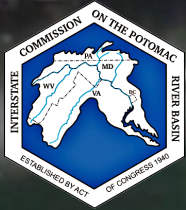# Improving Our Predictive Model of Stream Conditions Using the Chesapeake BIBI
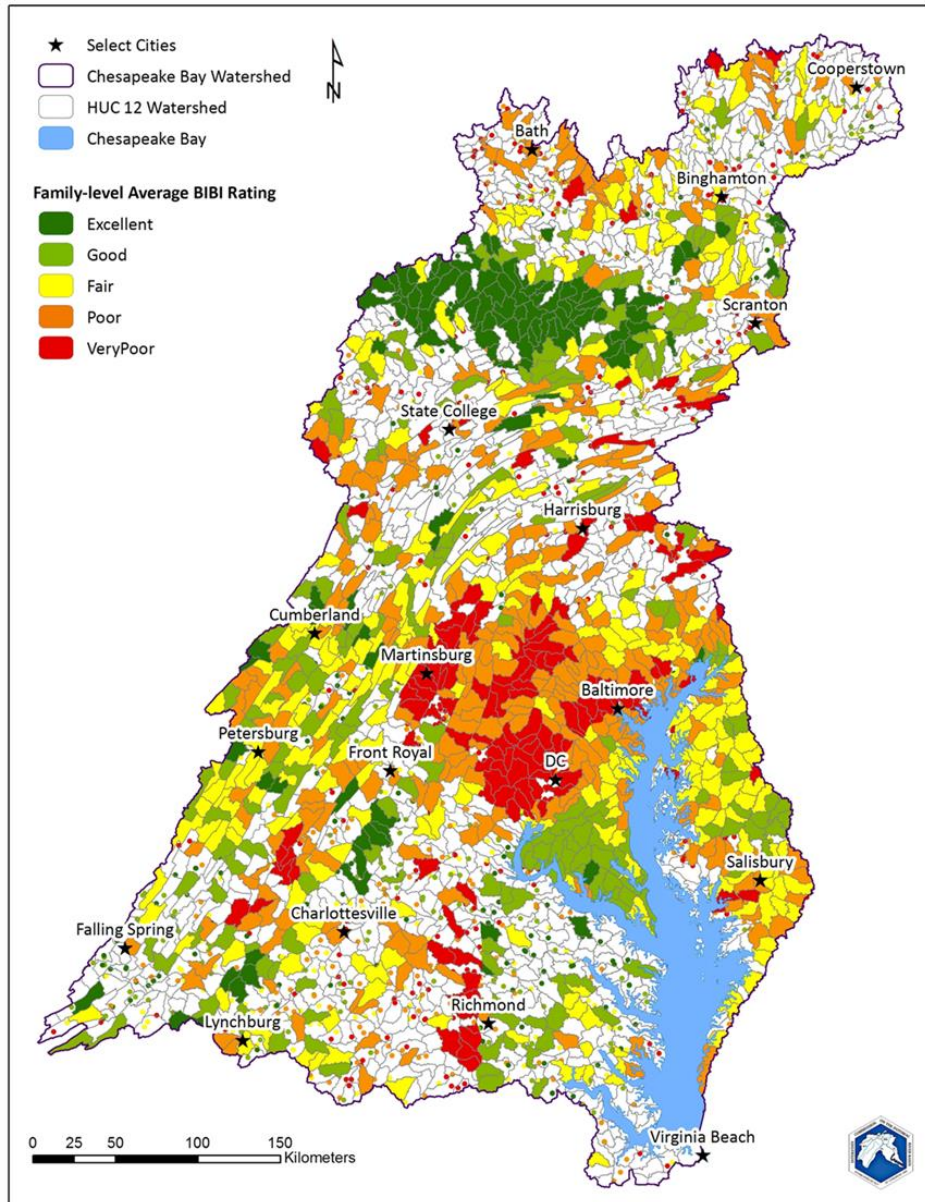
**Claire Buchanan**

**Kelly Maloney**

# Chessie BIBI - Chesapeake Basin-wide Index of Biotic Integrity



Built from ground up with the raw data (ICPRB with States & CBP 2011)

Updated database; refined index (ICPRB 2017)

Identified baseline period 2006 – 2011 (Workshop 2018)

Related landscape to Chessie BIBI rating with Random Forest model (USGS Leetown 2018)
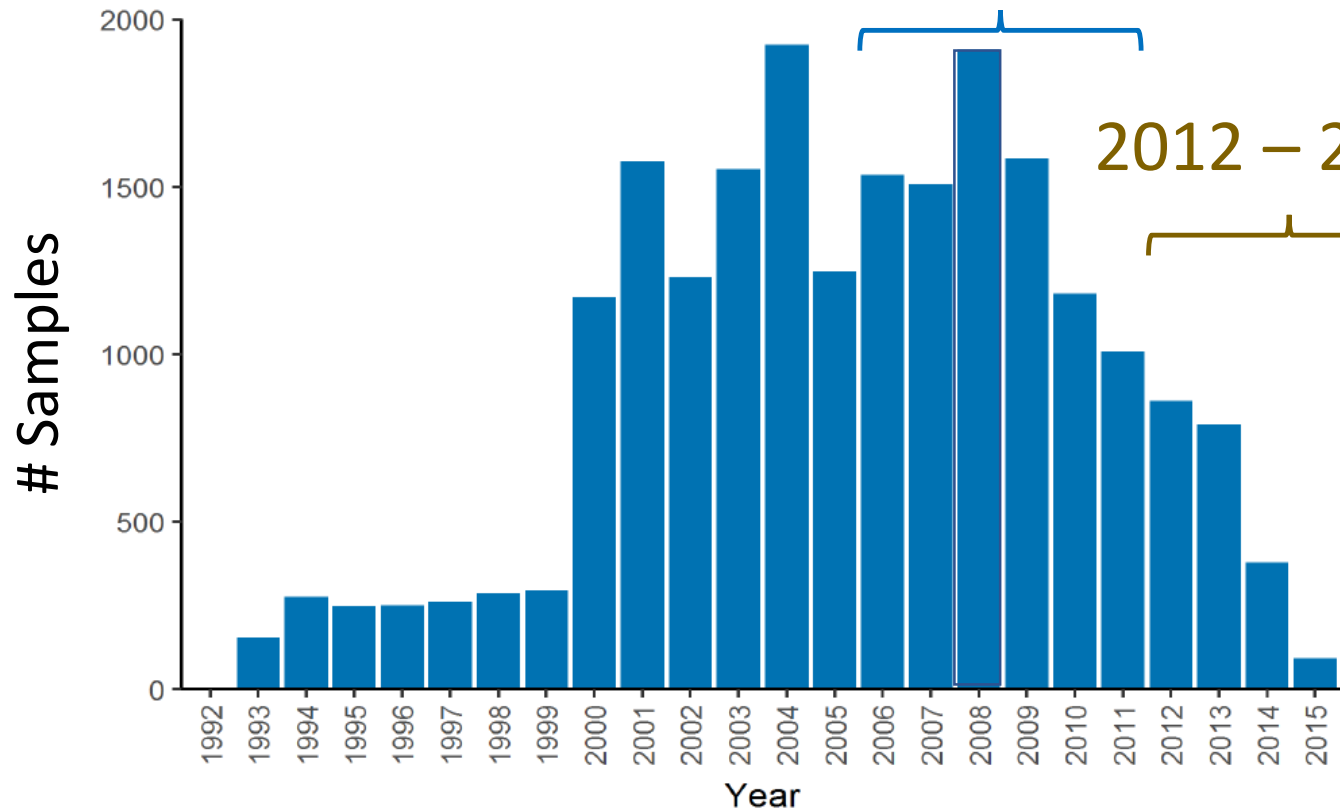
Future work (ICPRB & USGS Leetown 2020):
- Update Database
- Refine Criteria for Reference Condition
- Predict Chessie BIBI in Unsampled Streams

- ## Update Database



**2006 – 2011 baseline**

**2012 – 2017 first interval**

Obtain data from mon. programs

Incorporate data into CEDR

Normalize data

Calc metrics & Chessie BIBI scores

Weight scores by catchment area

Combine with weighted model results

Sum and calculate % of Bay watershed area with Fair/Good/Excellent streams
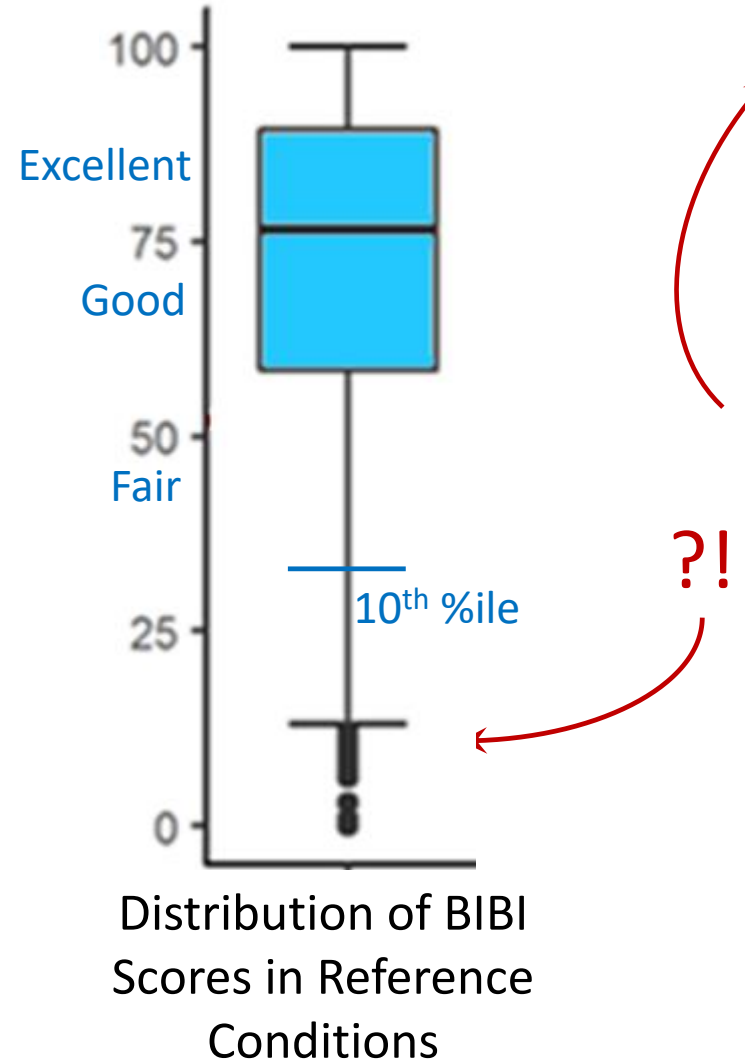
# Refine Criteria for Reference Condition

**Original Criteria – All Must Be Met**

Water Quality
- Conductivity less than 300 uS/cm
- DO greater than 5 mg/liter
- pH between 6 and 8.5

Instream Habitat (~ 8 metrics)
- 75% of RBP habitat scores are 16 – 20 and none is less than 12



Excellent

Good

Fair

10th %ile

?!

Distribution of BIBI Scores in Reference Conditions

*Add Watershed Criteria…*

- Upstream imperviousness *
- Upstream canopy cover *
- Elevation
- Soil type
- $SO4^{-2}$ deposition
- Dams (withdrawals, discharges)
- Precipitation
- Other factors?

*… And Tighten Range for High Quality Scores?*

- **Predict Chessie BIBI in Unsampled Streams…**

Predicting biological conditions for small headwater streams in the Chesapeake Bay watershed

Kelly O. Maloney[1,3], Zachary M. Smith[2,4], Claire Buchanan[2,5], Andrea Nagel[2,6], and John A. Young[1,7]

[1]US Geological Survey, Leetown Science Center, 11649 Leetown Road, Kearneysville, West Virginia 25430 USA
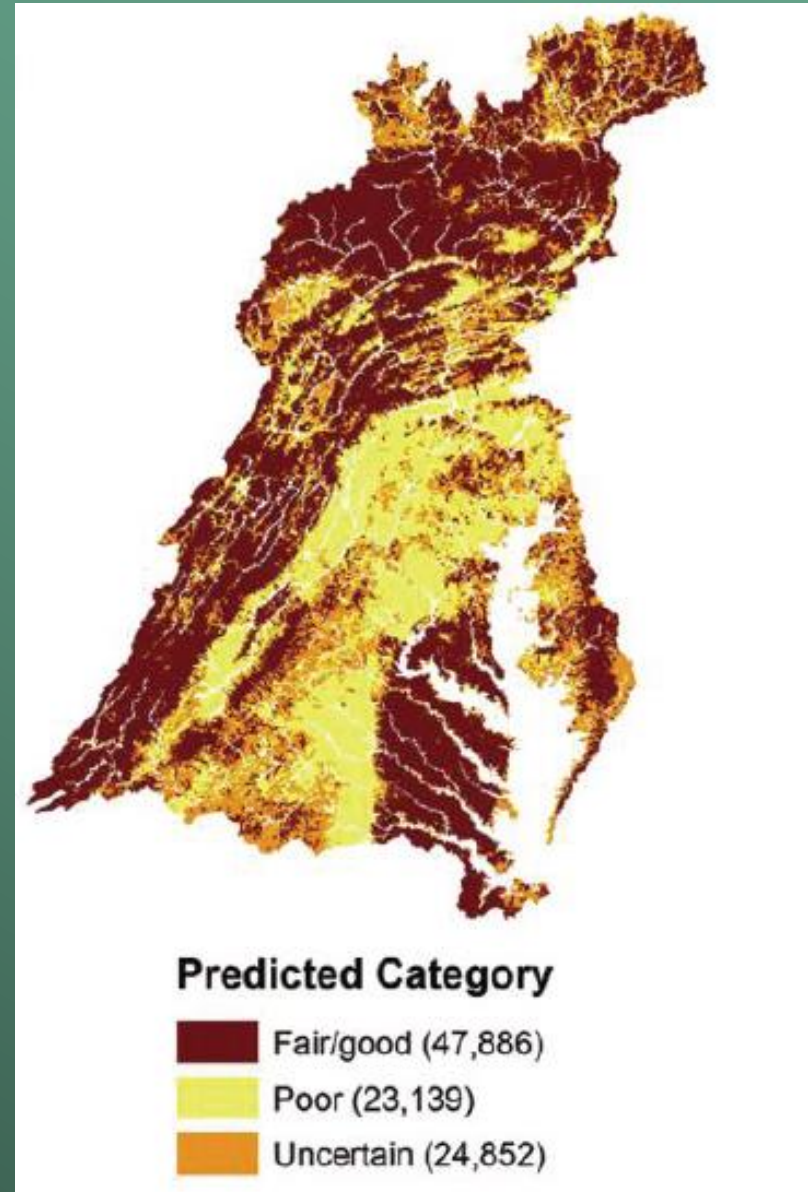[2]Interstate Commission on the Potomac River Basin (ICPRB), 30 West Gude Drive, Suite 450, Rockville, Maryland 20850 USA

**Maloney et al. (2018)**

**Objective: develop a model to predict conditions of small unsampled streams in the Chesapeake Bay watershed to aid in baseline estimate of stream conditions.**
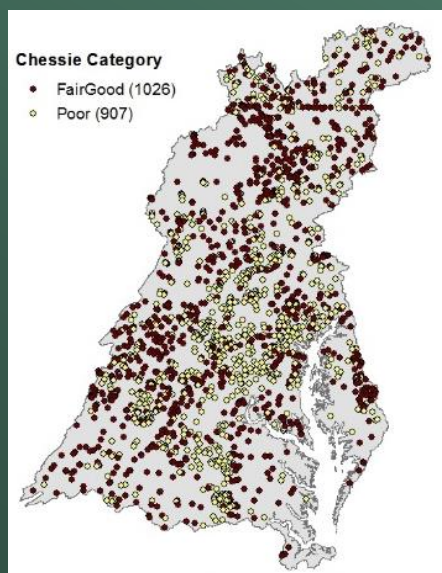
**Baseline: ~64% of stream segments predicted in fair/good/excellent condition**

**Uncertainty analysis - 57% ±0.05, 50% ±0.10**



**Predicted Category**

- Fair/good (47,886)
- Poor (23,139)
- Uncertain (24,852)

- **Forecast future stream conditions (2030, 2060, 2090) using future land use and climate scenarios**



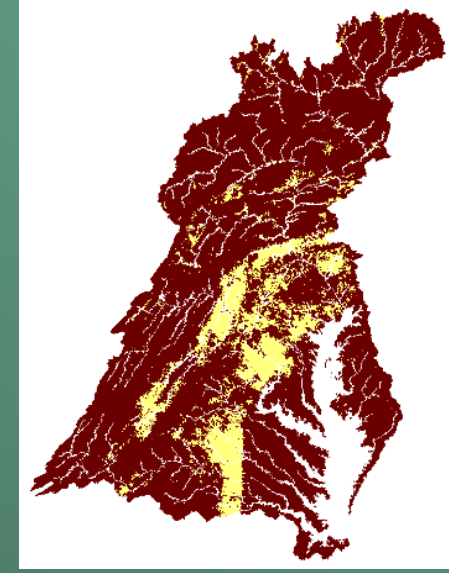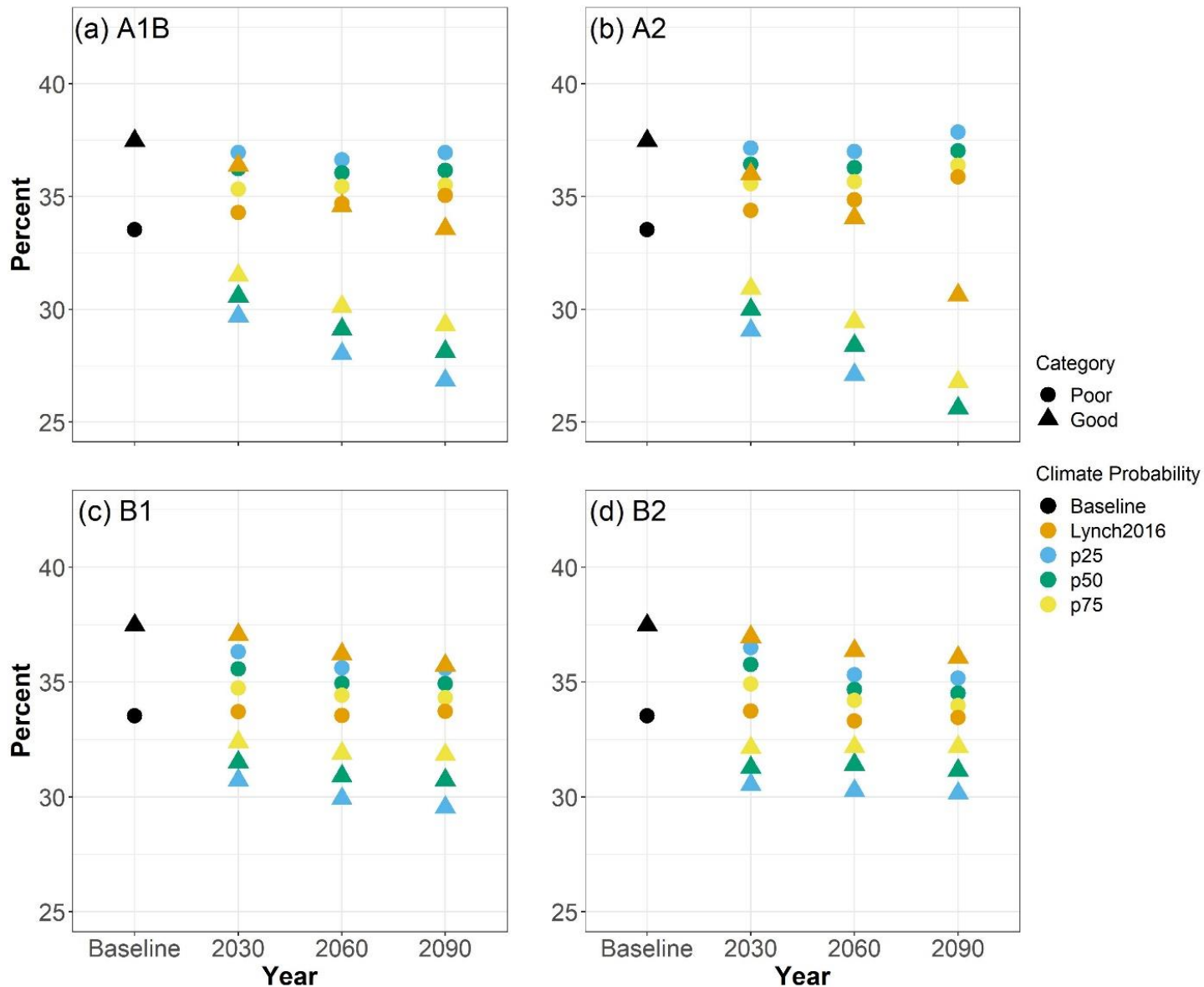Today's Data → Today's Conditions → Predicted Conditions Time 1 → Predicted Conditions Time 2
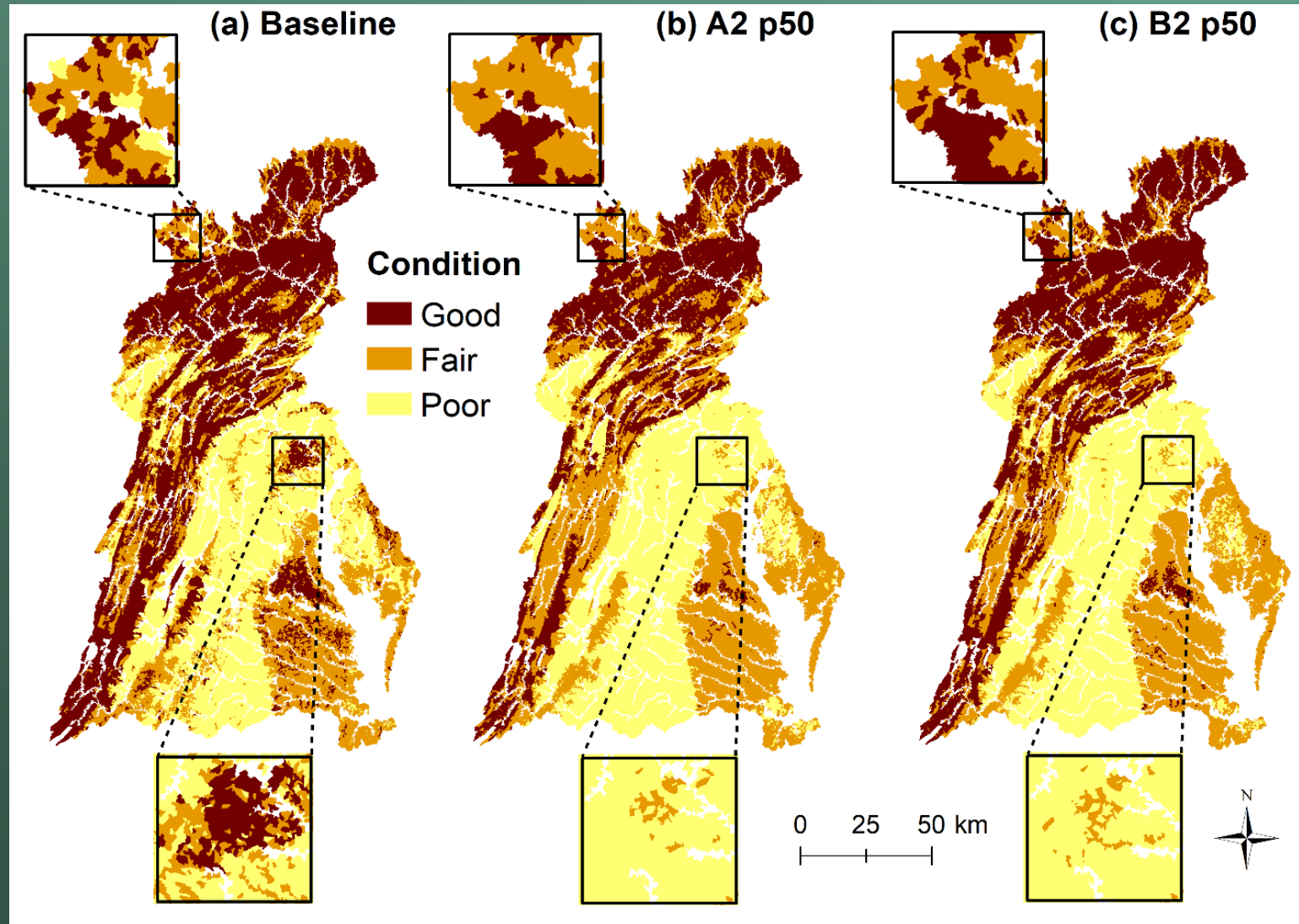
USGS

# Model Results

# Model Results

# Model Results

**Predicted change in stream conditions in 2090 under CMIP p50 climate projections**

# Forecasting Summary

- Combined land-use and climate change scenarios highlighted their interaction and predicted a wide spectrum of future conditions, ranging, by 2090, from watershed-wide degradation in 16.2% (A2 CMIP5 p25) to 1.0% (B2 with watershed-wide uniform values) of stream kilometers



- Implications for 10% goal - meeting and sustaining this goal until 2090 may require improvement in 11.0%–26.2% of stream length.

USGS

# Proposed Work to Improve Predictive Model

- **Test additional stressors and drivers being collated for the Fish Habitat Assessment project.**

- **Evaluate updated Chessie BIBI.**

- **Assess NHDPlus High Resolution database.**

- **Forecasting – test more locally scaled land use and climate futures.**

| Factors | # Variables | Description/ Examples |
|---|---|---|
| Watershed | 18 | Layers and information used to delineate watershed boundaries, salinity zones, drainage or catchment areas, stream order |
| Pollution | 38 | Toxic Release Inventory, nitrate deposition, NPDES major sites, pesticide applied |
| Dams | 12 | Number of dams, type, habitat fragmentation due to dams |
| Mines | 53 | Mine density and type, abandoned areas, unconventional/conventional wells, pipelines |
| Water Use | 7 | Water withdrawal information |
| Human | 5 | Population density information |
| Urban | 34 | Road length/crossing density, urban areas, impervious surface cover, landfills |
| Agiculture | 26 | Percent hay/agriculture, pesticide use, confined animal feeding operation information |
| Natural | 86 | Elevation, slope, habitat, runoff, soil information, geology, stream density, ecoregions |
| Nutrient | 29 | Nitrogen and Phosphorus amounts, 303(d) |
| Water Quality | 19 | Salinity, water temperature, dissolved oxygen |
| Climate | 20 | Precipitation, temperature, sea level rise, number of wet days |
| Habitat | 38 | Bathymetry, wetlands, tidal marsh vegetation |
| Biological (Response and Predictor) | 46 | Fish abundance, stream IBI, biological condition |
| Miscellaneous | 10 | Shoreline Structure/erosion, dredging |
| **Total = 15** | **441** | |

USGS