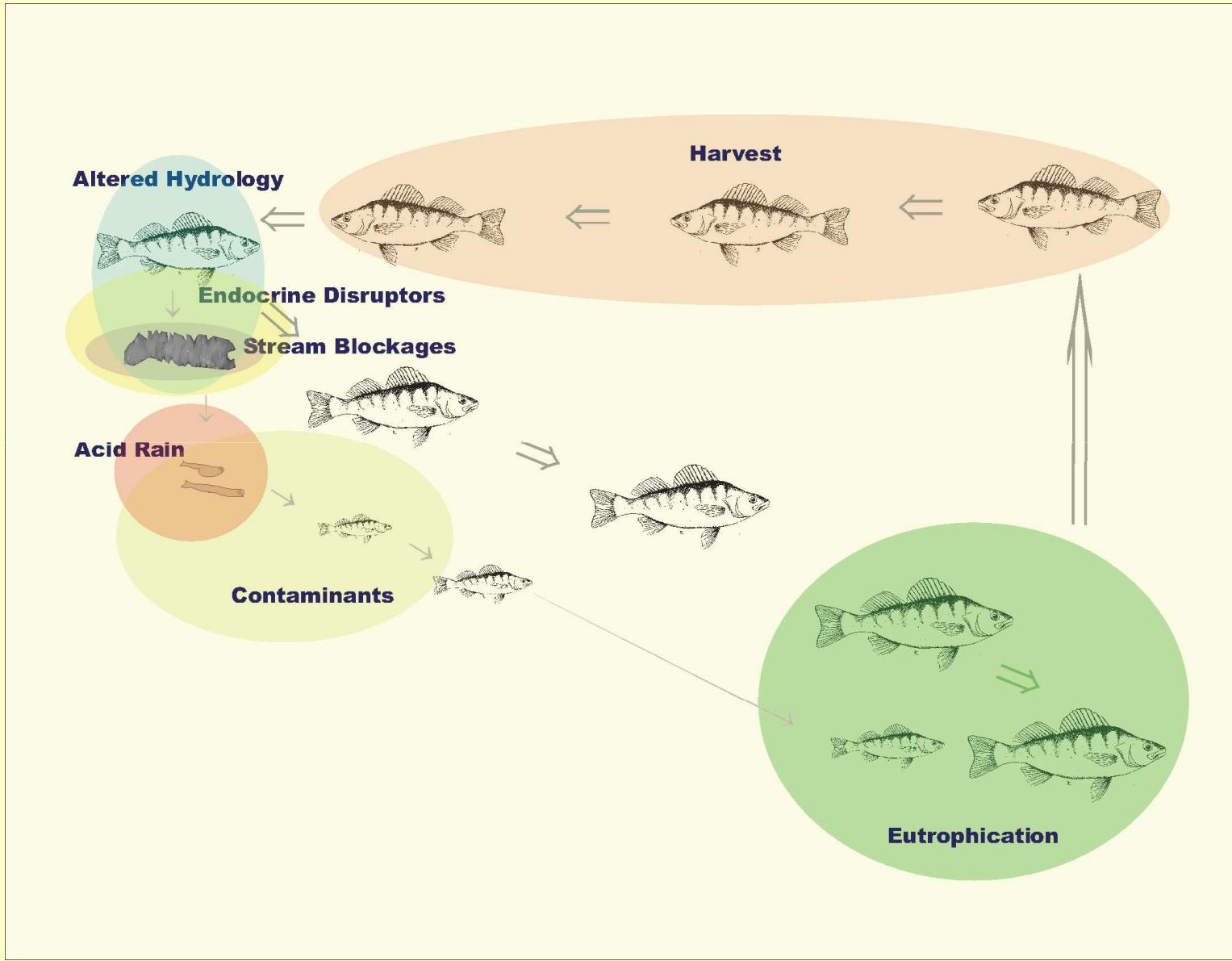


Anadromous spawning habitat (Cumulative freq of combined egg and larvae data, Dovel, 1970)



**Map
distribution by
habitat
occupation
category and
score habitat.**

Identify stressors by life stage.

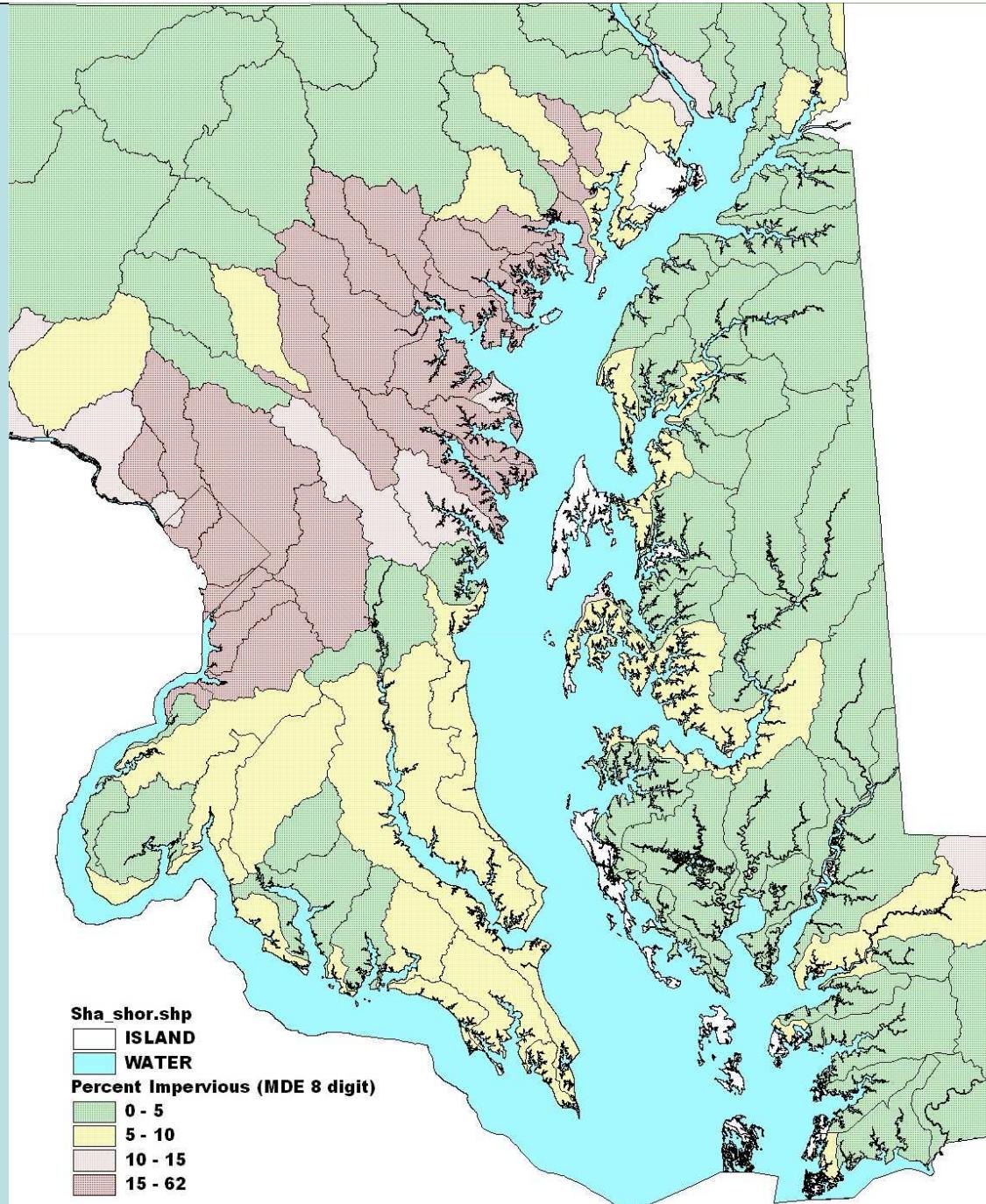


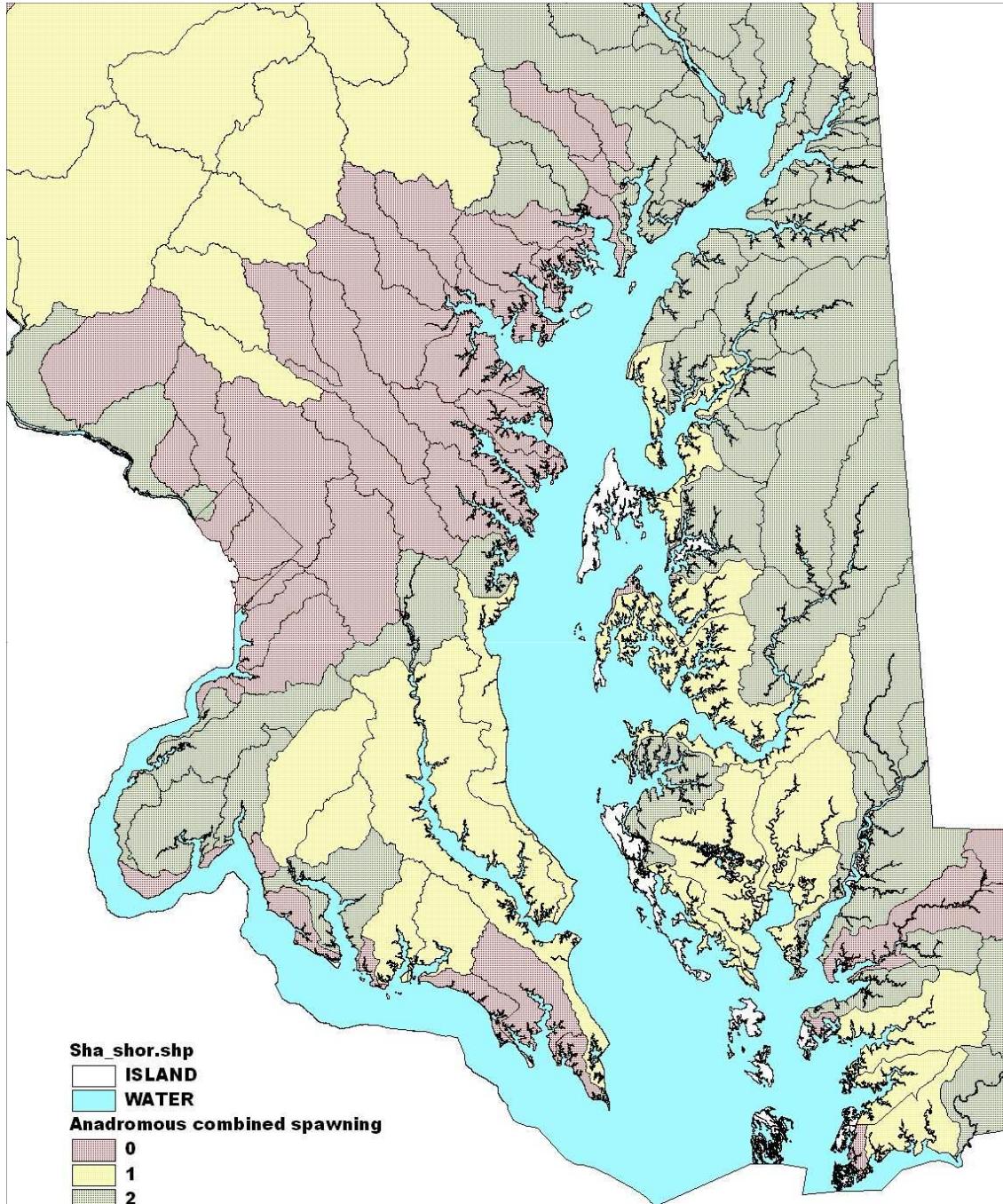
**< 5% impervious - harvest
restrictions & stocking; preserve
watershed**

**5-10% - option to decrease harvest
& stocking to compensate. Preserve
& fix watershed**

**>10% - preserve & fix watershed.
Managing harvest & stocking not
sustainable strategies.**

Map and score stressor.



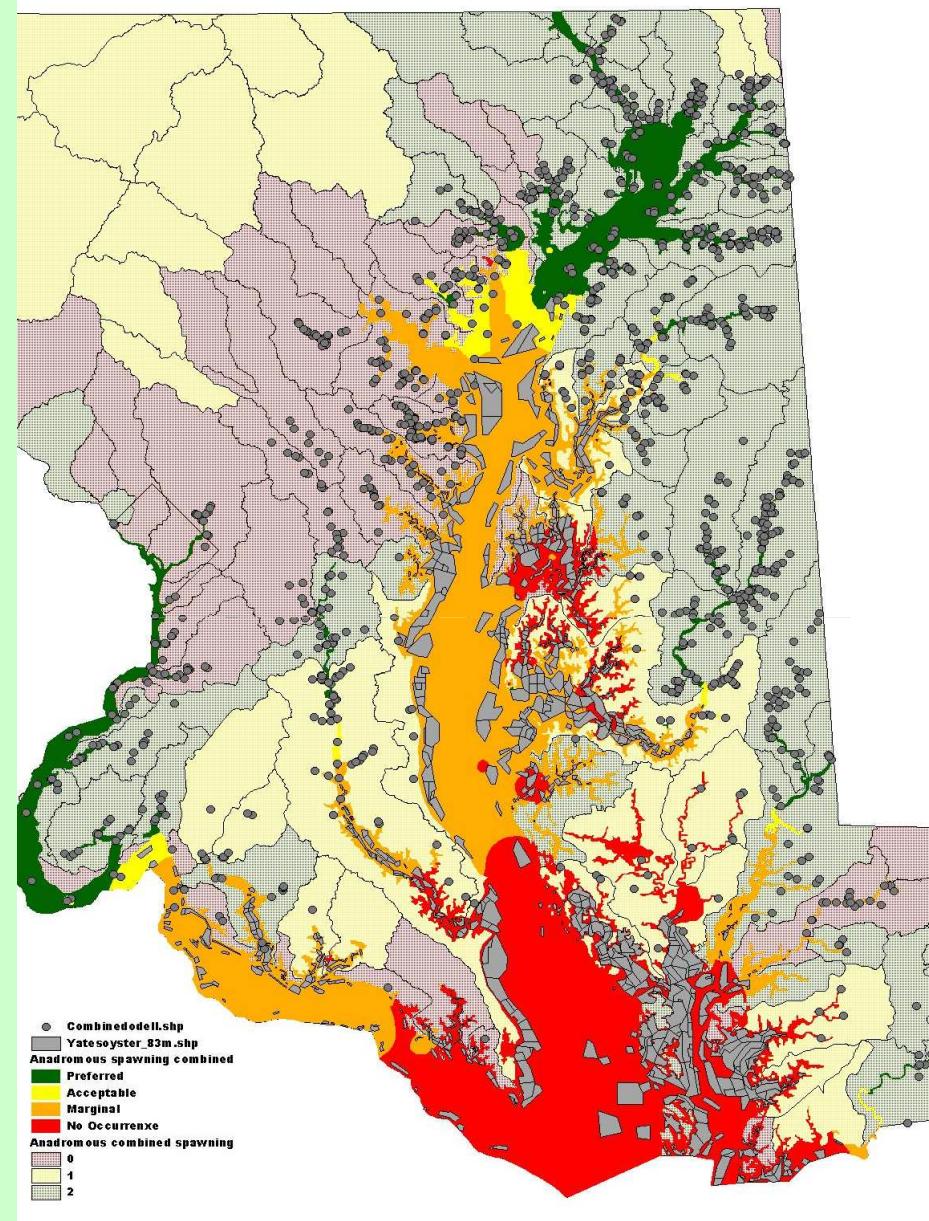


**Combine
habitat and
stressor score
and rank
habitat based
on combined
scores.**

Applications to Fisheries Management: Delineating EFH

Developing Management Priorities

Permit Review (ER)





Tools Applied to

Targeted Ecological Areas (Land acquisition)

Plan Maryland (State Planning Guidance)

County Comprehensive Plan Review (Charles Co.)

Watershed Ecosystem-based Management Plan (Mattawoman)

Comprehensive Communication Tools (Web-based maps – Bay Stat)



**Goal Specific Mapping
Tools Valuable in
Informing Process**

**Accounting for
Stressors, key in
establishing Realistic
Management Priorities**

**Partnering with
Multiple Stakeholders
and Adapting
Management Promotes
Success**

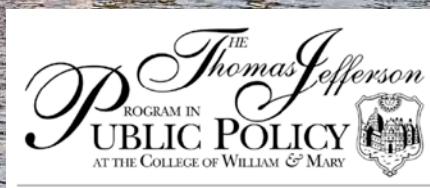
www.dnr.maryland.gov/fisheries/fhep

Local Governance Networks



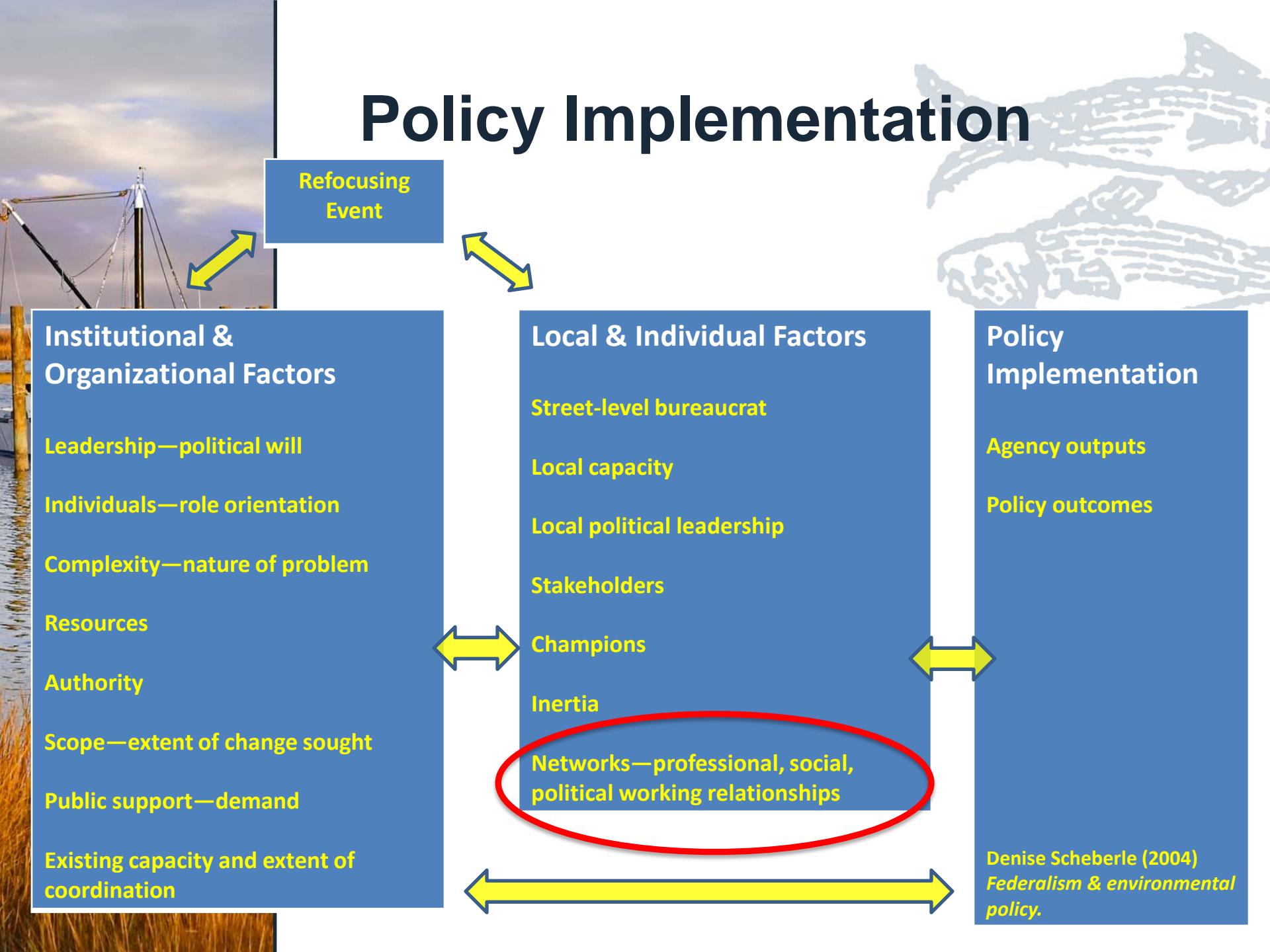
Research in Accomack County, VA and Somerset County, MD

So who do I talk to?



Troy Hartley
Research Associate Professor of
Marine Science & Public Policy

Policy Implementation





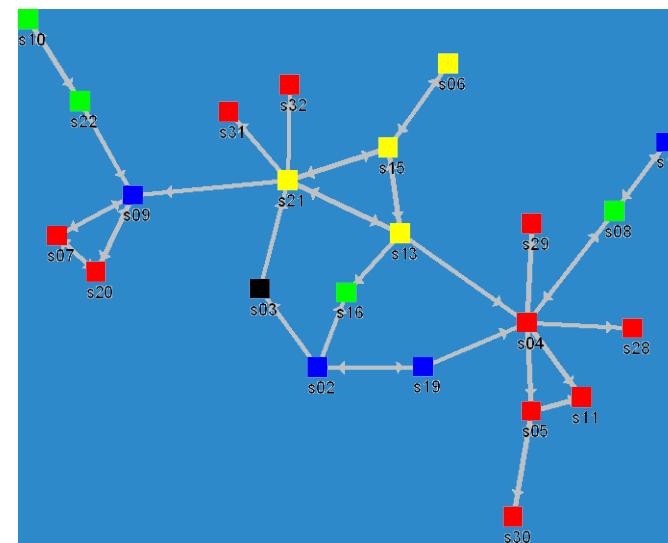
“Governance” Networks

Governance = government +

Network Analysis.

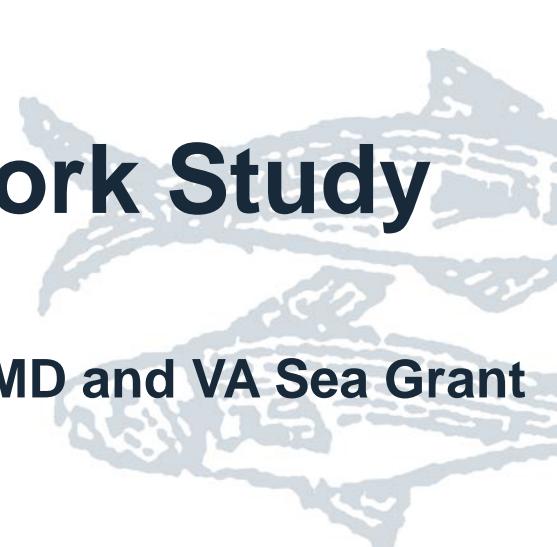
Nodes & Links

- Individual and organizational networks,
- Quantitative measures of connectivity





Governance Network Study



National Sea Grant Law Center, MD and VA Sea Grant

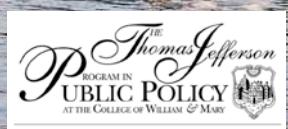
Two Phases

Phase I (summer 2010)

- MDSG's EBFM pilot project
- State-Federal/Scientist-Manager networks
- Two summer graduate interns

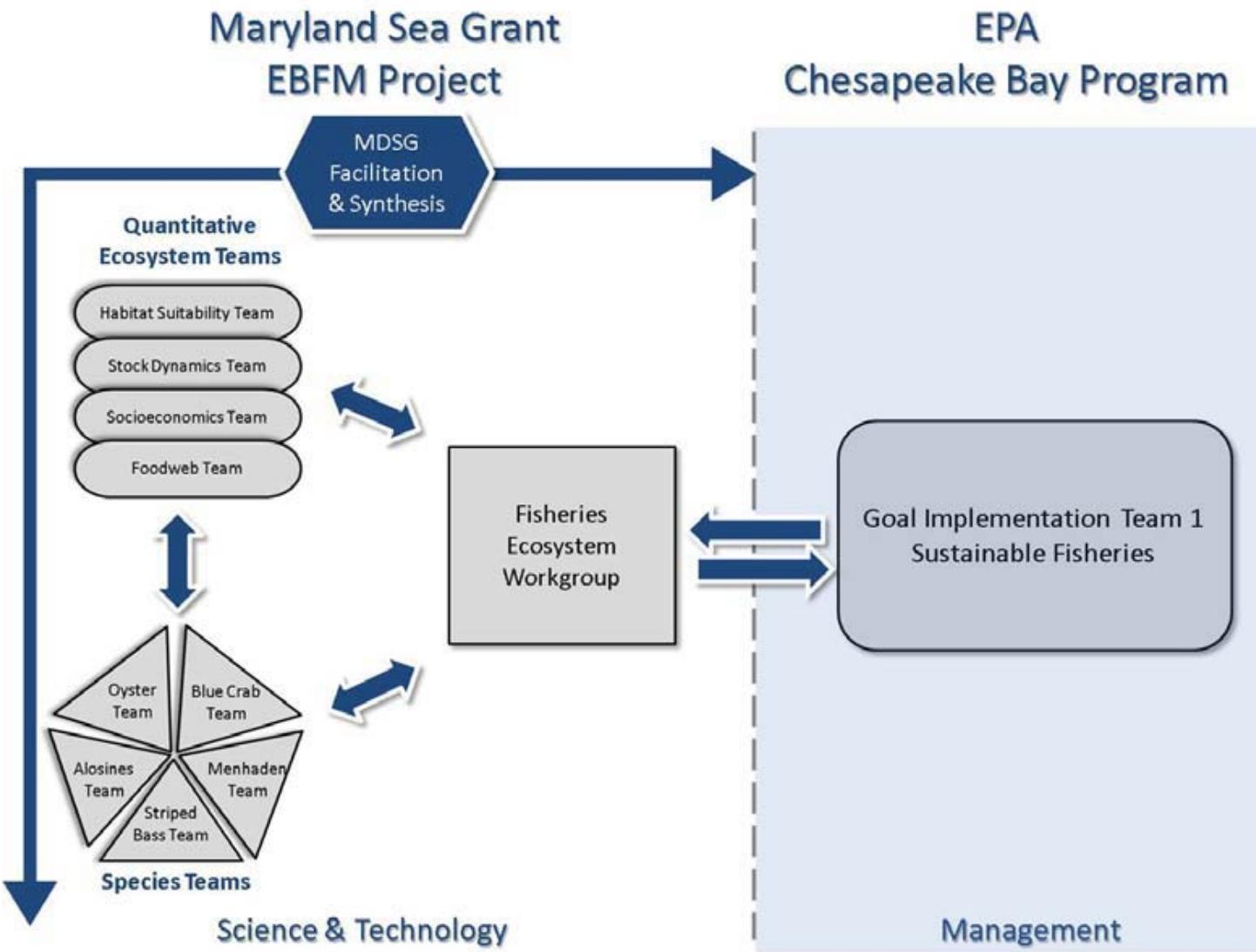
Phase II (summer 2011)

- Local level land use decision-making context
- Local-State-Federal networks
- One summer graduate intern

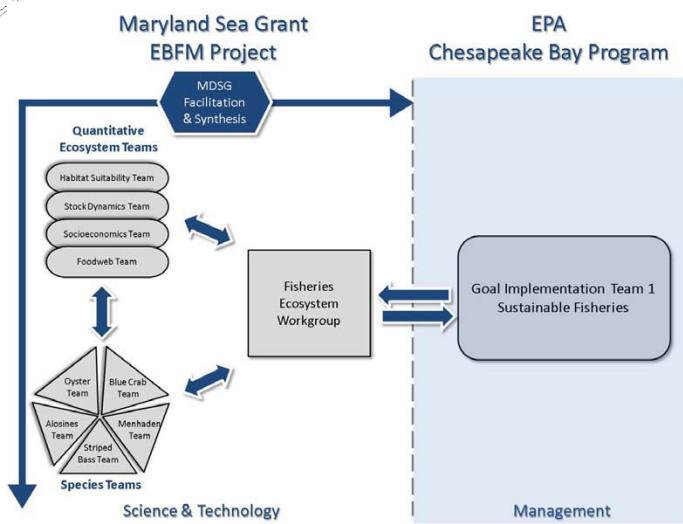
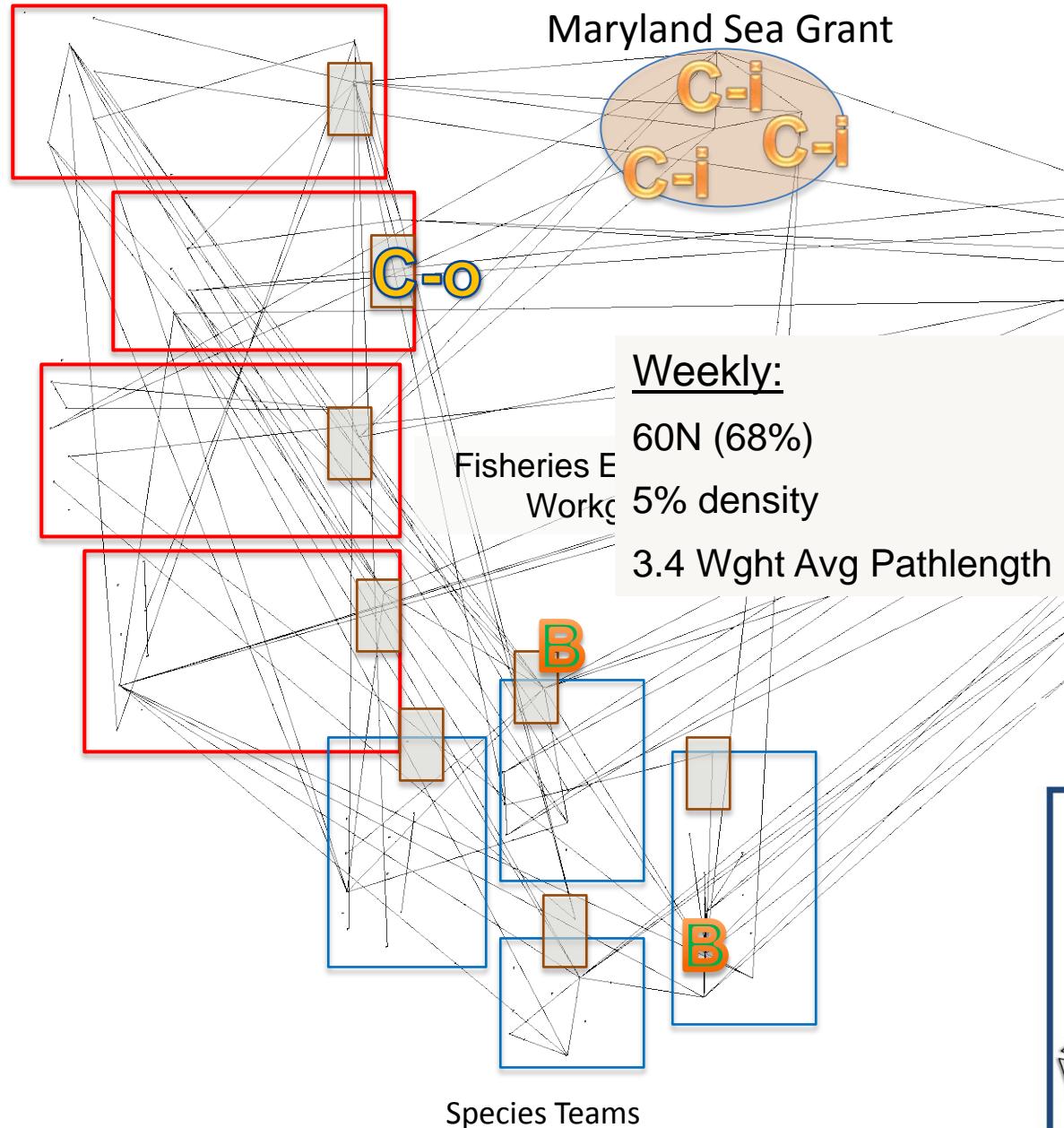




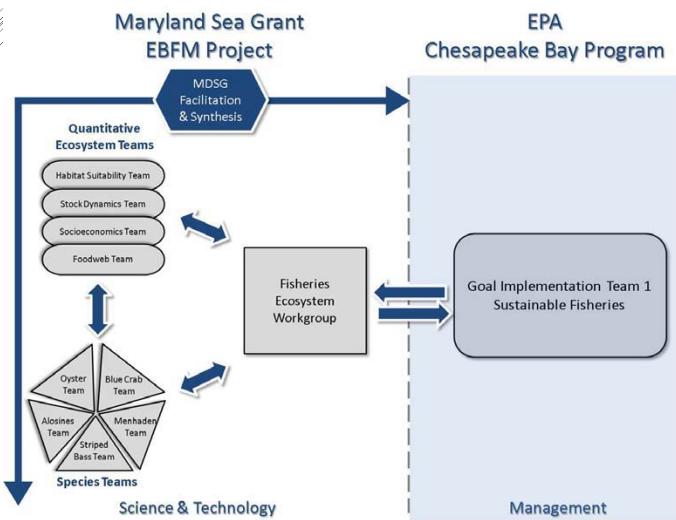
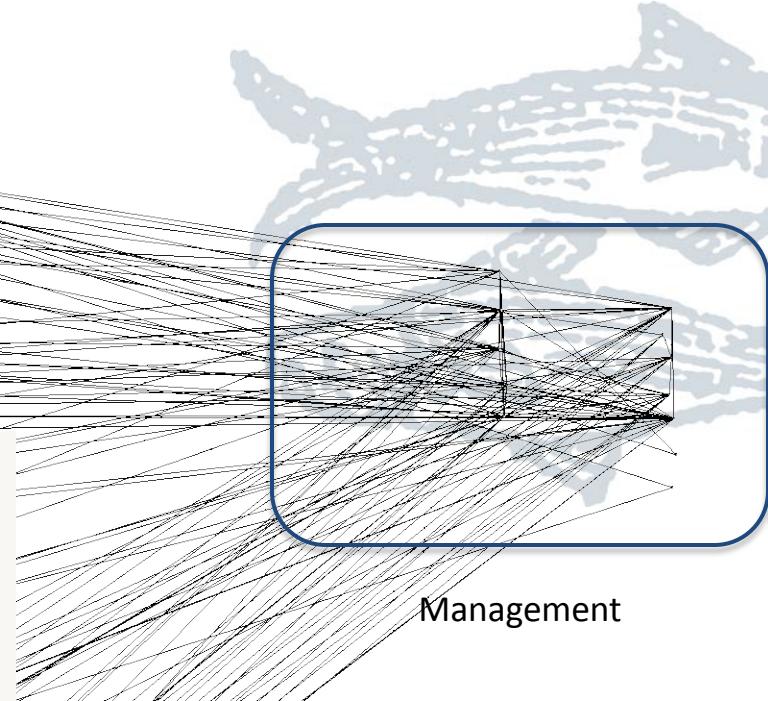
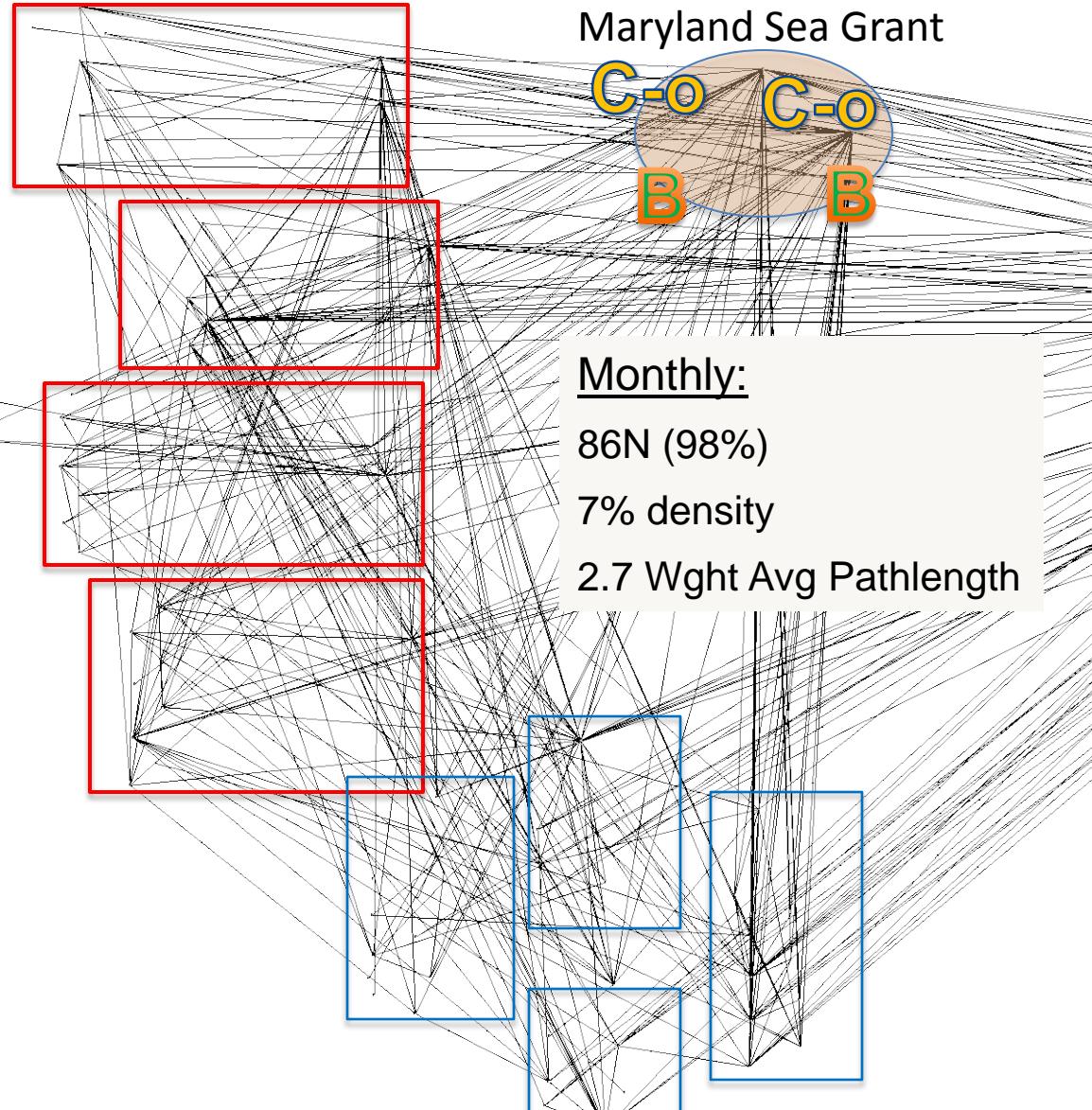
Governance Network Study



Quantitative Ecosystem Teams



Quantitative Ecosystem Teams





Governance Networks in EBFM



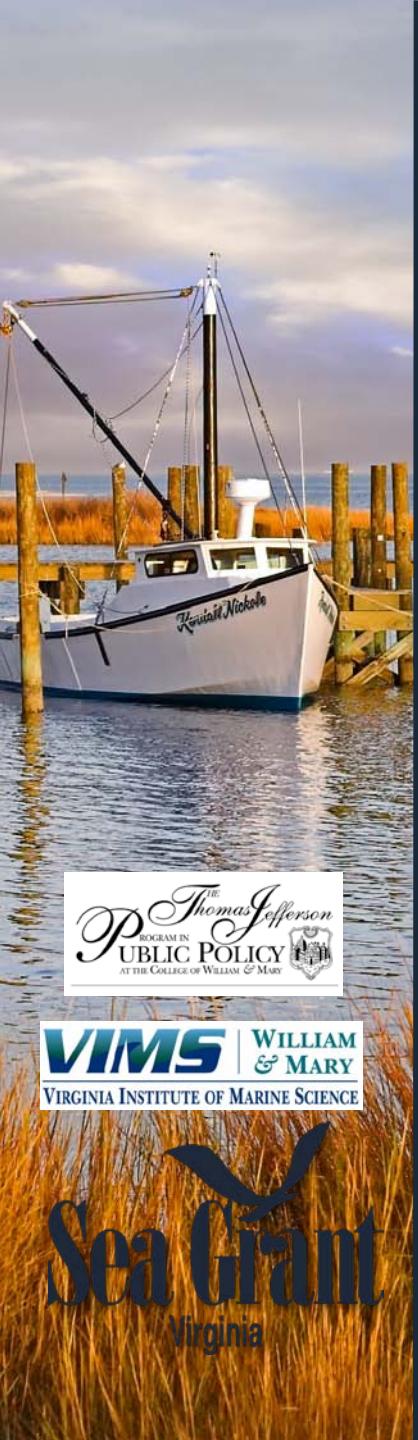
So what...what does this say about governance in the Bay

- Communication does not follow the org chart
- Would we manage differently under networks—knowledge mgt
 - Network roles—not always defined by org chart
 - Tools for bridging, info sharing, gathering

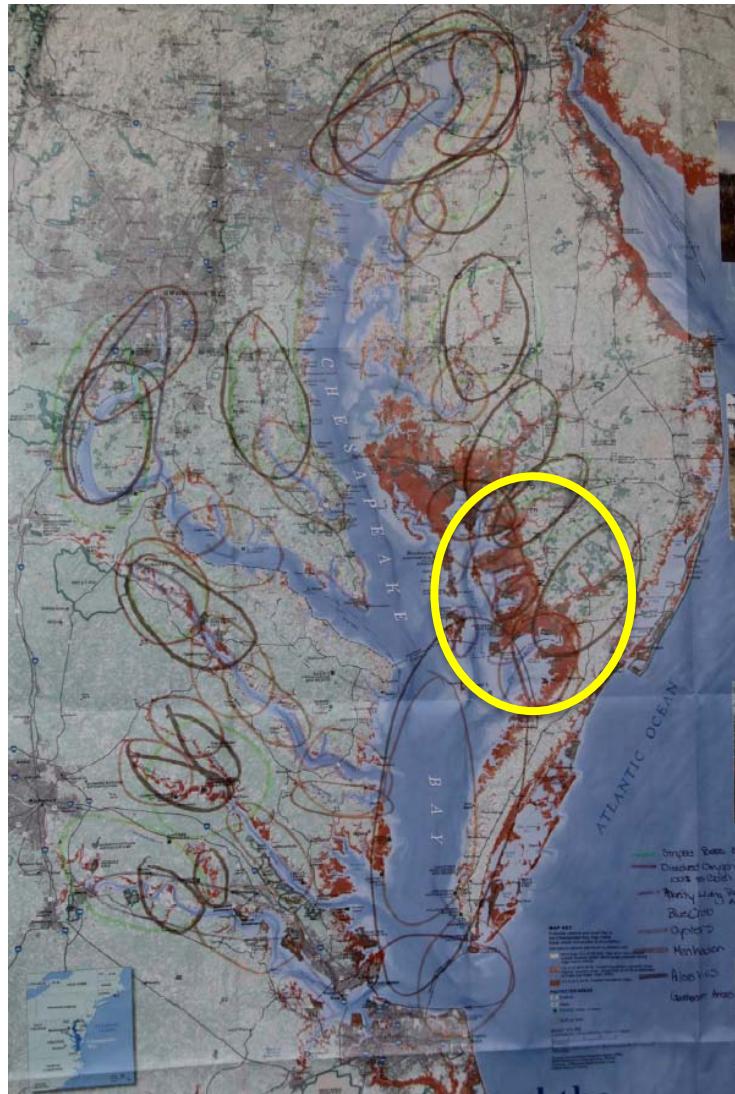
State-Federal Science-Management Network

- State-Federal science-management network has high connectivity
 - Low average path lengths, High density values
 - Mutual understanding, awareness of knowledge
- High Density values—how bridge to new knowledge?
 - Are you collaborating more or less or same: 61.6% same
- Scientists and resource mgrs are connected—the science has access.





Governance Network Study

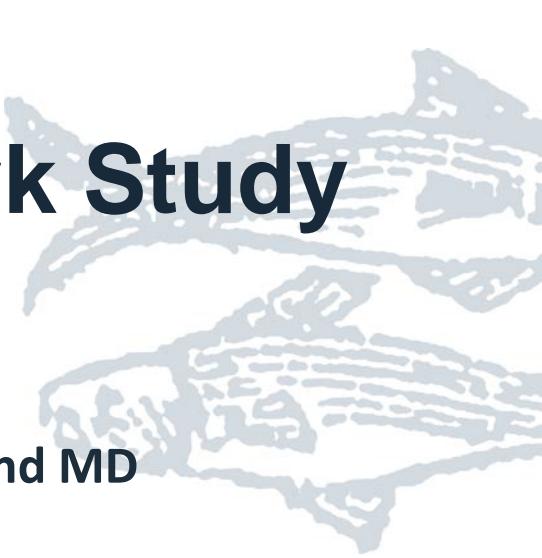


Phase II

 Local



Governance Network Study

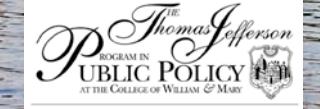


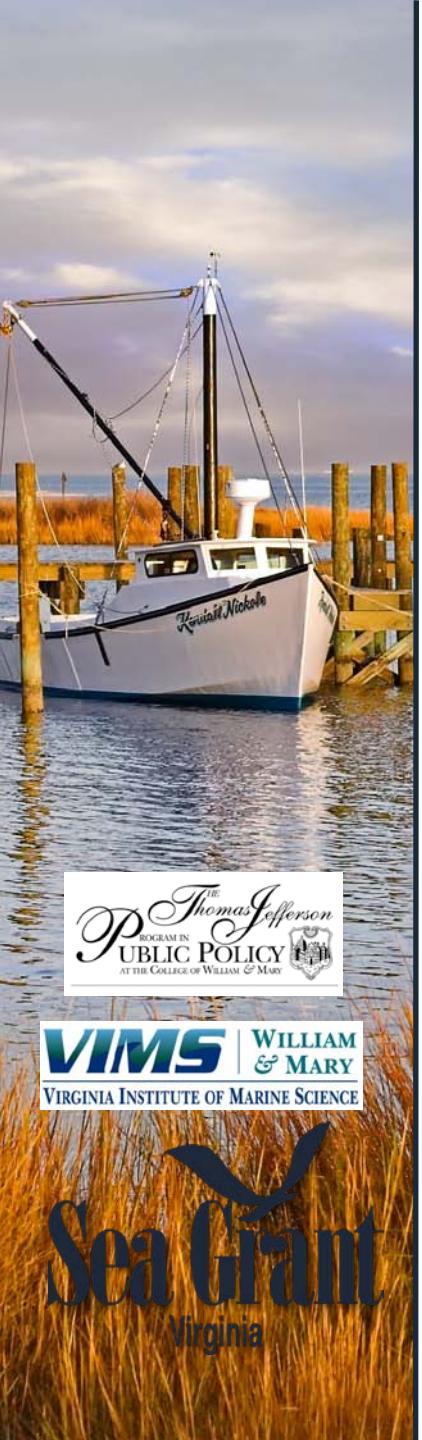
Accomack and Somerset Counties—VA and MD

- Policy Perspective—why this case
 - Crossing state and county boundaries
 - VA—Dillon Rule and MD—Home Rule state
 - Rural counties—fewer decision-making entities than urban centers

Network measures

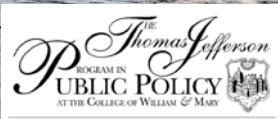
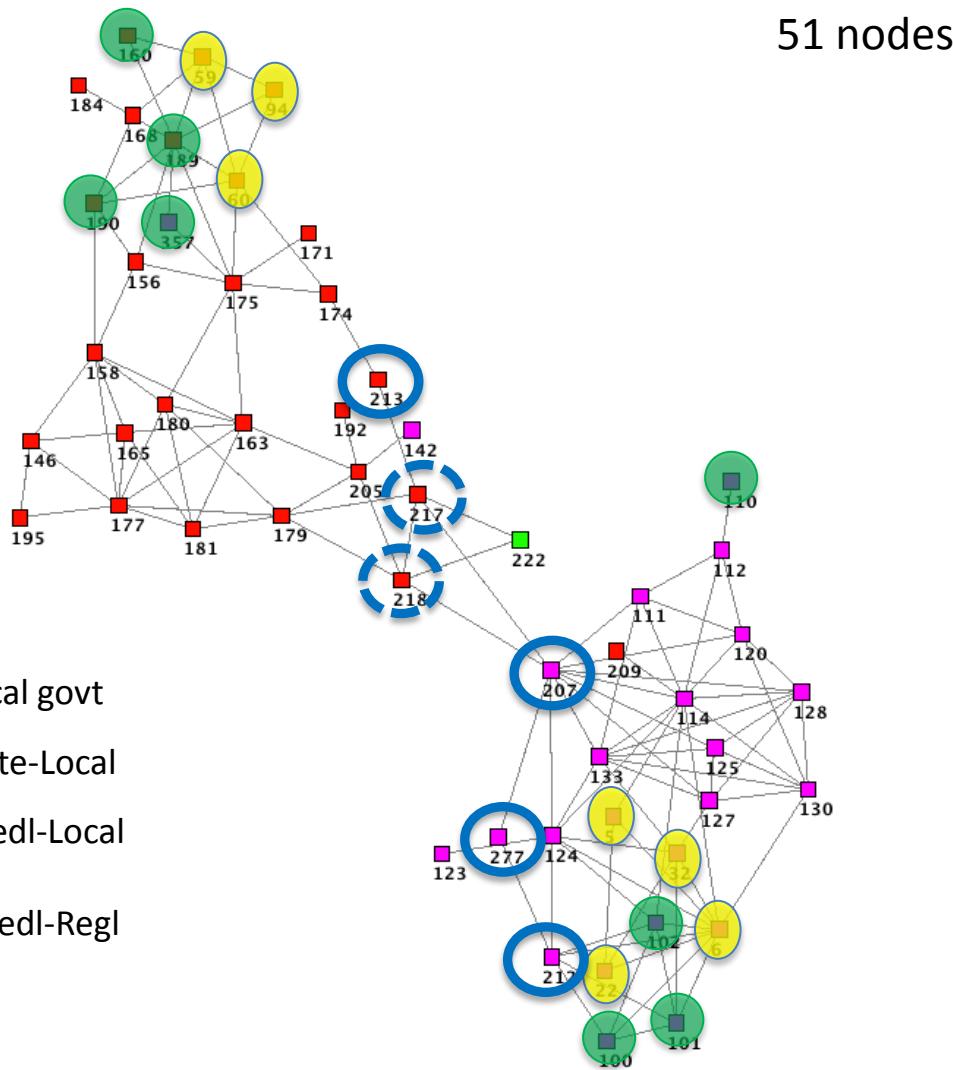
- Universe—public record and key informant {499}
- Measures
 - Communication frequency: 0-5 scale
 - Usefulness of information or resource: 0-5 scale
 - Effectiveness at solving potential use conflicts: 1-5 scale





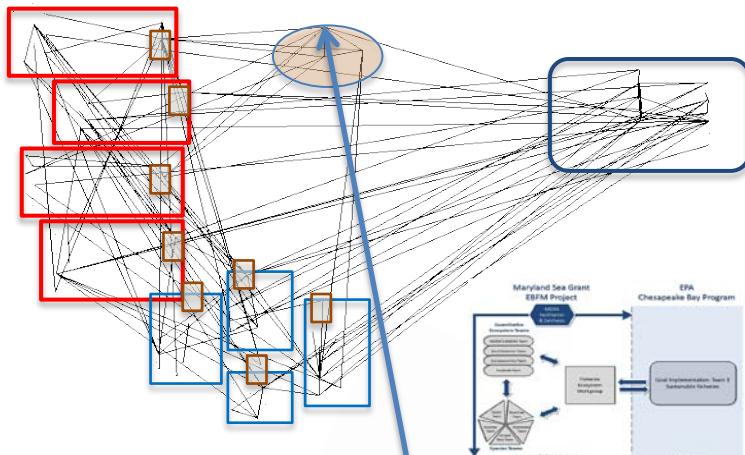
Governance Network Study

MD

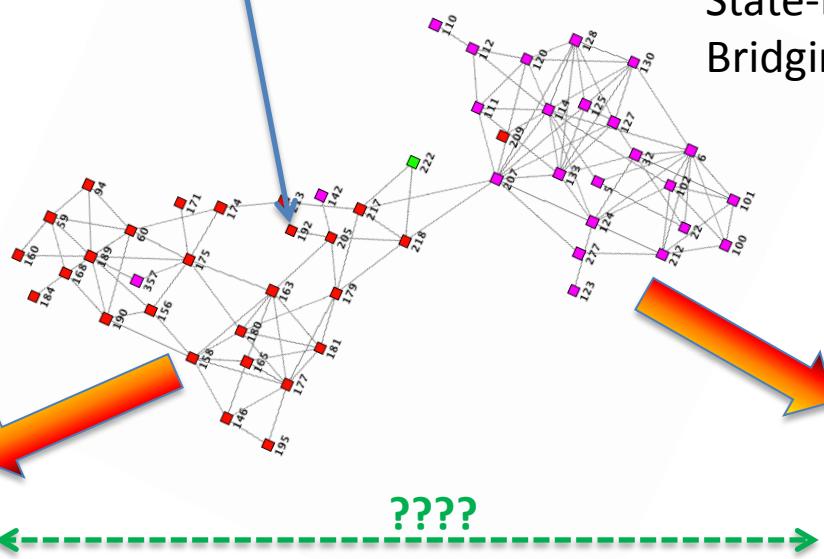




Governance Network Study



State-Local Planning
Bridging Network

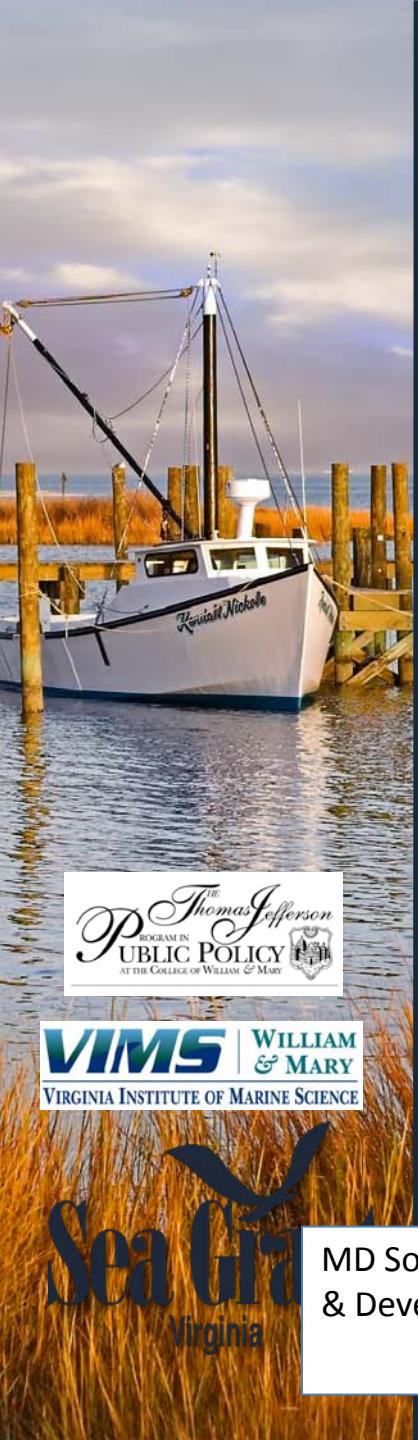


MD Somerset Local Planning
& Development Network

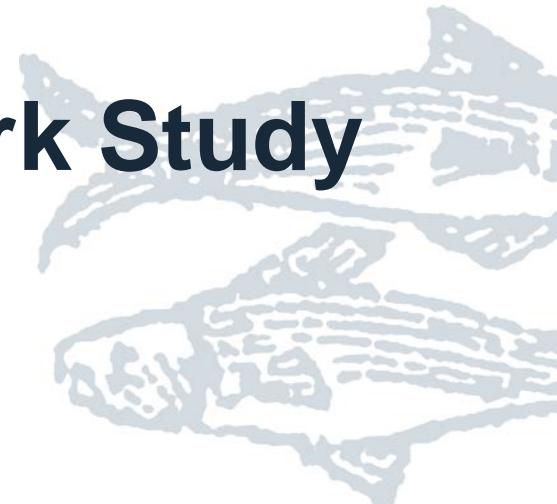
?

VA Accomack Planning &
Development Network

?



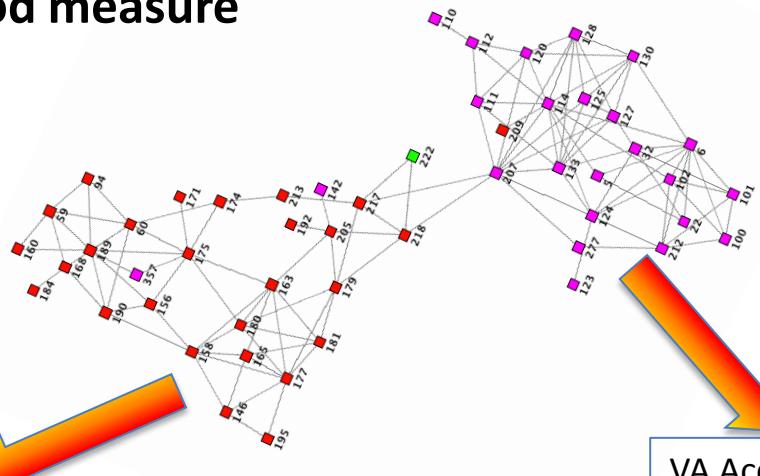
Governance Network Study



State-Local Planning Bridge Network

- Effectiveness of county solving potential use conflicts—perception
 - Average (49N): 2.1 (rarely effective)
 - All local (24) = 2.4; State (14) = 2; University (6) = 1.7; Fed-Regl (4) = 1.8

Usefulness—good measure

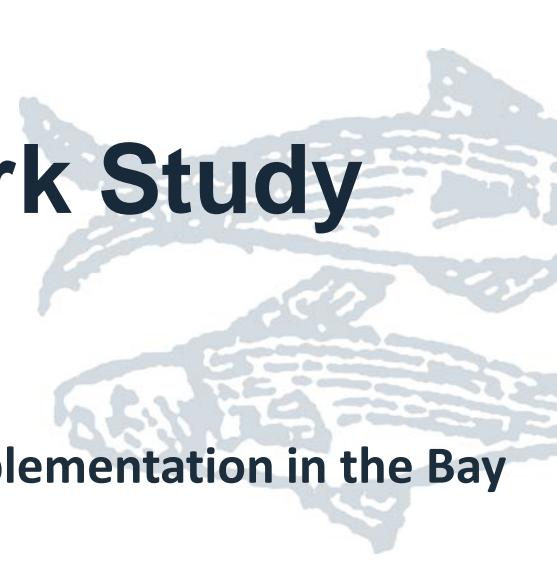


MD Somerset Local Planning & Development Network
?

VA Accomack Planning & Development Network
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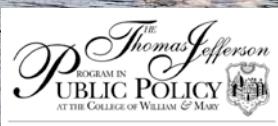
Governance Network Study

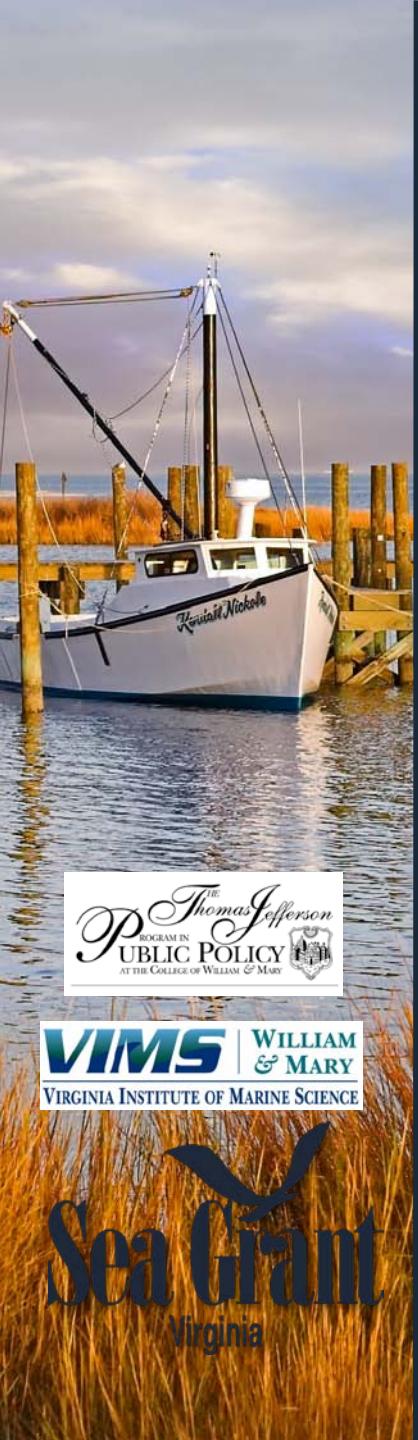


So what...how do we improve EBFM implementation in the Bay

Local Planning & Development Network

- Local decision-making networks are big and complicated
 - Jurisdiction fans out...more players not less, even in rural
 - While each local network will have unique characteristics, what do they have in common?
 - Commonality may be in network roles, not formal positions
- May be nested networks with intermediate state-local bridging
- Where are the bridges from intermediate to the local level?
 - Local staff of state and federal agencies?
 - State agencies—crossing division/department boundaries?





So, who do I talk to?



Start with staff in the field:

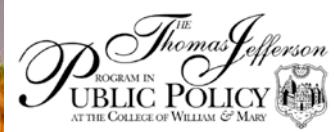
- Accept there is a local network and you cannot control it
 - Imposing new organizational units may have limited impact
- Who are the local opinion leaders and decision-makers?
 - Organizations and individuals (e.g., who leads and who follows)
 - Local stakeholders, champions, opposition
- What does the community network look like? History, culture, inertia.
- Where are the bridges that cross organizational units?
 - MD DNR – MD Planning
 - VMRC – PDCs
 - Field staff: Federal agencies, Universities, Cooperative Extension

Low hanging fruit may not mean easiest; may mean opinion leader—which counties do others respect?

Plod county-by-county: opportunity/incentive of info sharing

Local Governance Networks

Thanks



Troy Hartley
thartley@vims.edu