Synthesis of A2

Katie Skalak, Dorothy Merritts, John Brakebill

A2 Panelists: *Jim Pizzuto (University of Delaware), Cliff Hupp (USGS, retired), Allen Gellis (USGS), Karl Wegmann (North Carolina State University)*

SUMMARY

1. Target, Mitigate, Monitor - at the Management Scale <250km^2
2. Need to target the sediment contribution from all sources - get the most ‘bank for the buck’ –

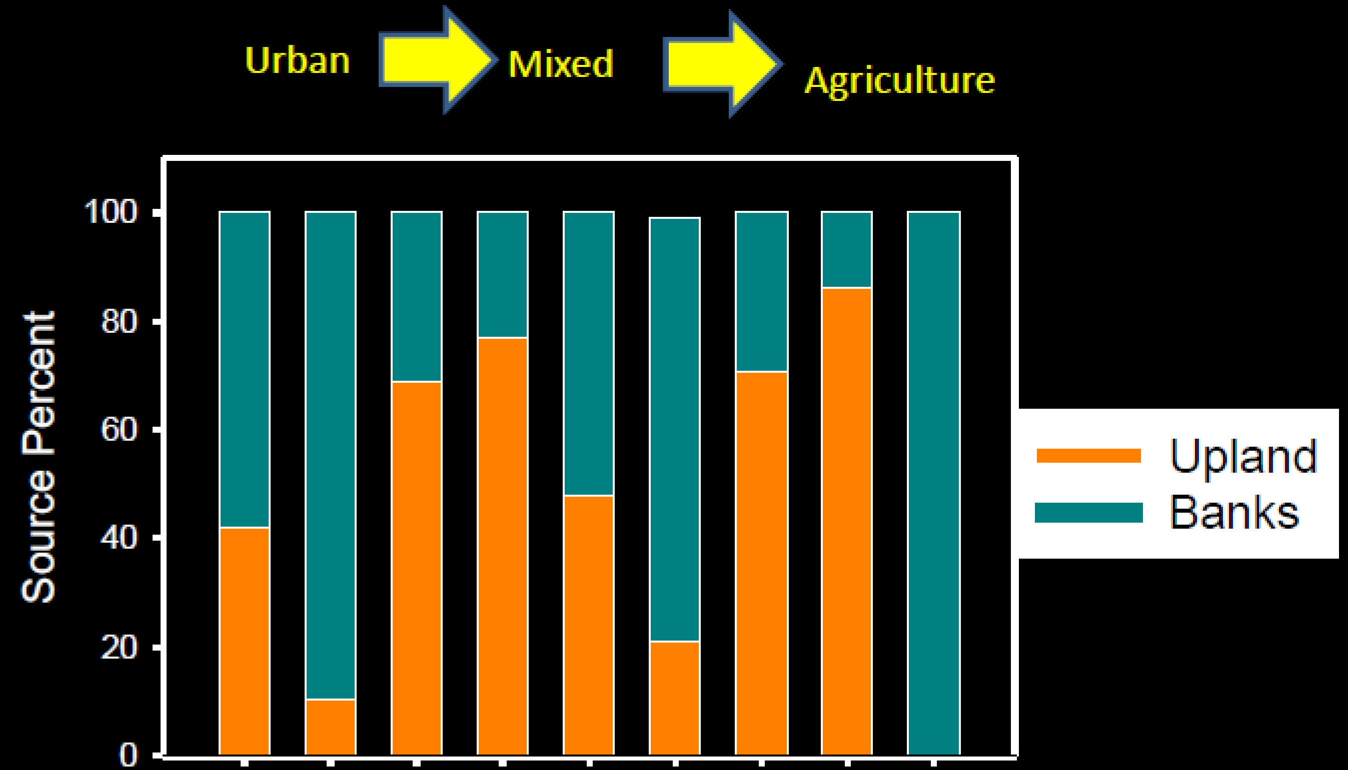
fingerprinting, sediment budgets, next generation of tools etc.

3. Importance of sediment in storage

Age of sediment and residence times to understand time scales and effects of management actions

4. Monitoring

Summary of sediment fingerprinting studies (n=9) for watersheds in the Chesapeake Bay Region



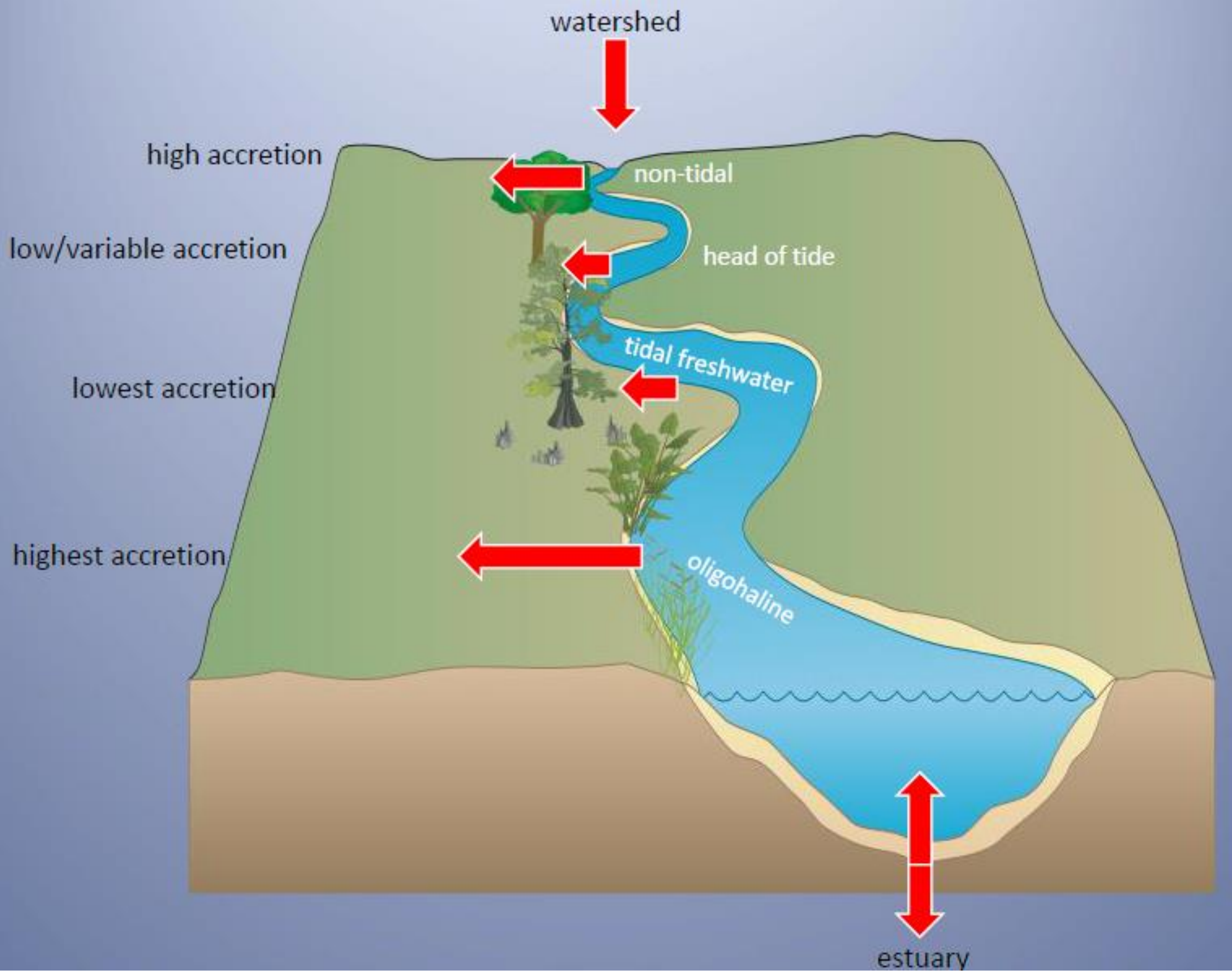
Upland includes all sources outside the channel – (cropland, pasture, forest, streets, construction sites, dirt roads, ditch beds)

Our results suggest that the Difficult Run floodplain is composed of fill/legacy sediment but that mill ponds are not requisite for substantial historic deposition on floodplains and that they remain active fluvial features, not terraces.

Regimes may have changed, but the floodplain is still a floodplain

The floodplain traps most of the sediment supplied by the watershed (+ 2184 kg/m/yr) thus maintaining an ecosystem function and underscores the importance of preserving floodplain connectivity.

Magnitudes of sediment sources change along tidal river gradient



Piedmont Physiographic Province and Historic Upland Soil Erosion Rates

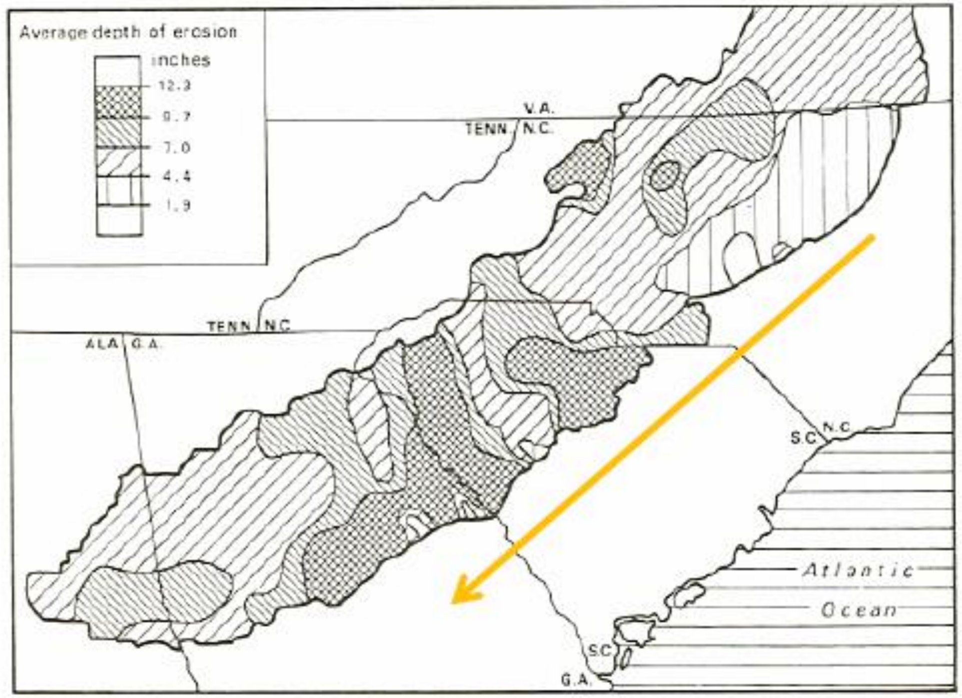
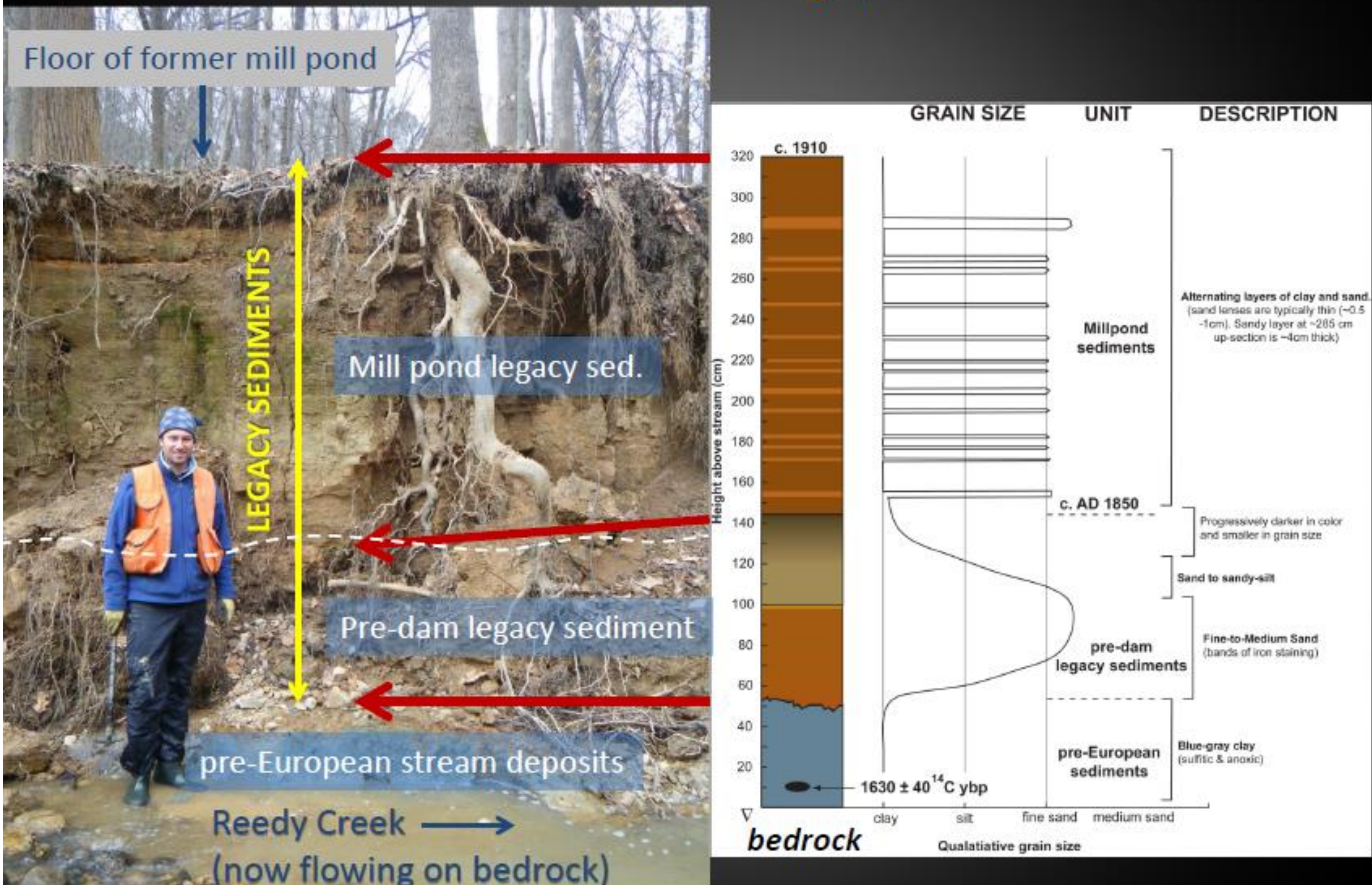


Figure 12.2 Average depths of total erosion (Trimble, 1974)

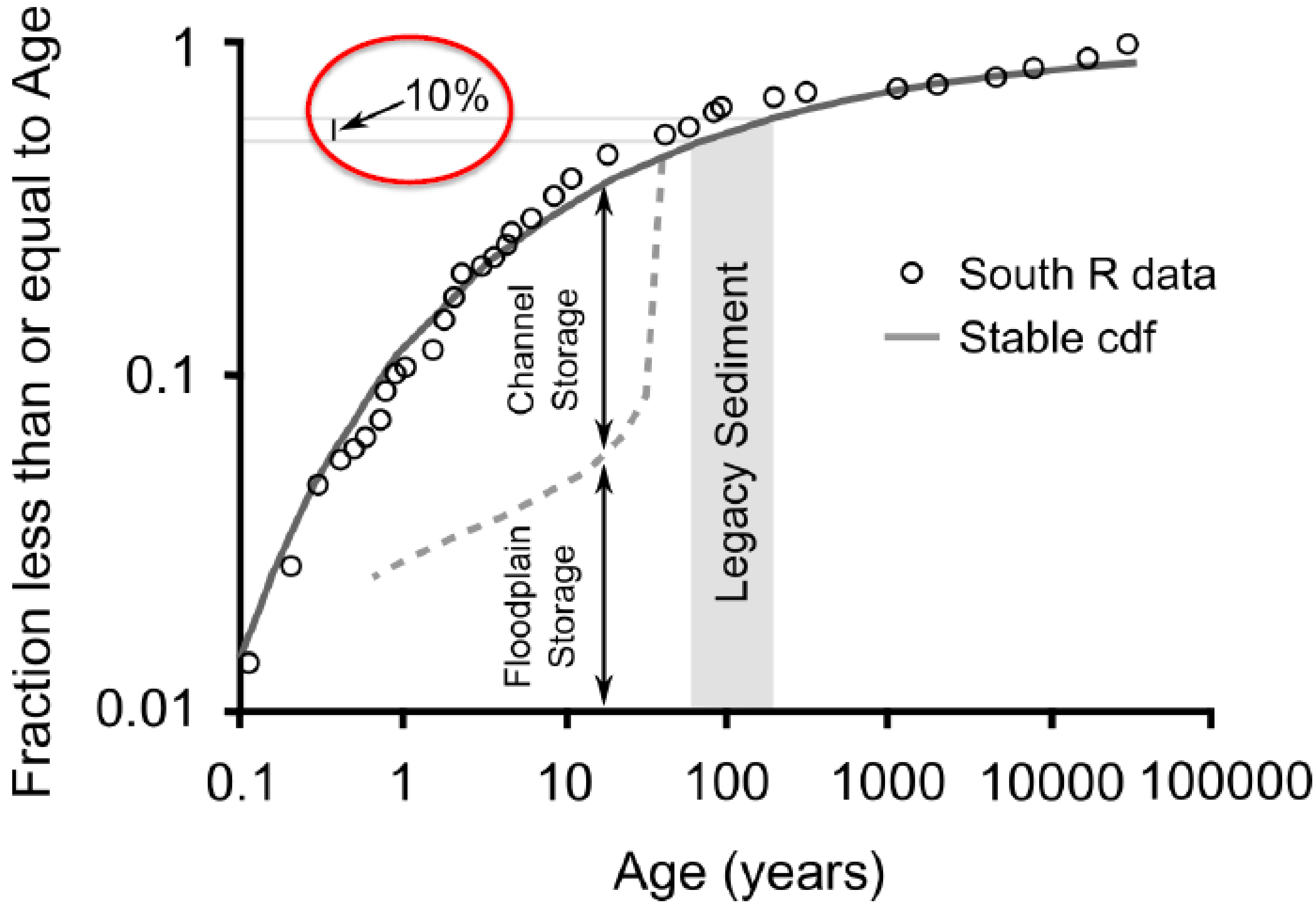
Historic spatially-averaged rates of upland soil erosion increased from the NE to SW along the axis of the Piedmont Physio. Province

Typical NC Piedmont Stream Bank Stratigraphy
- W.B. Umstead State Park, Raleigh, NC

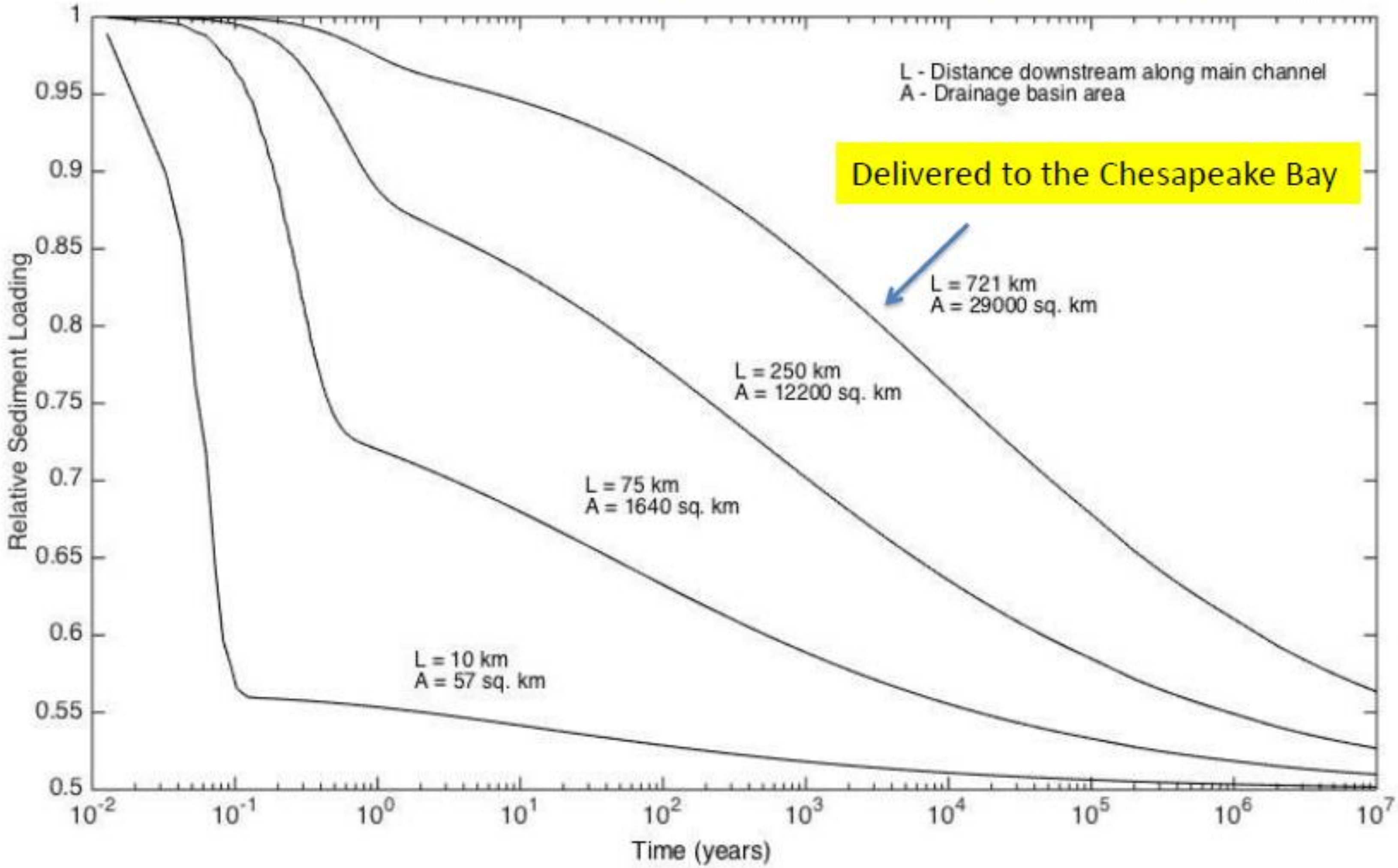


“Legacy” Sediments *Are not as important as you think…*

(for this data set)



Sediment Flux vs Time – 100% of watershed covered by instantaneously effective BMPs



Pizzuto, Skalak, Karwan, in prep

Key Questions

- How do the distribution, characteristics and relative magnitude of legacy sediment vary with watershed scale or geographic location?
  - Generally, deposits get thicker moving from NW to SE
  - Watershed geology controls accumulation (both historically and currently)
  - Mill dams trap large amounts of legacy sediment deposits; THERE ARE 10s of THOUSANDS OF MILLDAMS
  - But not all legacy sediment is associated with mill dams
  - Embayed systems (Choptank) and non-embayed (Pamunkey) accumulate sediment differently – landscape structure is critical

Key Questions

- To what extent are lag times for sediment delivery and intermediate floodplain storage processes relevant to our assessment of the problem?
  - Lag times are highly variable, but ultimately control the downstream delivery of sediment
    - The farther the distance the higher the likelihood that sediment will be stored, which is why measuring BMP effectiveness on loads at the mouth may not show improvement
    - This also implies the importance of local sources and sinks

A2 Synthesis

- Understanding the historic condition is important for providing potential “restoration” benchmarks as well as trajectories
  - What does a valley of beaver dams in various successional stages look like? Where is the evidence on the landscape?
  - What is the spatial distribution of legacy sediment? What controls this?
  - How does knowing this change management?
- “Legacy sediment” is a useful construct, but…
  - Large volumes of material, potentially minor contribution to process
  - Sediment budgets are critical for assessing this
    - This includes quantifying current rates of erosion and deposition on the landscape
    - We also need sediment residence time information
- How can we regionalize site specific information?
- We need more data!
- What about storms?

Five points we can (likely) agree on:

1. Spatial variability in erosion and deposition
2. 1st, 2nd, and 3rd order streams are the majority of the watershed area
3. New tools and techniques allow us to quantify both sources and sinks, rates of erosion and deposition
4. Fine sediment is making it to the Chesapeake Bay

    but…what is the real issue?
5. Landscape has evolved from low erosion, to rapid erosion and deposition, now we are in a phase of degradation

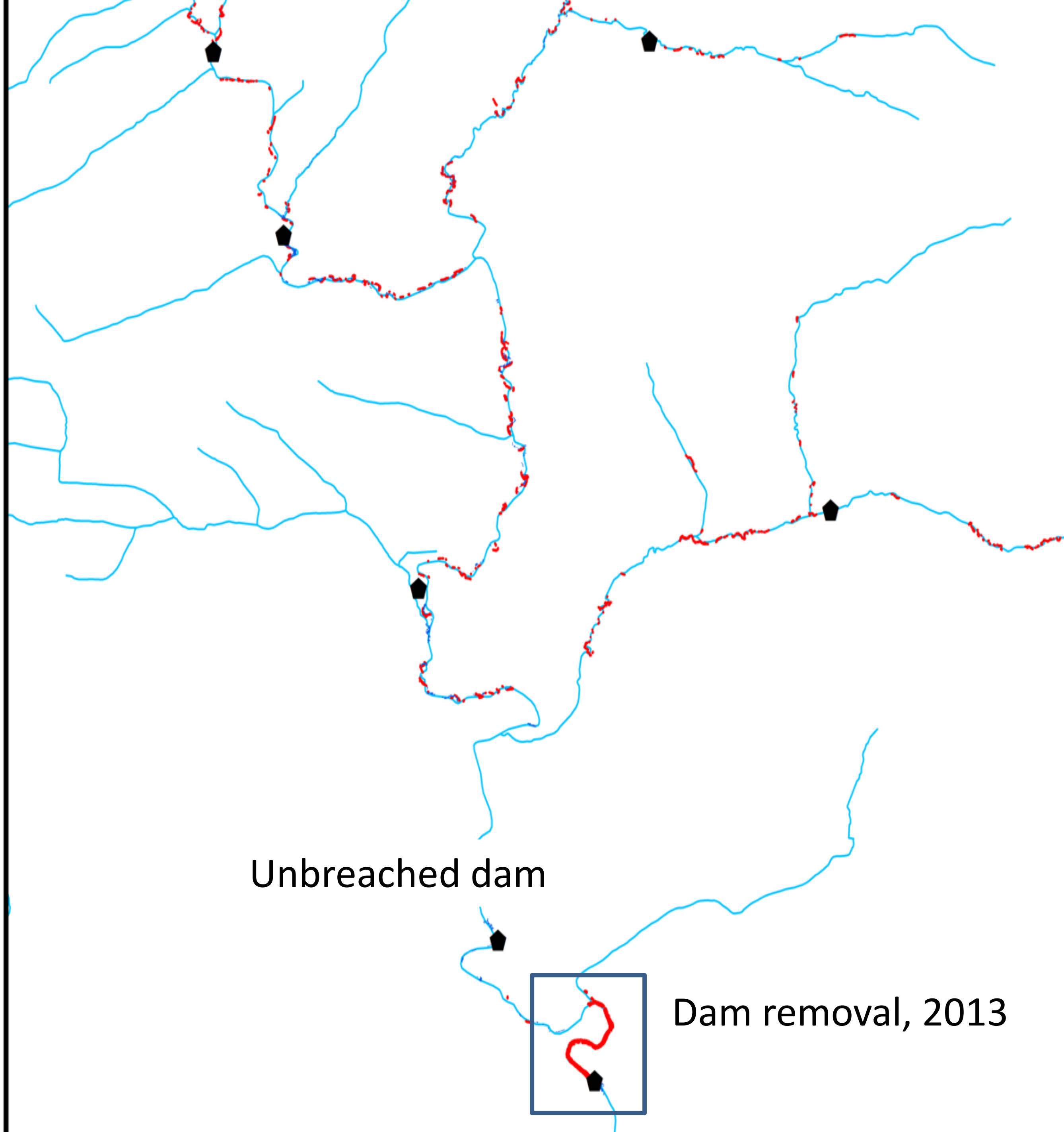
Chiques Creek Watershed, PA

Lidar DEM differencing 2008-2014

Red is bank erosion in 6.6 yrs

Analysis:
M. Rahnis

Erosion hot spots in hot moments



Synthesis of B2

Karen Prestegaard, Matt Baker, Tom Schueler

Effectiveness of nutrient retention practices: The watershed perspective

1. **N and P concentrations are high in agricultural soils NOW**. Therefore, it is necessary **to keep these materials on or close to the sources.**
2. **Existing techniques can help keep N and P near their sources**. (Techniques include cover crops, swales, riparian zones), but some continues to leak downstream.
3. **P and Sediment are mobilized by surface runoff processes** in headwater watersheds. Sites of high runoff may or may not correlate with high concentrations of P in soils.
4. **Stored soils and P may become sources of P, particularly under reducing conditions.**
5. **Nitrate in GW that traverses high C and reducing conditions may be denitrified.**
6. **Stored Legacy sediments may have low N and P** if they were deposited prior to the 1950’s

Prediction and targeting of nutrient concentrations

- We know about erosion and deposition processes of sediment from upland fields and within river corridors, we still know relatively little about how these processes translate into sediment discharges from watersheds.

- Watersheds are complex, with high spatio-temporal heterogeneity. Simulation models may *assume* scaling of processes, but we need statistical models to test discharges to the Bay.

- Efforts to predict sediment discharges as concentrations from field scale models are very poor. Estimates of loads over longer time scales are pretty variable too. Performance suggests most models do not capture dominant source, transport or delivery processes.

- Predictive models of N are much better than for P, and models including buffers have quantified their impact across broad watersheds, but it has been difficult to show effectiveness of installed BMPs at watershed scale.

- Targeting sources of N and P and their access to streams is likely required across watersheds.

Urban Watersheds: general comments from several speakers and audience

1. **Urban construction and post-construction urban runoff mobilizes sediment** resulting in the formation of modern Legacy sediments, some of which have high N and P.
2. **There are new sources of N and P in urban areas**. (e.g. sewer leaks, waste water, fertilizer, atmospheric deposition, and septic systems come from urban areas.

Synthesis of C

Ann Swanson, Lisa Wainger, Dave Goerman

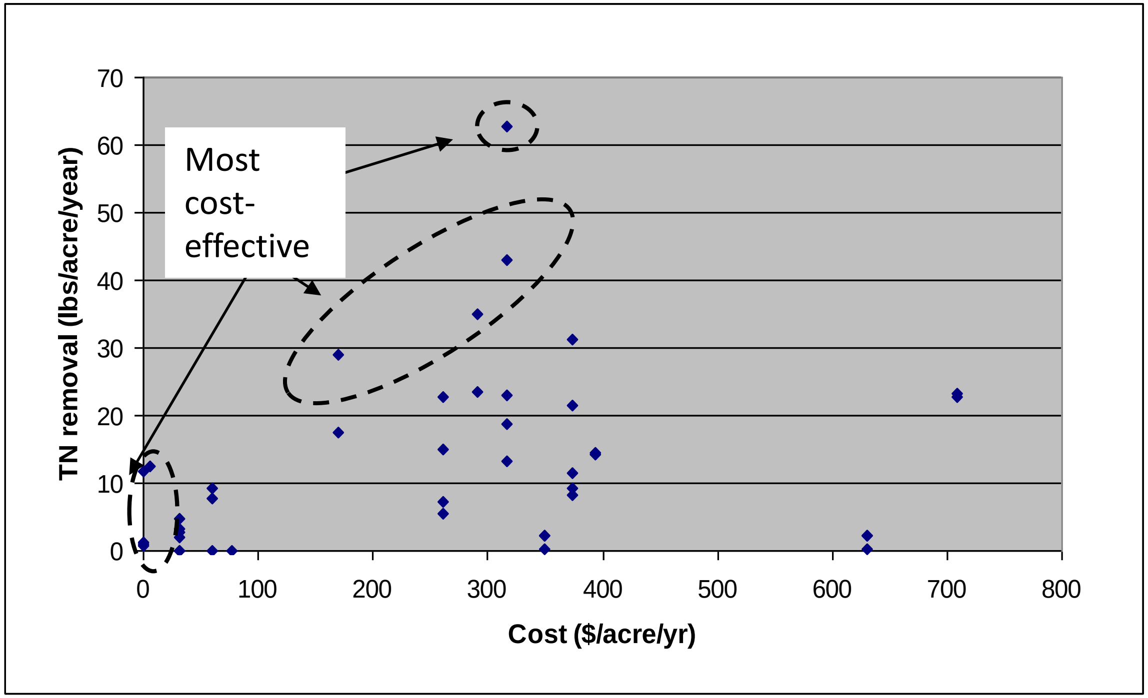
Summary (1 of 2)

1. Need metrics to judge a full suite of net benefits and tradeoffs
   - Environmental uplift
   - Key tradeoffs
   - Understand "echoes through time" of decisions made today (short and long term)
   - Capacity to achieve total goal (TMDL cap)
2. Not only optimizing from the perspective of the Bay TMDL
   - Local TMDLs
   - Other goals (habitat, flooding, aesthetics)
3. Human loss aversion & concerns creates constraints
   - Avoid, minimize, mitigate or "First do no harm"
   - Risk-weighted benefits (e.g., beaver habitat)

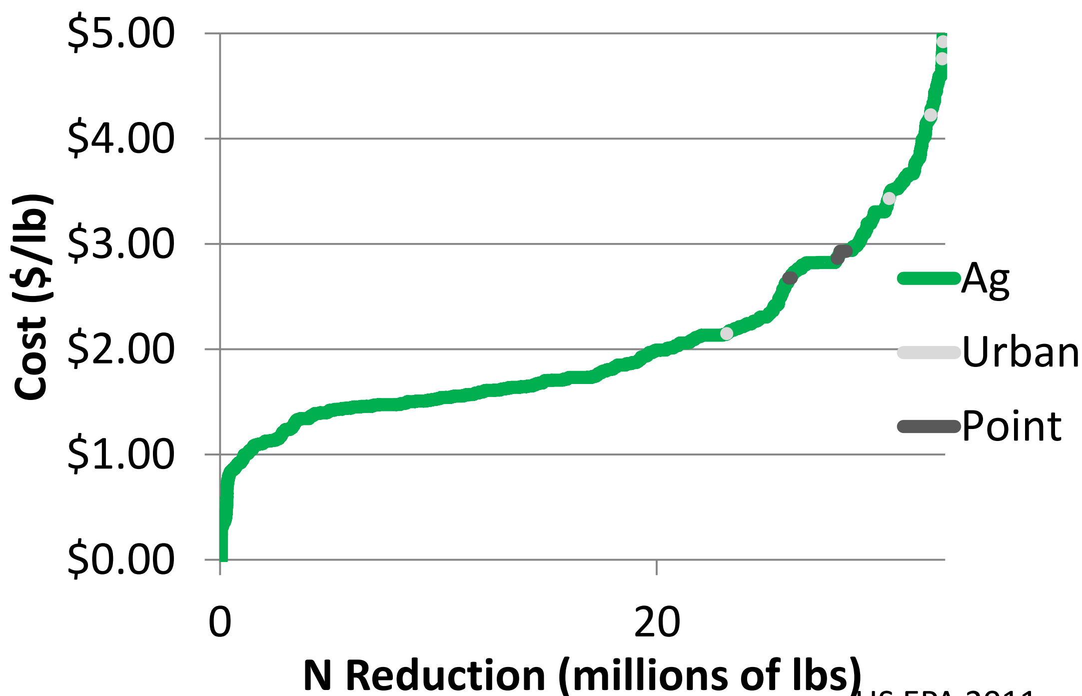
Summary (2 of 2)

4. Promote flexibility & creativity
   - Keep flexibility in the policy system – policy goals ahead of the science
   - Different solutions in different places
   - Cost-effective sediment controls might come from completely different practices than we are currently envisioning
     - In-stream vs out-of-stream efforts
   - Different knowledge needed for the accounting model vs developing site-specific recipes
     - Can initial simple conceptual models be used without creating biased decisions?
     - Coarse and fine sediments moved by different forces, need to recognize and manage separately

BMP-Site Cost Effectiveness Results

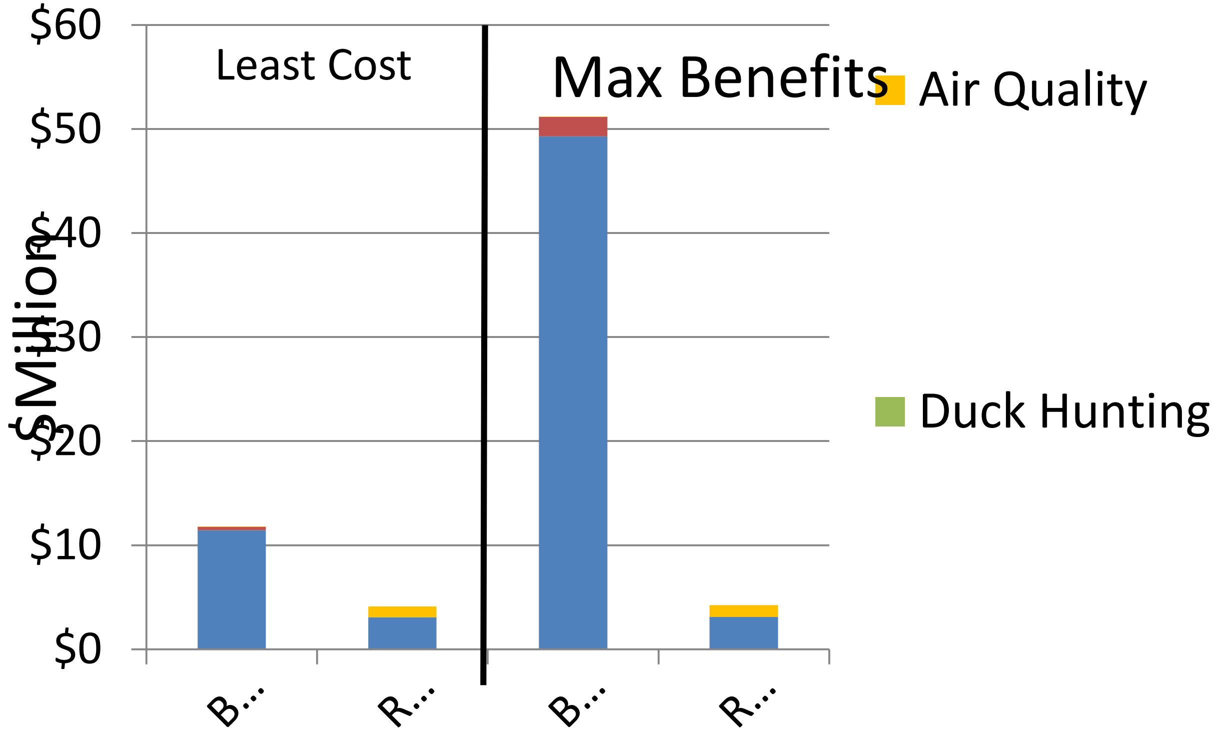


Marginal Cost Curve
for TN in the Susquehanna



US EPA 2011

Using Ecosystem Services Values to Compare Implementation Options & Ability to Meet Total Cap



US EPA 2011

Conclusions

- Economic analysis and decision support tools can be used to assess benefits and tradeoffs of different policies
- New research can support policy by improving understanding of
  cost-effectiveness of
  - BMP/site combinations
  - Total capacity to meet goals
- Different information needed for the CBP accounting model vs local permitting decisions
  - Understanding average costs and benefits may serve accounting model but not be as useful for a strategy to optimize conditions on individual sites

D. Goerman's Slide

Theme C Take Aways

- Regulatory process needs adapted both permitting and TMDL
  - Restoration Permitting
  - TMDL Load Allocation – acknowledge legacy contributions not sector driven
- Remove traditional silo approaches and allow crediting across regulatory frameworks
  - Compensatory mitigation, Stormwater, Water Quality, etc.
- Better communicate complexity of problem and time scales
  - Does require dedicated third party funding fro basic research as well as applied research
  - Requires better coordinate research efforts across disciplines and jurisdictions
- Change the point of measuring progress from outlet to more local scales