Monitoring Changes in Hydrologic Response Due to Land Management Changes at the Watershed Scale: Time Lag and Other Issues

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Adapted from:

Realistic Expectations of Timing Between Conservation and Restoration Actions and Ecological Responses

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Goal and Context

- Goal: Provide realistic estimations of the times required before desired PES outcomes are attained.
- Focus is on changes in "primary indicators" of watershed service improvements due to changes in land management.
- Data is predominately from research on hydrologic response to agricultural land management changes in the USA.

Primary Indicators

- Measurable changes in water quality
  - Sedimentation (TSS, turbidity)
  - Nutrients
  - Pesticides
  - Temperature
  - Aquatic biodiversity
- Measurable changes in hydrology
  - Increased dry season stream flow
  - Reductions in flooding
  - Increased reservoir storage

Secondary or Indirect Indicators

- Contracts signed
- Hectares of practices
- Kilometers of restored riparian zones
- Poaching snares and guns collected

The above indicators are useful, but they do not provide direct measures of actual ecosystem services provided. Buyers should get what they are paying for.

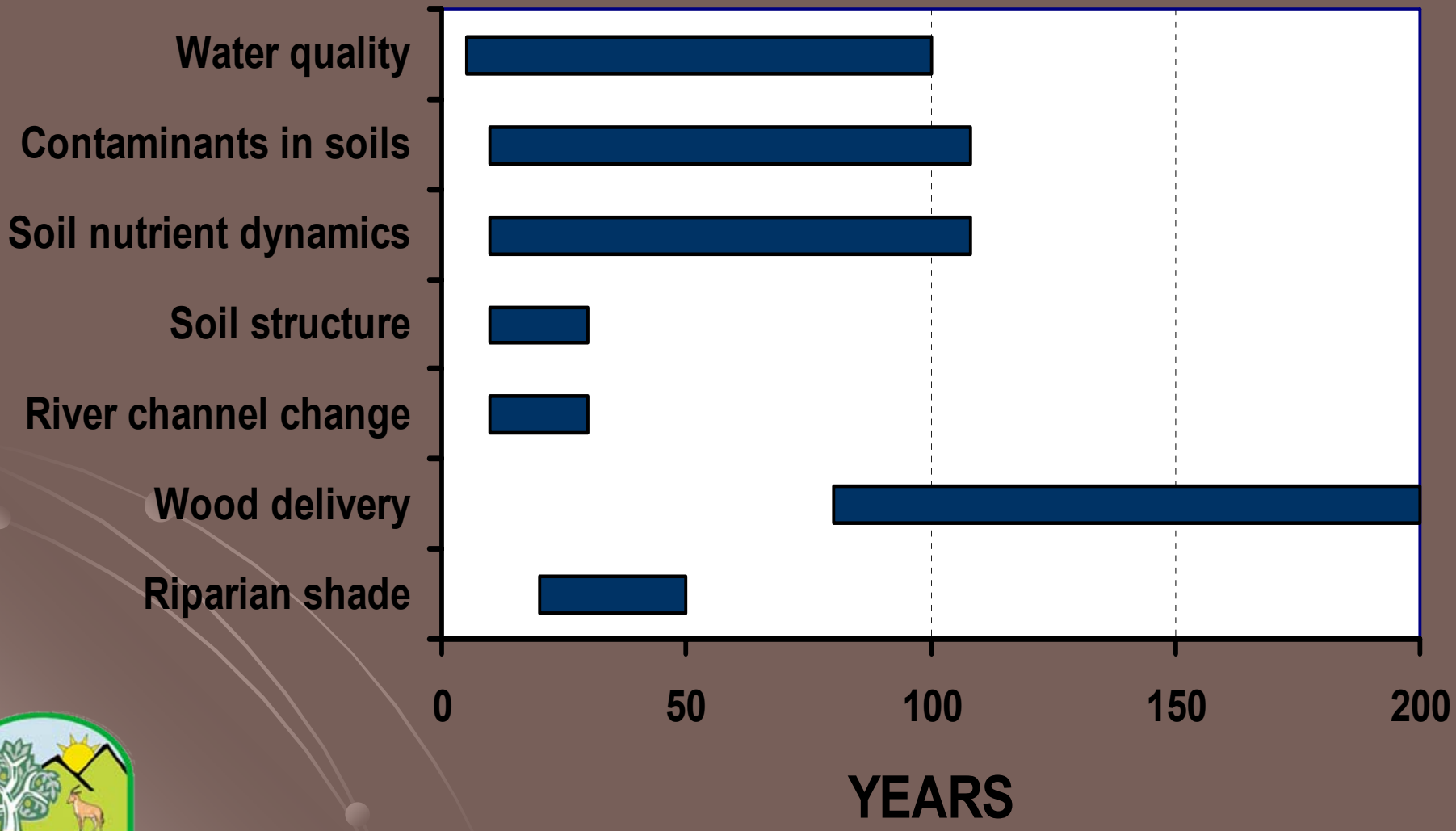
Key questions:

1. How old will he be when the PES goals are met?
2. How long is a PES buyer willing to wait for measurable improvements?

Response to Restoration

- **Study team reviewed 100s of journal articles on hydrologic and ecosystem response to changes in agricultural land management at the watershed scale.**
- **Serious lack of statistically significant quantitative data.**
- **Implementers seemed to purposely avoid measuring outcomes with primary indicators.**

Timeframes for Responses at Watershed Scale



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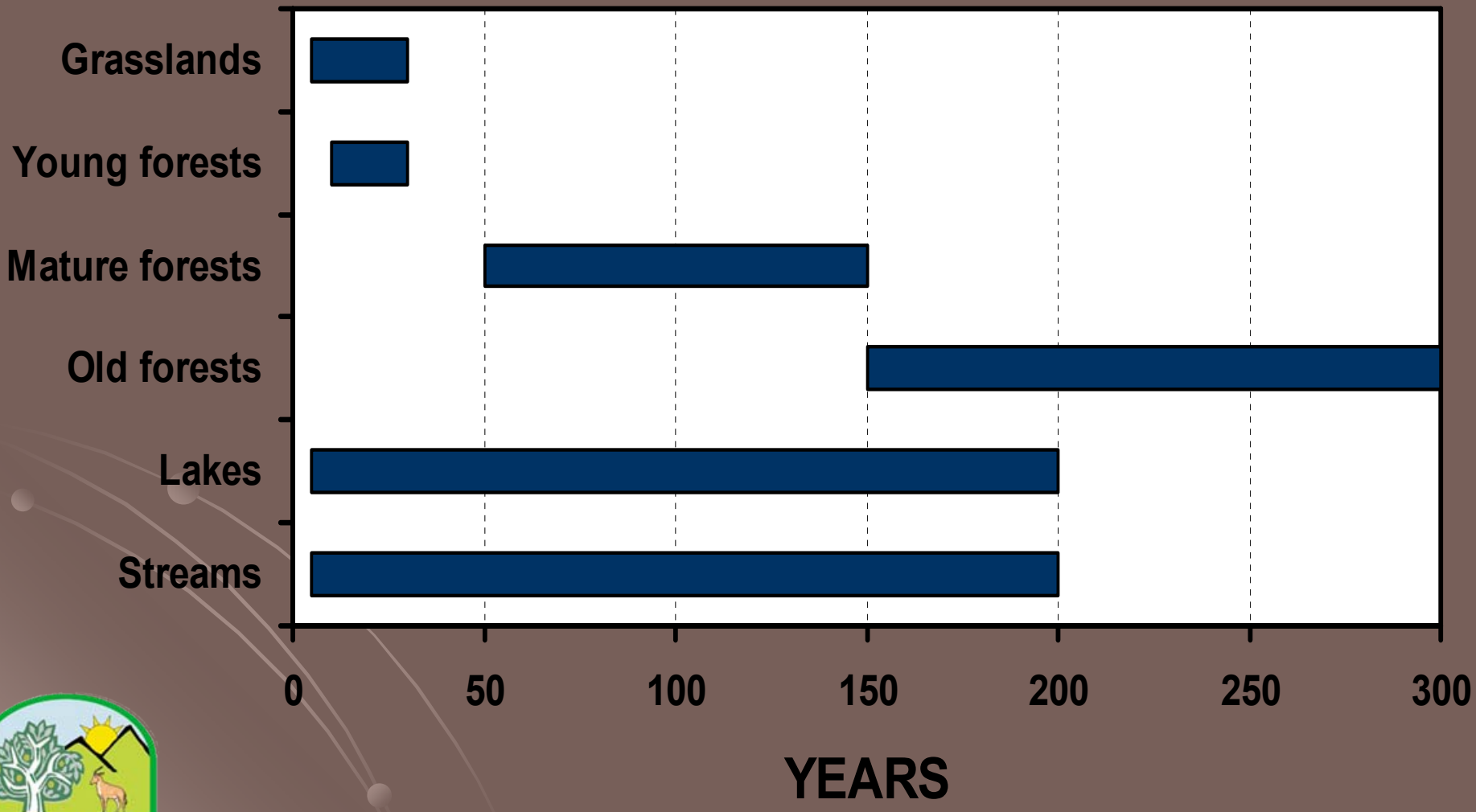
Timeframes for Responses at Watershed Scale



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Chesapeake Bay Watershed

- **170,000 km^2 watershed in eastern US**
- **Water quality has not improved despite 20 years and >$1 billion of widespread restoration activity.**
- **Significant concerns about effectiveness of restoration efforts.**

Chesapeake Bay Issues

- Most water in the Chesapeake Bay watershed takes ≈10 years to reach the Bay
- Average time for ground waters to reach the Bay ranges from 10-20 years.
- Consequently, minimum time lags of 10 to 20 years in system response to land management changes. May be much longer.
- Inadequate scope of implementation.
- Implementation in the wrong places.
- Unrealistic expectations for practices.
- Unrealistic water quality goals.

Realistic Expectations of Time

- **Tools and ways of thinking have to be changed so that realistic timeframes are inherent in program goals, the management questions asked, and the solutions explored.**

Likely Time Lags: 1 to 10 years

- Simple systems
- Inputs simple to control
- Rapid flow paths
- Low storage of nutrients, toxic substances, sediments, or human additions
- Rapid reproductive rates of native biota
- Succession not required
- Abundant legacies of native ecosystems
- Little influence of alien species
- Minor landscape alteration

Likely Time Lags: 10 to 50 years

- Simple systems
- Inputs simple to control
- Intermediate flow paths
- Moderate storage of nutrients, toxic substances, sediments, or human additions
- Rapid reproductive rates of native biota
- Early successional stages required
- Abundant legacies of native ecosystems
- Slight influence of alien species
- Intermediate landscape alteration

Likely Time Lags: 50 to 100 years

- Complex systems
- Inputs not simple to control
- Slow flow paths
- High storage of nutrients, toxic substances, sediments, or human additions
- Slow reproductive rates of native biota
- Mature successional stages required
- Few legacies of native ecosystems
- Extensive alien species
- Major landscape alteration

Likely Time Lags: >100 years

- Complex systems
- Inputs not simple to control
- Very long flow paths
- High storage of nutrients, toxic substances, sediments, or human additions
- Slow reproductive rates of native biota
- Late successional stages required
- Few legacies of native ecosystems
- Extensive and dominant alien species
- Major and irreversible landscape alteration

Conclusions

Successful PES programs are realistic with respect to:

- **Environmental, social and other goals**
- **Timing, adequacy, and quality of implemented practices.**
- **Timing of desired outcomes**

Successful PES programs:

- **Should be based on science, not faith**
- **Should utilize primary indicators to measure outcomes.**