Determining Ecologically Realistic Restoration Objectives

Q1: Watershed restoration assessment: What percentage of the ISC must be treated to see an effect?

Q2: Stormwater management assessment: Does the percentage of treated stormwater relate to ecological measures of success?

Q3: Resource tradeoffs: Which stream reaches may obtain the most ecological benefit by restoration activities?

Q4: Project scale effectiveness: Is ecological condition related to proximity to intact donor streams?

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Acknowledgments

Ken Mack, Montgomery County
Chris Ruck, Fairfax County

Key Research Questions

- What is ecologically realistic given watershed ISC?
- Which stream reaches are predicted to have the largest potential ecological gains from restoration activities?
- Does the percentage of treated stormwater, or its components, relate to ecological measures?
- Is ecological condition related to proximity to intact donor streams?

Restoration effectiveness questionable in urban streams

- Physical attributes sometimes (often?) repaired or stabilized
- Ecological attributes rarely improved
- GOAL – identify realistic restoration outcomes based on observations of restored sites that inform a predictive model
  - Assumes that ISC (impervious surface cover) is a good indicator of degradation and recovery potential

Conclusion

- Some restorations actually achieved their predicted benchmarks
  - None exceeded predictions
  - Other monitored streams exceeded predictions
- No detectable effect of stormwater management on ecological improvements
- Streams surrounded by areas with low ISC have better condition and better performance
  - May be an artefact of low ISC rather than proximity to donor streams

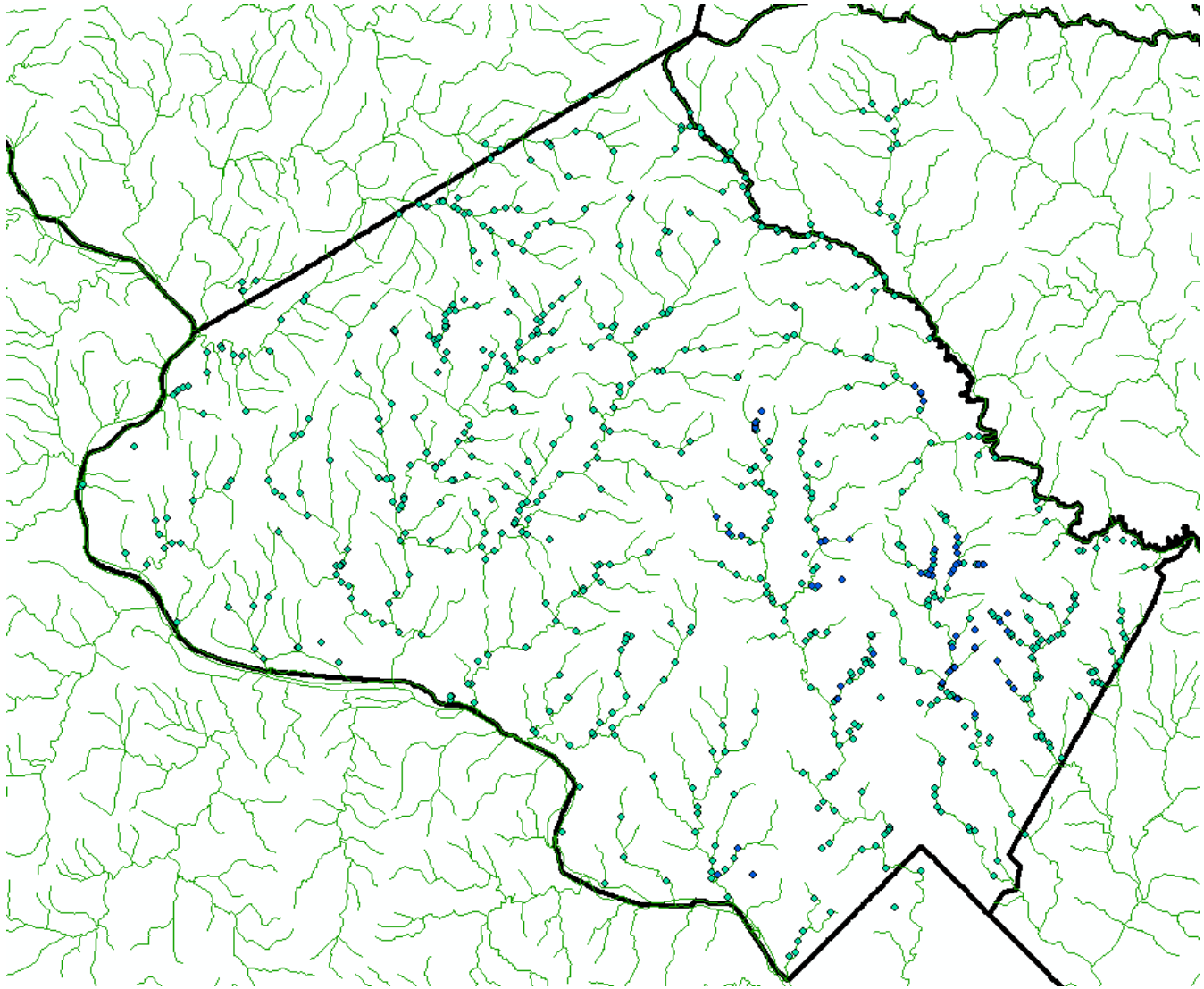
Approach

- Use monitoring data and watershed ISC to identify taxa capable of occurring in each stream reach
- Bootstrap distribution of BIBI scores based on taxa capable of occurring in stream reach
- Compare observed vs predicted to identify:
  - Realistic expectations for BIBI
  - Ecological performance of stream restorations
- Analyze performance in context of:
  - Proximity of donor streams
  - Stormwater management
- Create maps of predicted BIBI scores

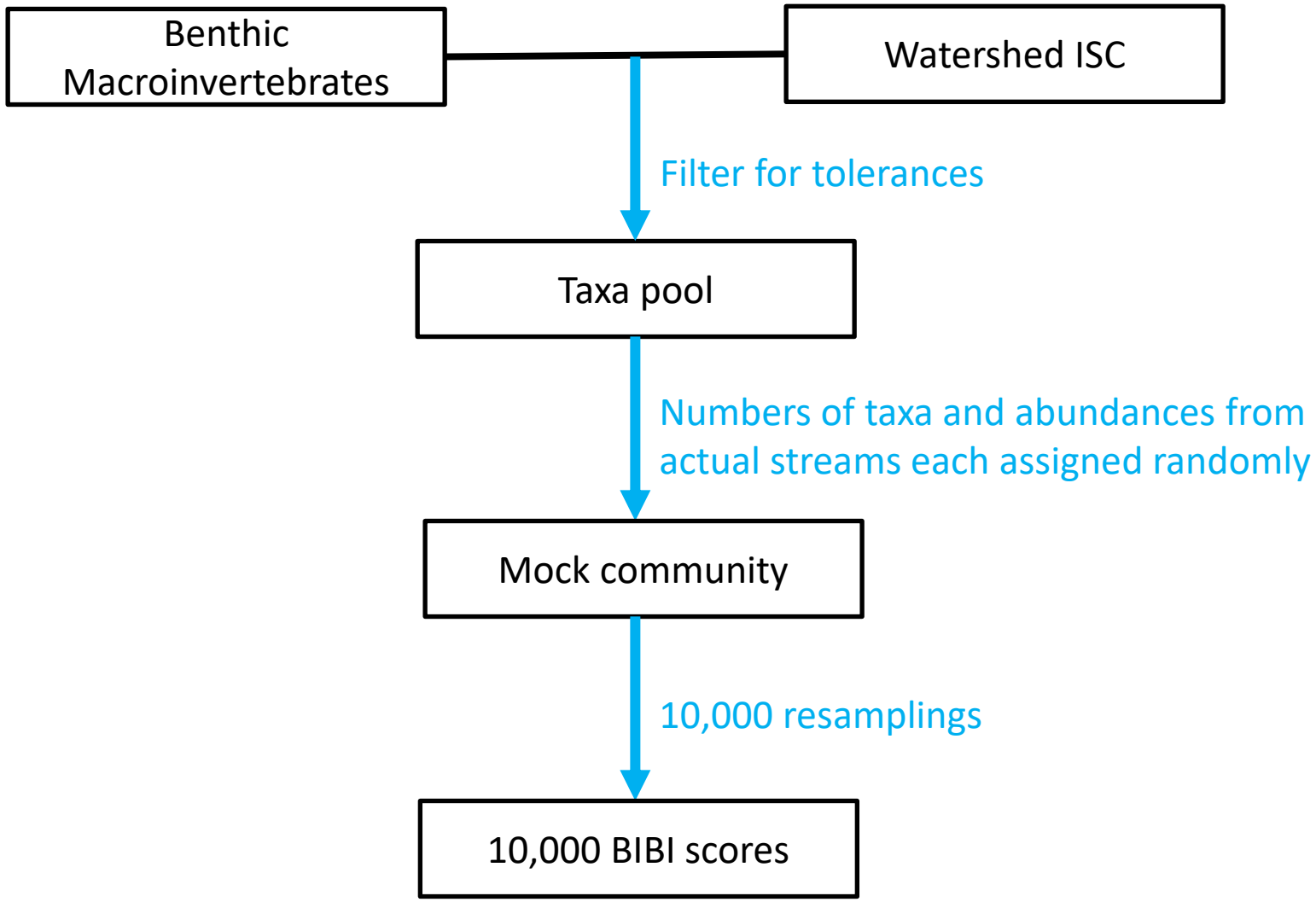
Data sources

- Benthic macroinvertebrate data sources:
  - Montgomery County
  - MBSS
  - UMCES/AL from prior CBT-funded project to Hilderbrand
- 2011 Land use/ Land cover
  - USGS Conte Lab SHEDS project data
  - http://conte-ecology.github.io/shedsGisData/
- Montgomery County stormwater database

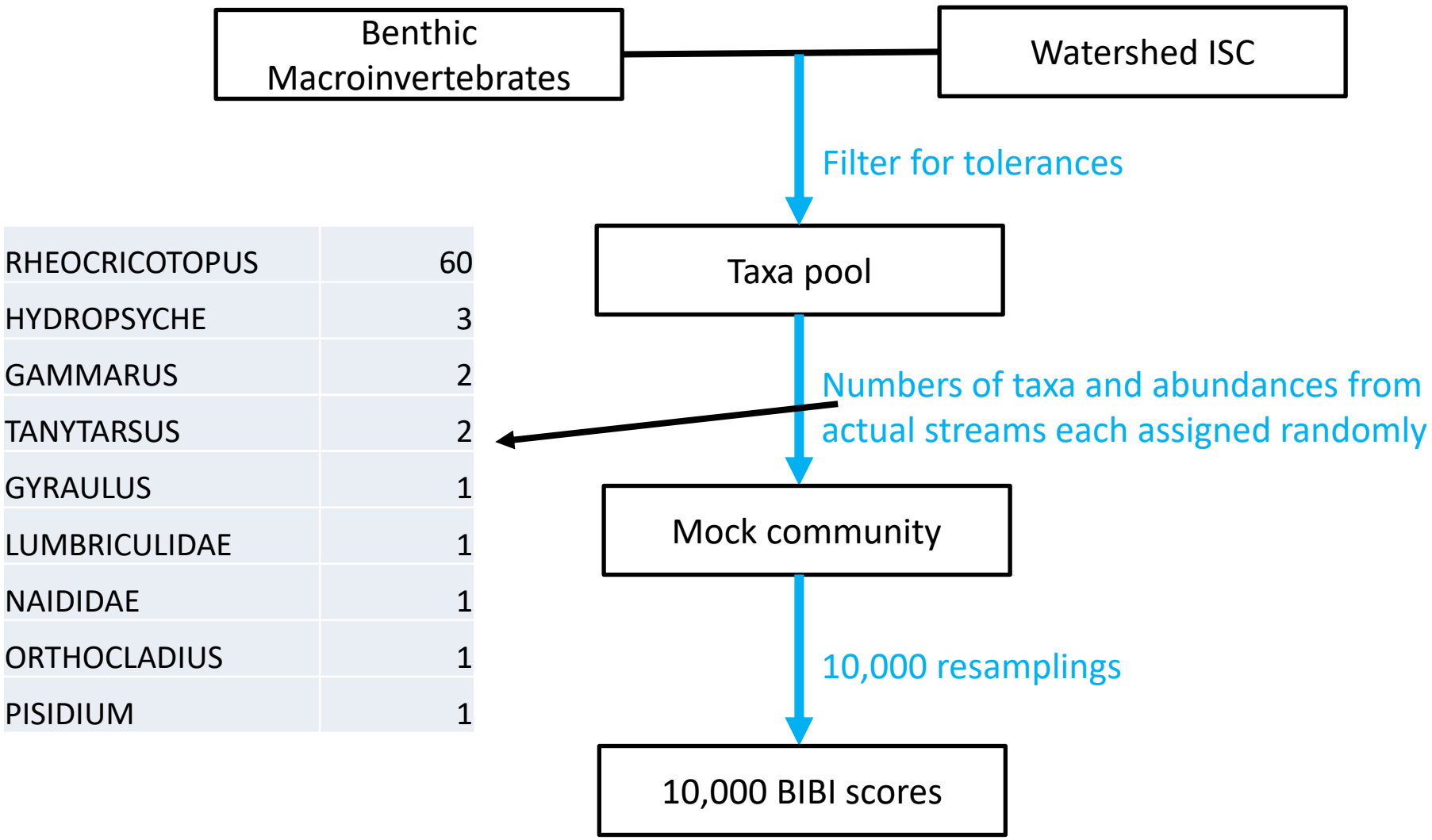
Benthic macroinvertebrate sample locations in Montgomery County



Resampling prediction work flow

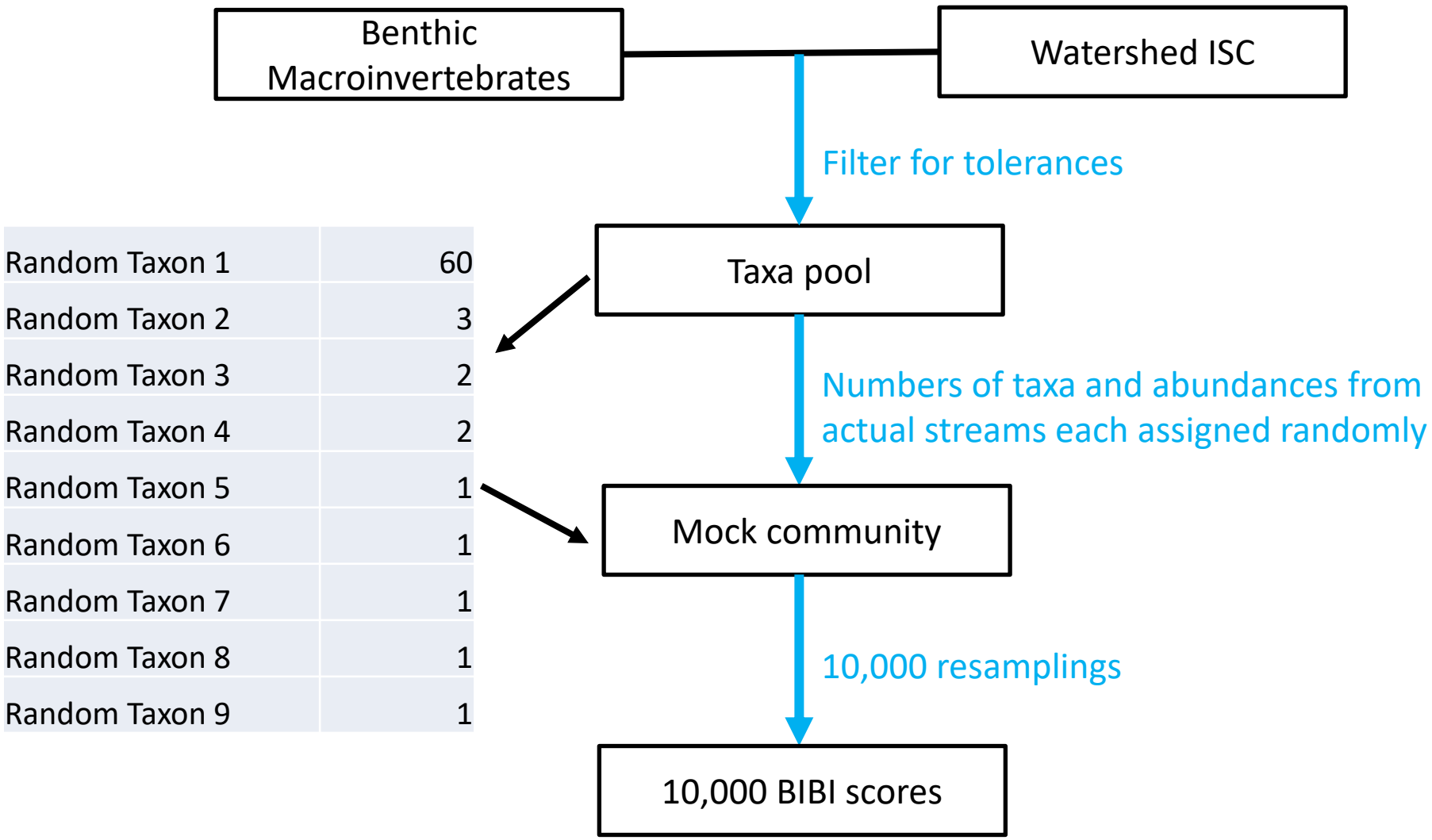


Resampling prediction work flow

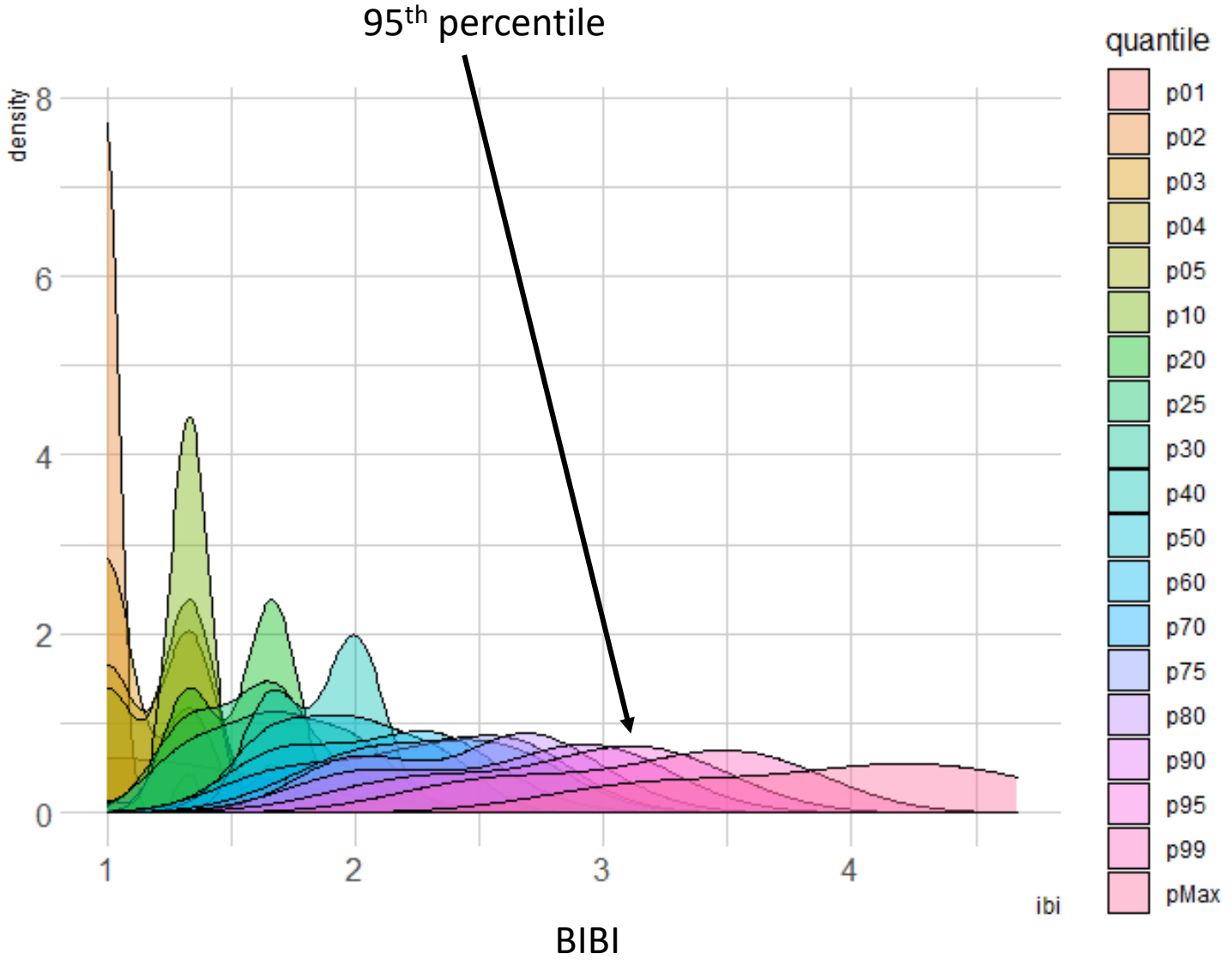


RHEOCRICOTOPUS	60
HYDROPSYCHE	3
GAMMARUS	2
TANYTARSUS	2
GYRAULUS	1
LUMBRICULIDAE	1
NAIDIDAE	1
ORTHOCLADIUS	1
PISIDIUM	1

Resampling prediction work flow



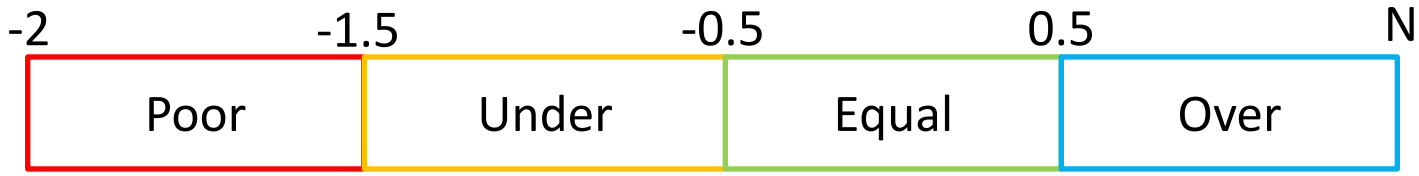
Density percentiles used for



BIBI

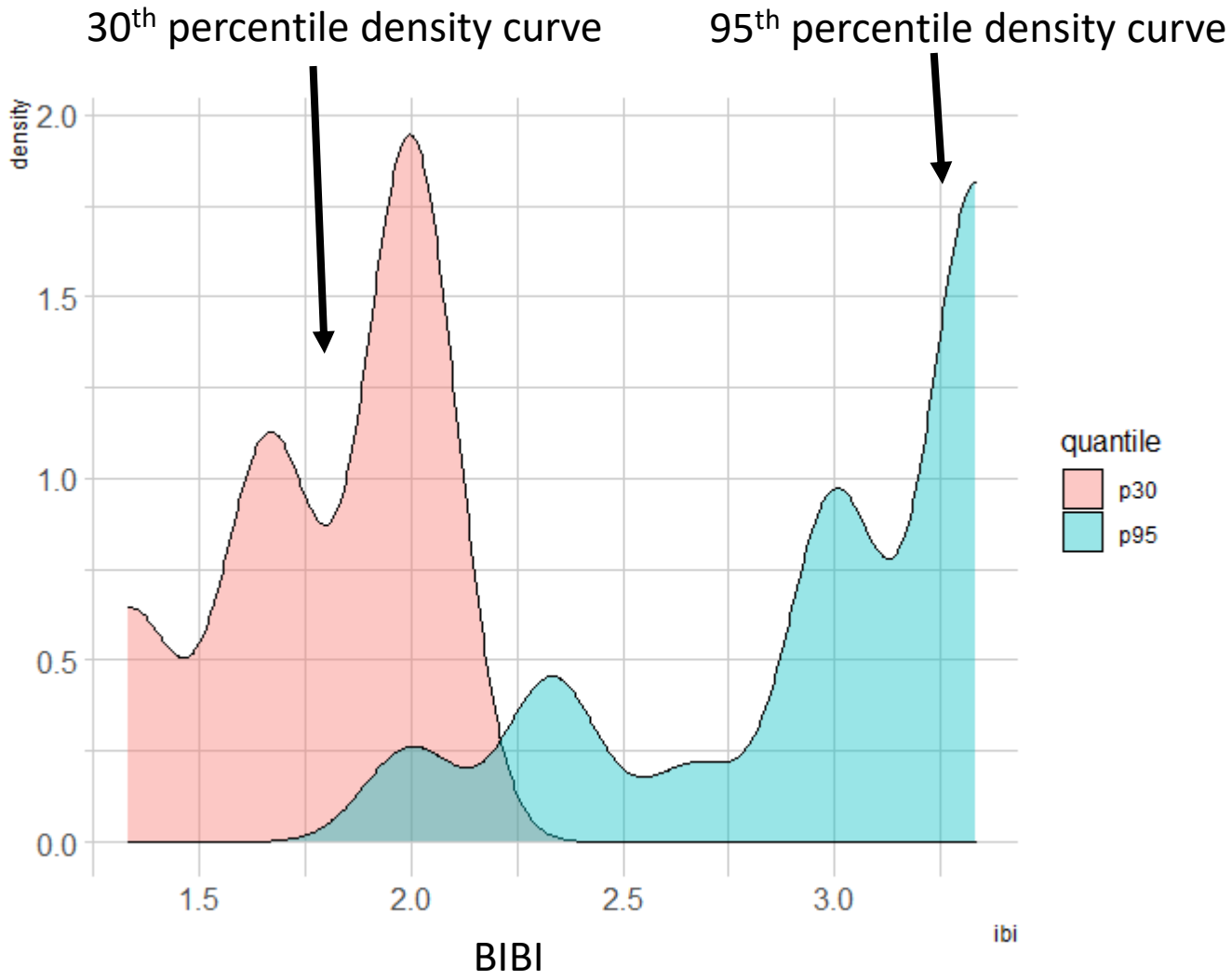
Data analysis: Performance of streams

Performance = Difference of BIBI – PredictedBIBI 95th percentile

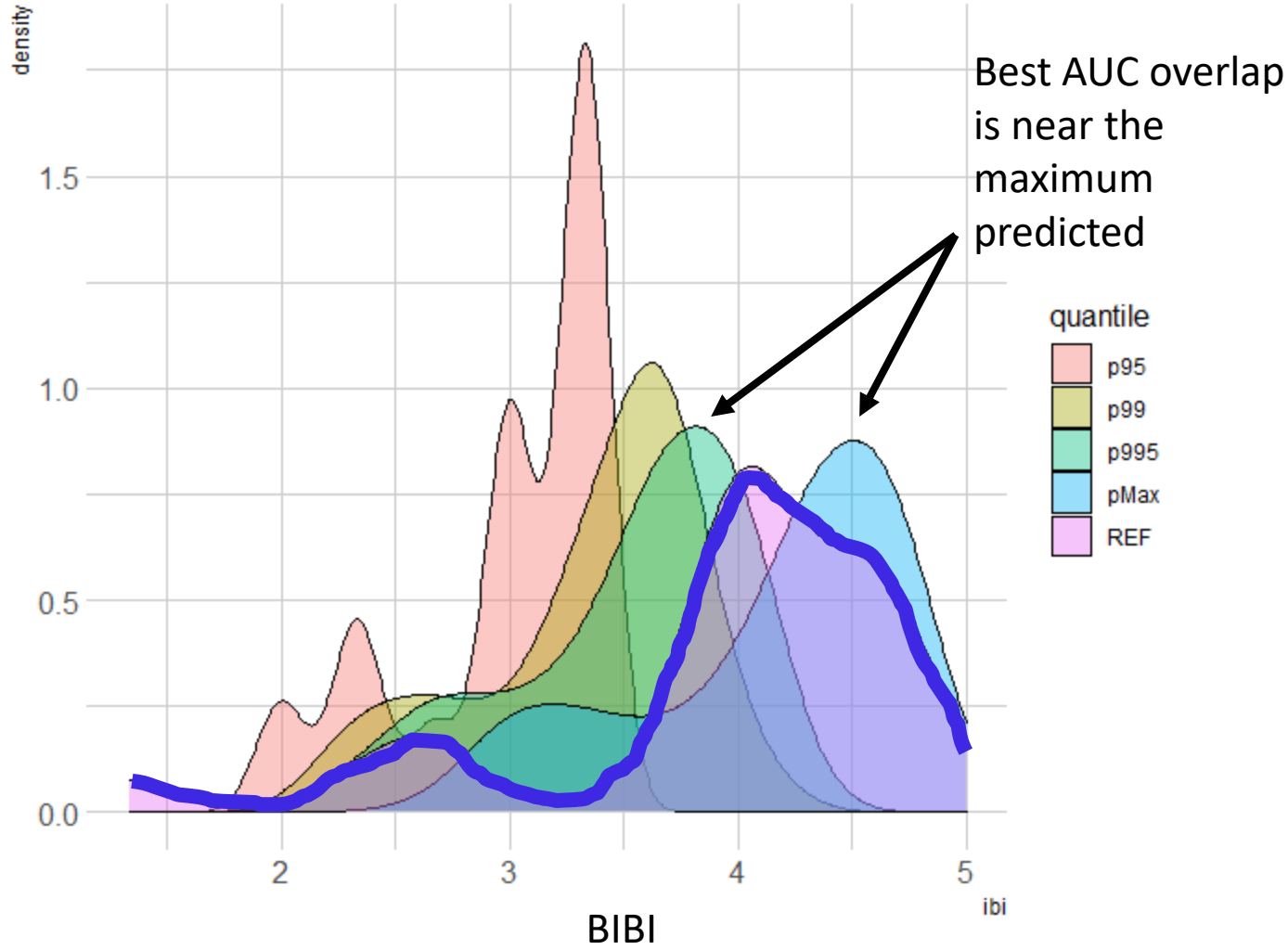


- Stream reach performance as function of:
  - Stormwater
  - Proximity of donor streams
  - ISC
- Statistical analyses:
  - DAPC (Discriminant Analysis of Principal Components)
  - Linear models (ANOVA)

Distribution of prediction percentiles used to determine goodness of fit



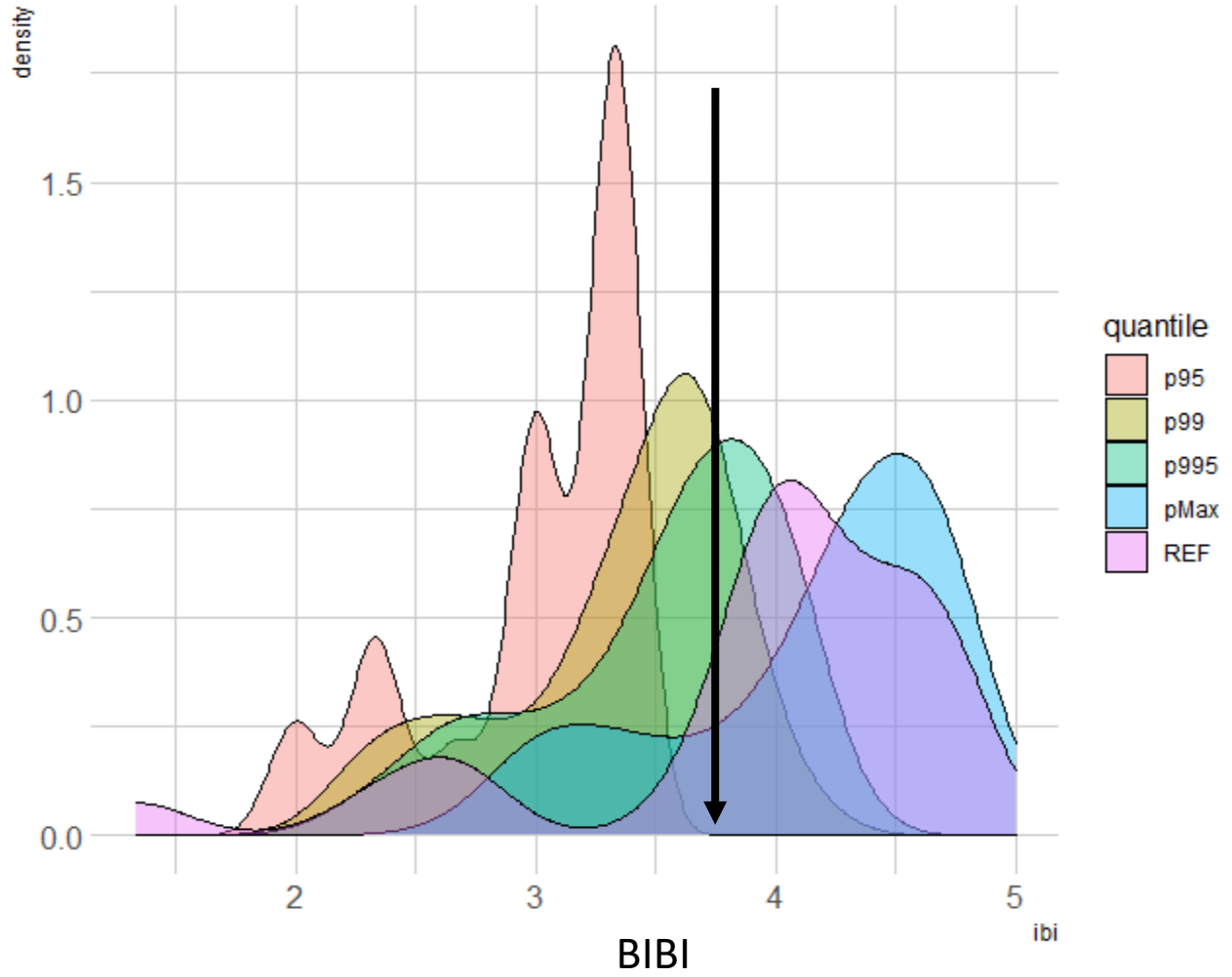
BIBI scores of reference reaches group near the best possible predictions – good rationale that predictions are reasonable



What is a realistic expectation?

- Not realistic to expect a reach to meet the 95th percentile of predicted BIBI
  - This is the gold standard for comparison
  - Some streams will be higher, but achieving 95% puts the stream in a special group
- Difference between having standards and expectations
  - Standards used for comparison to assess performance
  - Expectations incorporate pragmatism based on observations

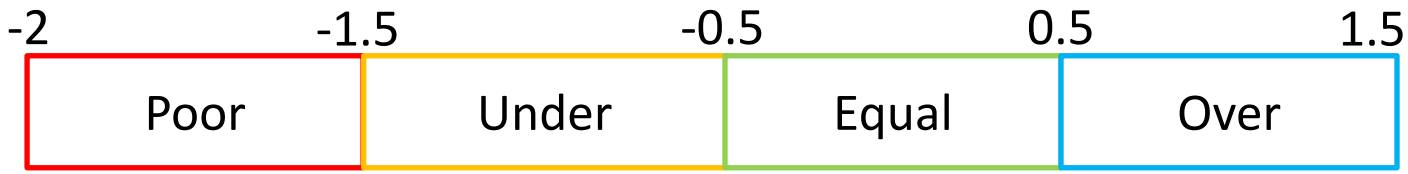
Max of the 95th percentile is about 3.7. So, the highest standard is 3.7 – 0.5 = 3.2. This is NOT too much to expect. Most streams have lower expectations



BIBI

Performance of Restored reaches not great

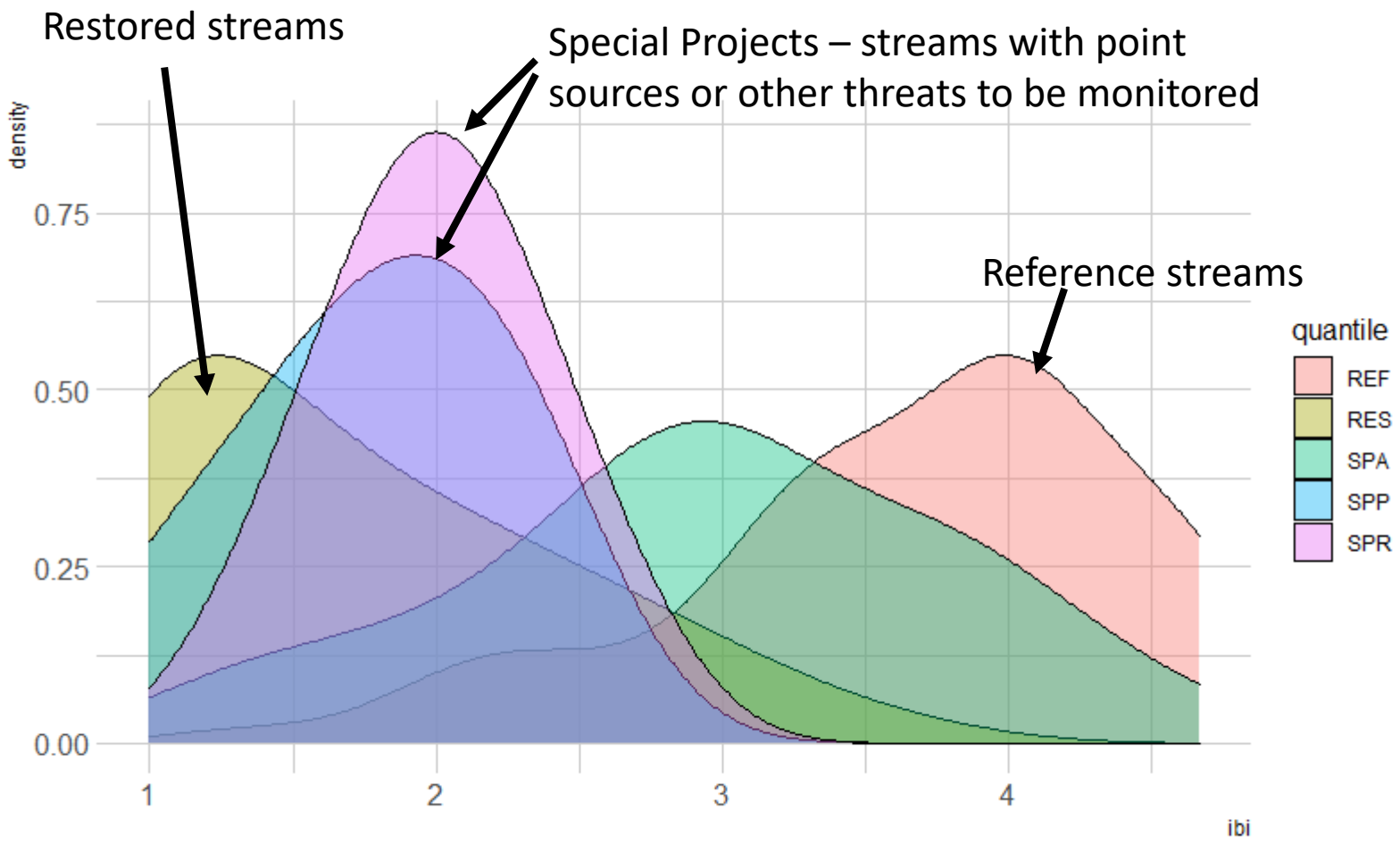
Performance = Difference of BIBI – Predicted BIBI



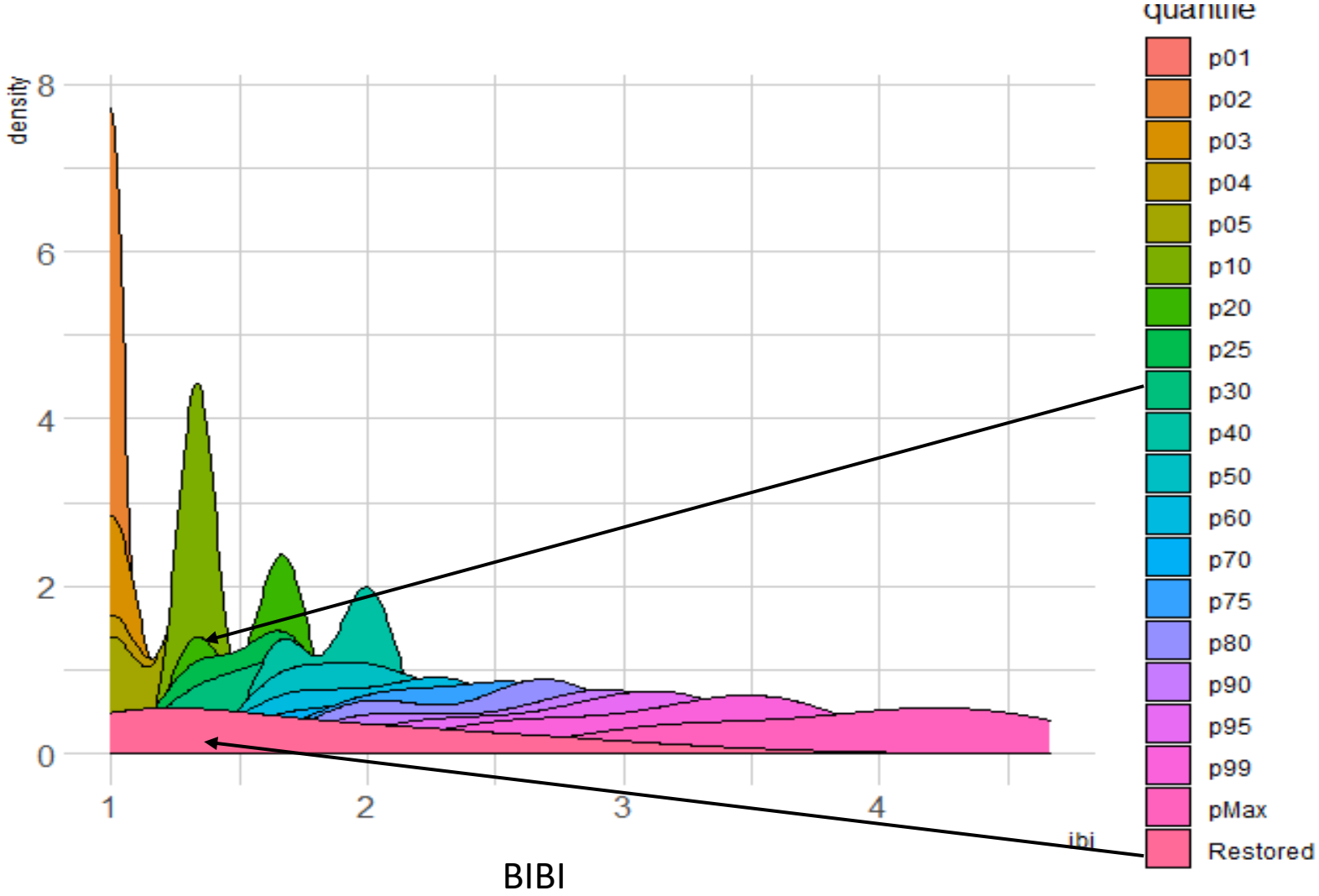
Restored	3	16	7	0
Others	23	86	67	84
All reaches	26	102	74	84

- No restored reaches exceeded expectations
- 27% of restored reaches met predicted outcomes
  - 73% of restored reaches underperformed (Under + Poor)
  - 12% of samples severely underperformed (Poor)
- 58% of non-restored reaches met or exceeded; 32% exceeded
  - 42% of samples from non-restored underperformed; 9% were poor

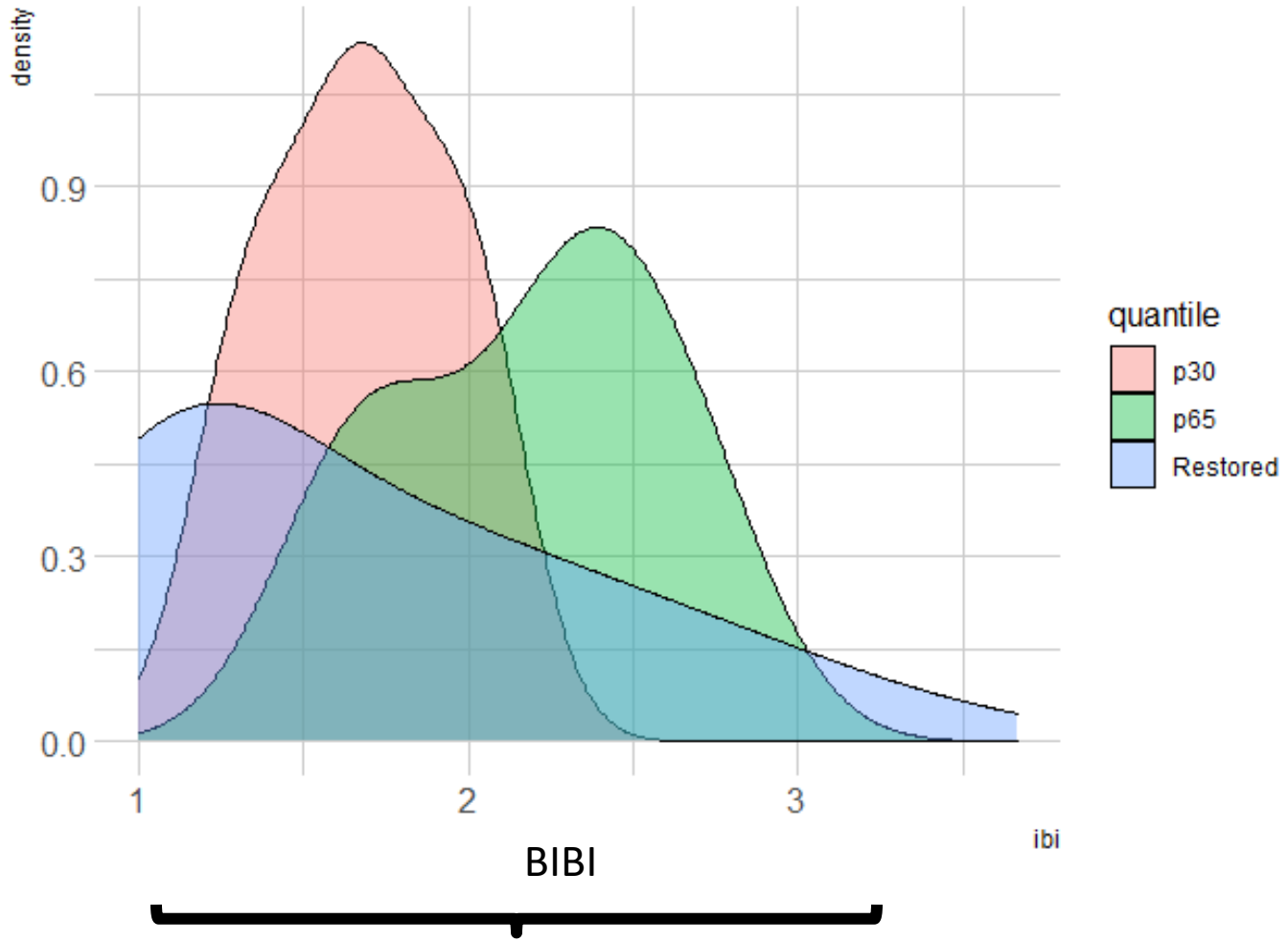
Observed BIBI scores of restored reaches low in context of other sampled reaches



Observed BIBI distribution of restored streams similar to the predicted 30th percentile of what could be achieved

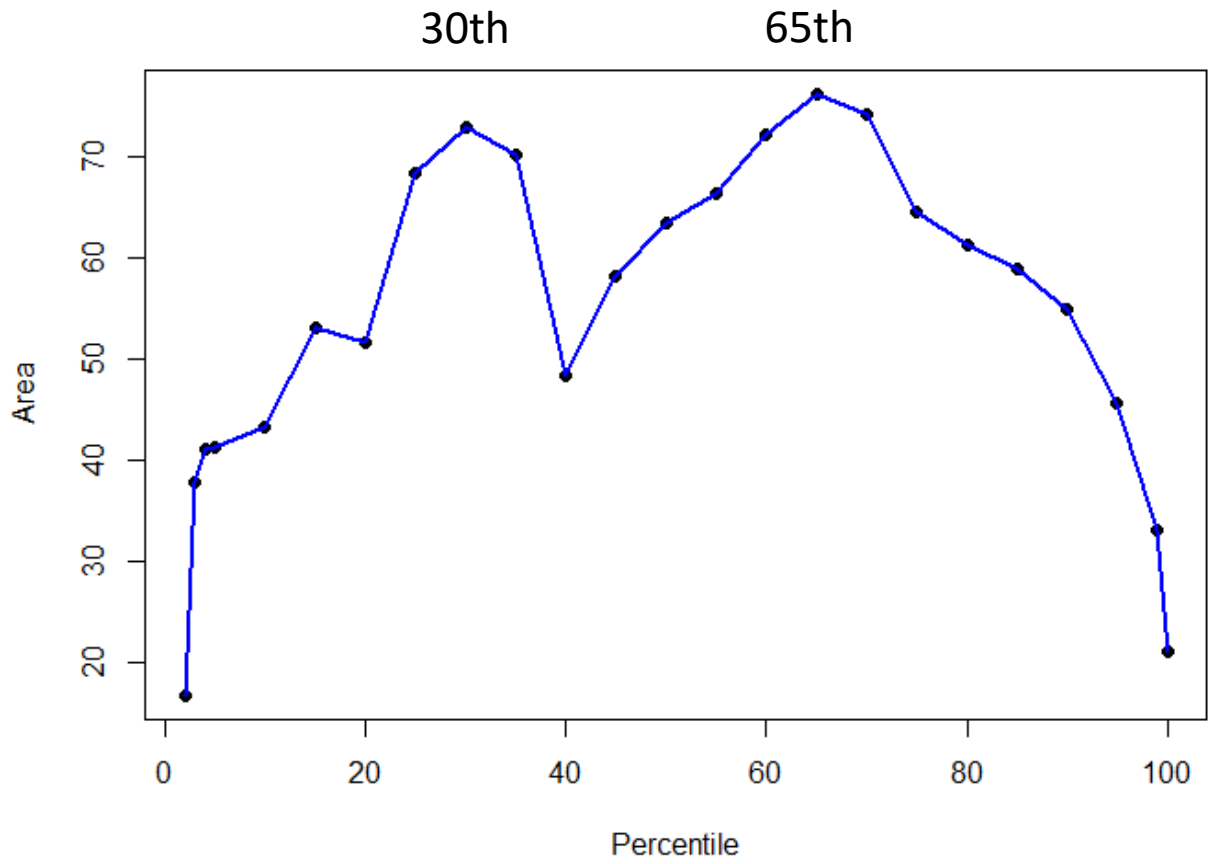


Restored streams observed BIBI distribution compared to 30th & 65th percentiles of predicted BIBI



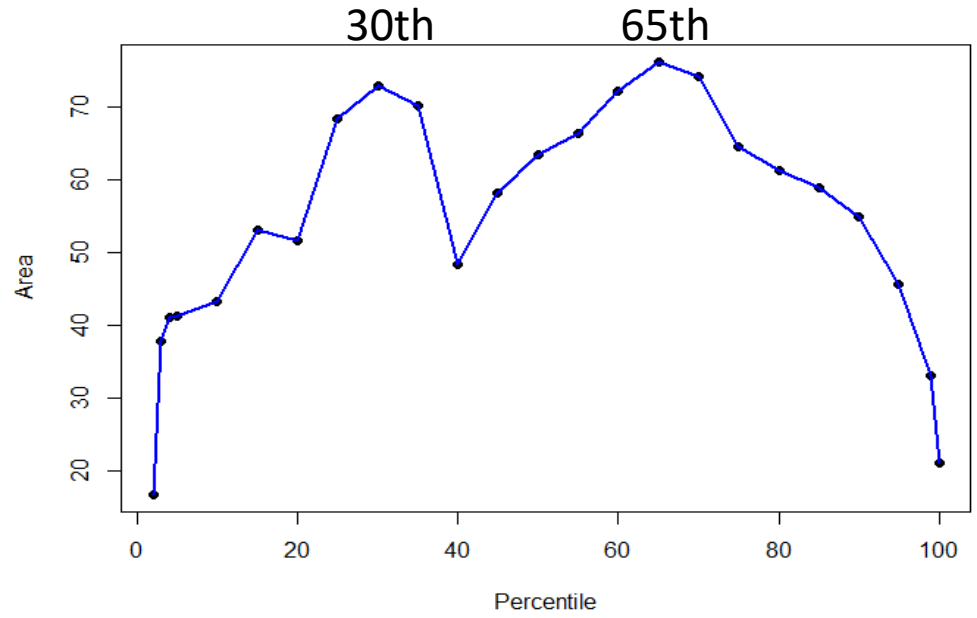
How to define a realistic expectation?

- Calculate area of restored that overlaps with each percentile

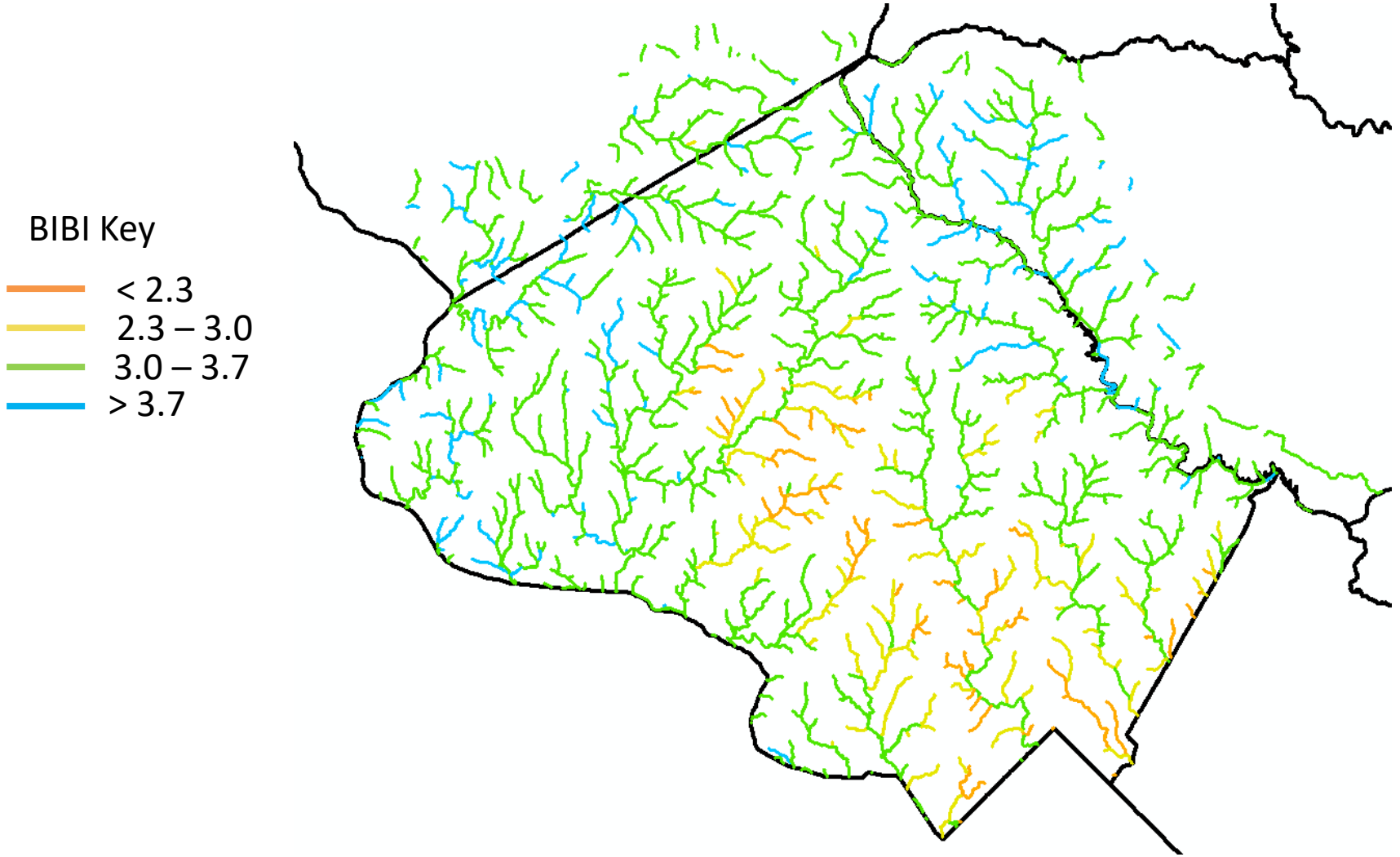


What is a realistic expectation?

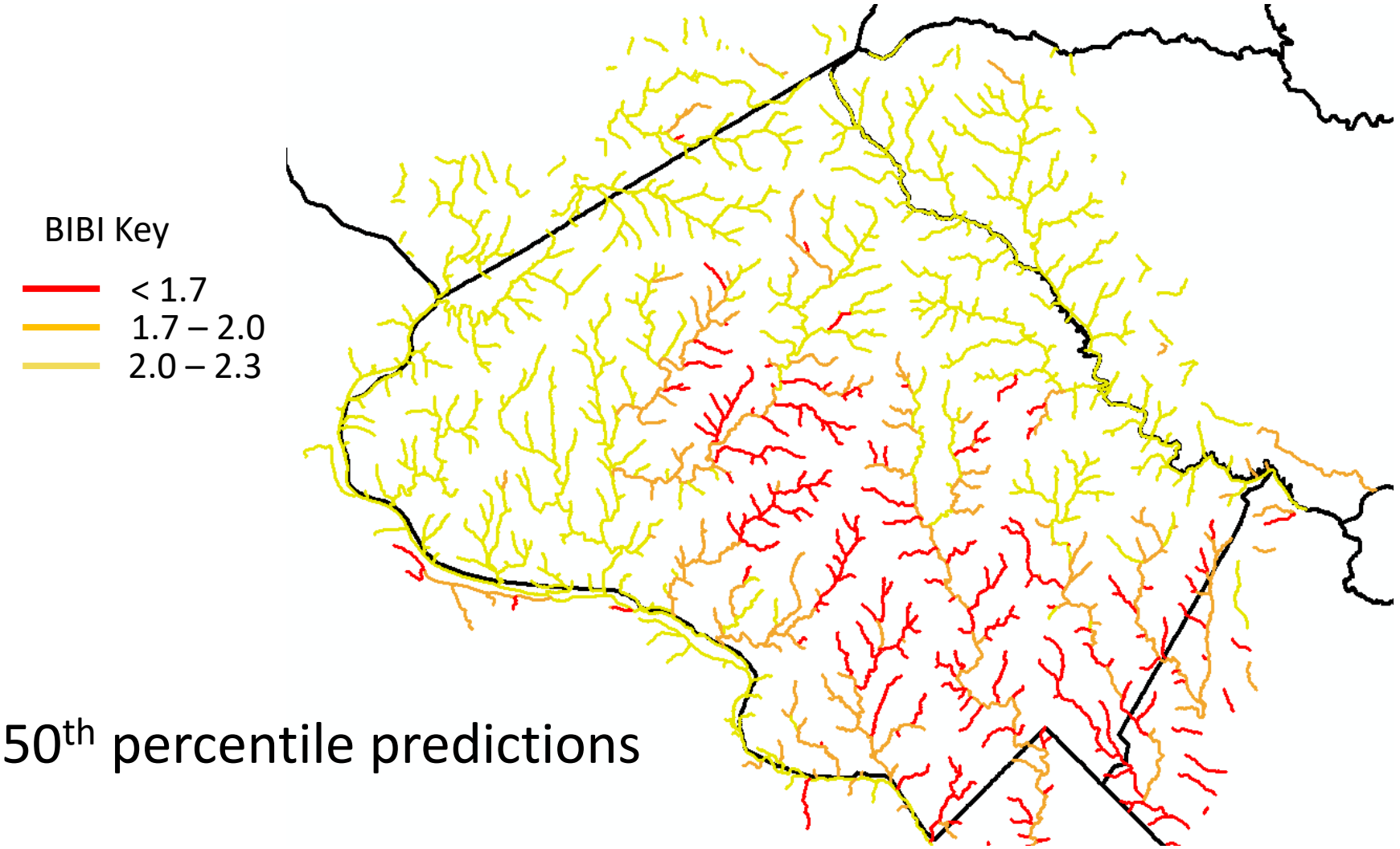
- Restored streams seem to contain two "populations" of streams.
  - One is best represented by 30th percentile – higher ISC watersheds
  - One is best represented by 65th percentile – lower ISC watersheds



Best-case achievable: 99th percentile



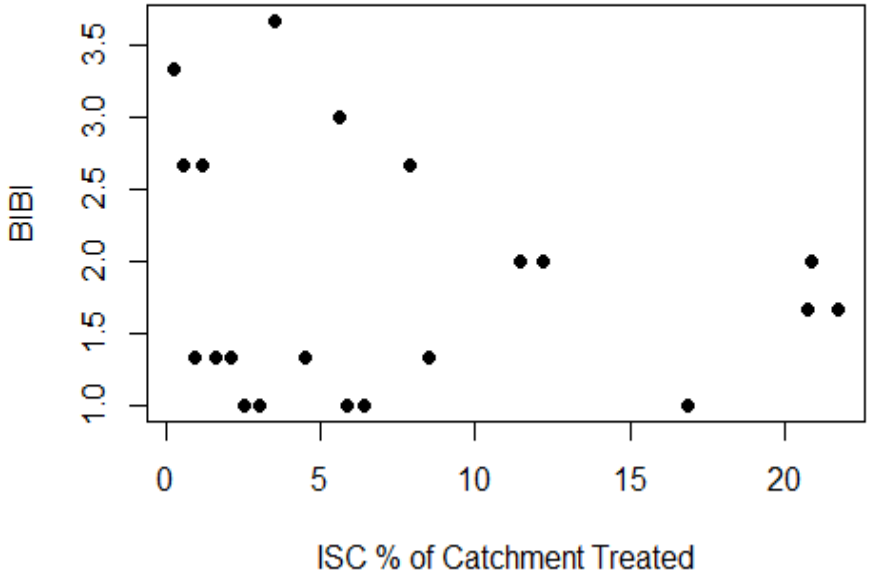
Realistic restoration expectations

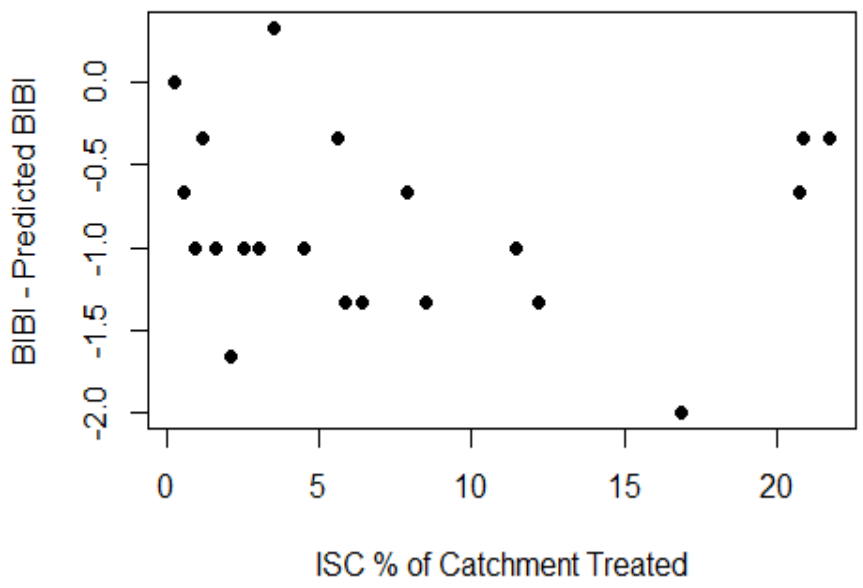


50th percentile predictions

No detectable effect of stormwater management on ecological performance

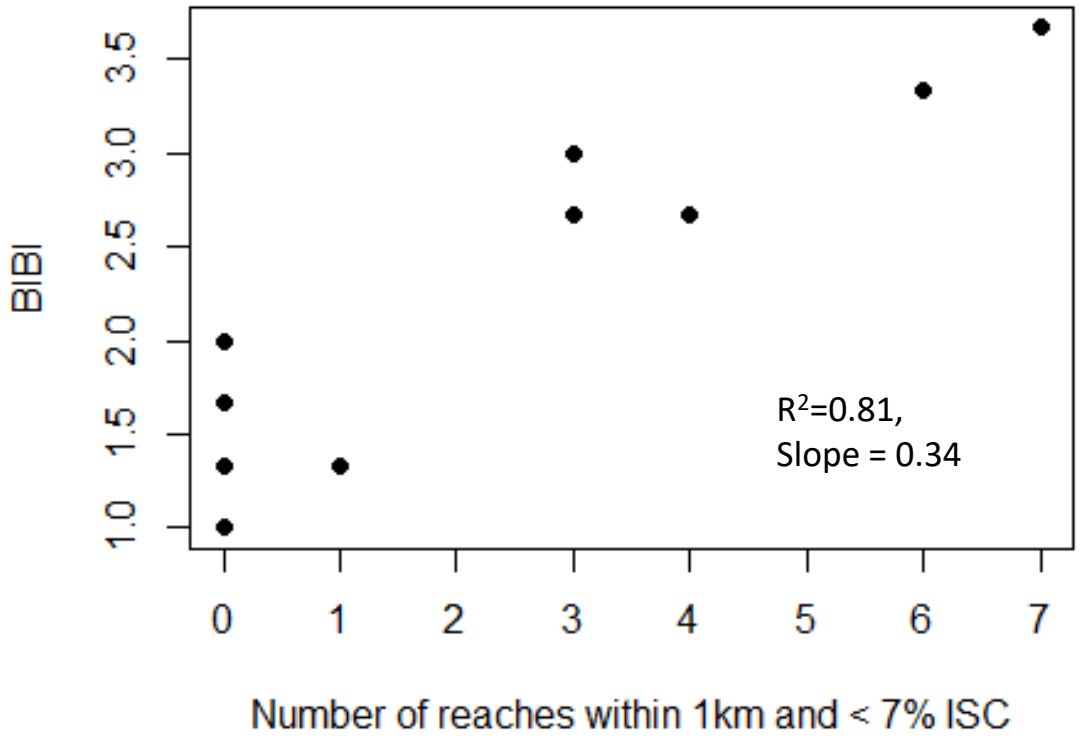
- No effect considering ALL or only restored reaches
- No signal for BIBI or reach performance





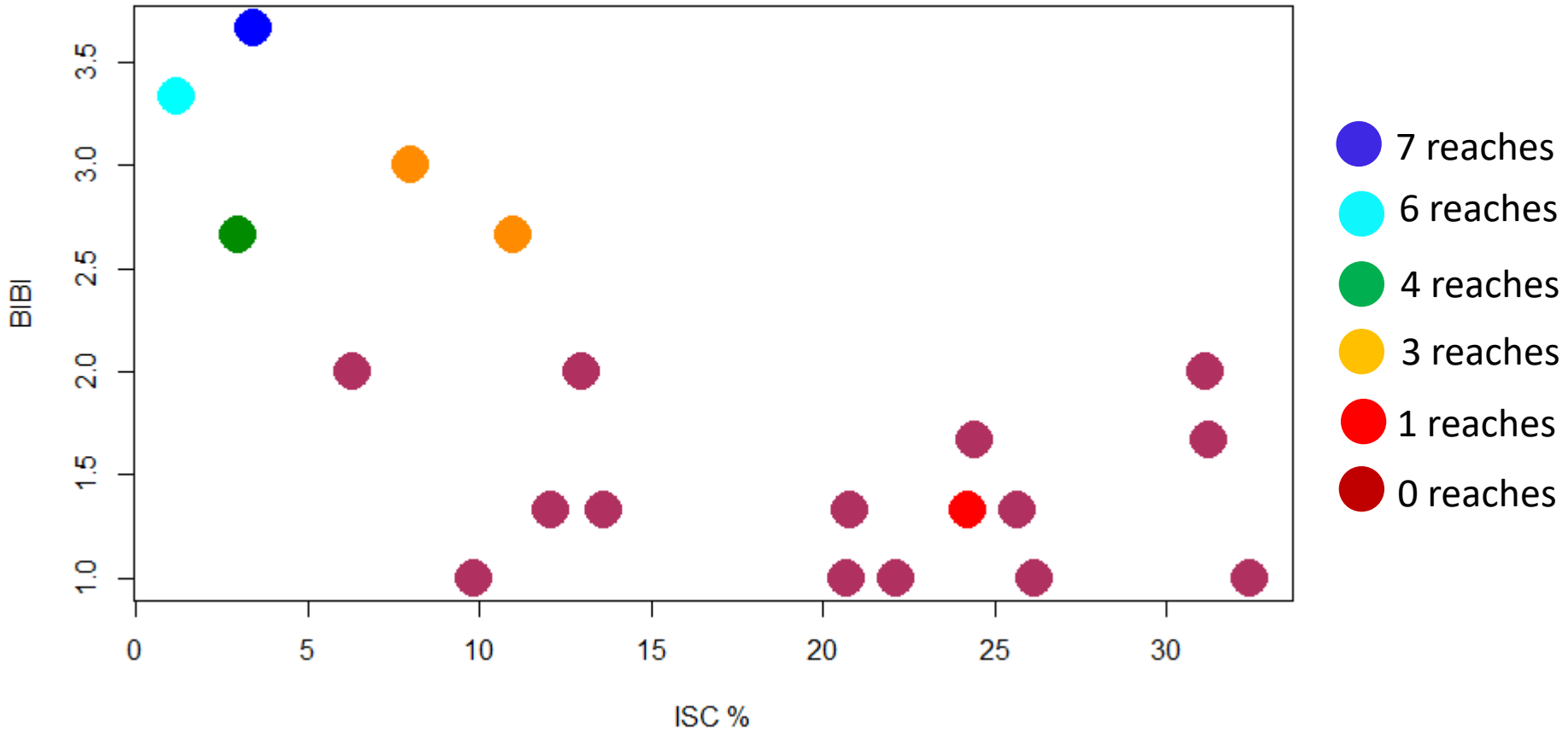
Proximity to donor streams related to higher performance

- Difficult to determine if effect is due to:
  - Donor streams in close proximity
  - Proxy for less intense development in the region



Probably a proxy for low ISC

- Sites with high number of nearby donor reaches also have low ISC in their own catchment AND higher BIBI



Summary Q1: What is ecologically realistic for restorations given watershed ISC?

- We can realistically expect a BIBI ~ 30% of the predicted maximum for watersheds with higher ISC and ~65% of predicted maximum in lower ISC watesheds
- Suggesting that restorations can do better may be misleading if that site has a high ISC and low BIBI prior to restoration
- Restorations unlikely to outperform expectations
  - ISC sets expectations regardless of stormwater activities

Summary Q2: Which stream reaches are predicted to have the largest potential ecological gains from restoration activities?

- Reaches in regions with lower ISC tend to have better performance
- Maybe we should not try to restore streams for ecological purposes that already have a BIBI > 50% of expected? Let's discuss later in meeting 

Summary Q3: Does the percentage of treated stormwater techniques on the landscape, or its components, relate to ecological measures?

- Unfortunately, no
- No detectable effect:
  - number of projects,
  - type of projects,
  - amount of ISC treated,
  - ISC% of catchment treated

Summary Q4: Is ecological condition related to proximity to intact donor streams?

- Maybe
- May be due to donor streams
- May be due to lower human pressure / low ISC in the catchment and surroundings

Hildebrand Translation Slides

Translation Slides by Ken Mack (Montgomery County Department of Environmental Protection) with input from Chris Ruck (Fairfax County Department of Public Works & Environmental Services)

Take home points

- If you build it, they will not likely come
  - Stream restoration may lower the potential for benthic recovery/uplift
  - Time lag for recovery is unknown
- Biological uplift should not be the sole driver for implementing stream restorations or stormwater management
  - These are minimally effective at increasing biological potential for recovery/uplift
- Impervious Surface sets the ceiling for BIBI scores
  - Incremental improvements may be likely, just not to the potential in similar natural systems
  - Stream Restorations do not outperform their predicted potential
  - Stormwater Management doesn’t reduce impacts from impervious surface on benthic communities

What does this mean for practitioners?

- Take care to avoid stream restorations in reaches with moderate to high biological scores
  - May take more time on front-end to get data
- Stormwater management is not effectively protecting stream biota (Regardless of BMP density, area of impervious treated, etc.)
  - Lower expectations and claims of recovery/uplift
- Avoid & minimize project impacts/LOD whenever possible.
- Implement long-term monitoring to determine lag effects and potential recovery/uplift
- Continue to advance “the way” we restore streams

What does this mean for regulators:

- Stream restoration should be limited to address infrastructure protection and nutrient/sediment benefits
  - Biology is not and should not be used as an indicator of Ches Bay pollutant removal
- Stream restorations will likely have a lower potential for biological recovery than natural channels
  - May require low pre-restoration BIBI scores if benthic health is a goal
  - Need to lower expectations/requirements for benthic recovery in a stream restoration
- Impervious area (urbanization) sets the ceiling for BIBI scores
  - Impervious surface should be limited during development and/or reduced during re-development
  - Previously implemented stormwater management applications are ineffective at protecting stream biota. These are not a “silver bullet” for biological improvements.
  - May need further development of an Urban Stream Standard and/or Biota’s Restoration Potential