

Biological criteria to evaluate restoration projects:



August 2003 after Restoration (Before Planting)



- Water quality
- Riparian buffers
- Habitat connectivity/dam removal
- Habitat restoration

Bio-Condition Gradient Conceptual Model

(Davies and Jackson, 2006)

Natural structural, functional, and taxonomic integrity is preserved.

2

Structure and function similar to natural community with some additional taxa & biomass; no or incidental anomalies; sensitive non-native taxa may be present; ecosystem level functions are fully maintained

3

Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained through redundant attributes of the system.

6

4

Moderate changes in structure due to replacement of sensitive ubiquitous taxa by more tolerant taxa; overall balanced distribution of all expected taxa; ecosystem functions largely maintained.

CWA protection & __ propagation threshold

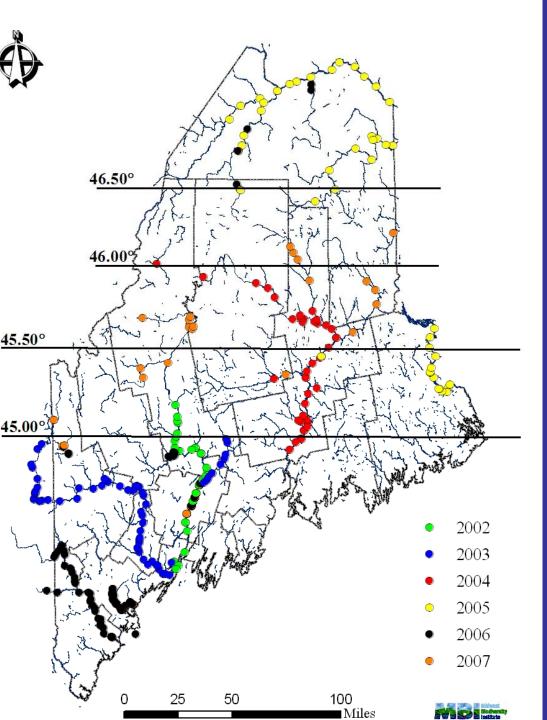
Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; ecosystem function shows reduced complexity and redundancy; increased build up or export of unused materials.

Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities; organism condition is often poor;

anomalies may be frequent; ecosystem functions are extremely altered.

LOW — Human Disturbance Gradient





Maine-wide IBI Program Over 300 sampling sites 2002-2007

Major watersheds:

- Penobscot 2004 & 2007
- Kennebec
- Androscoggin
- Saco
- St Croix
- St John/Allagash
- Presumpscot



IBI model for cold water assemblages Currently developed; undergoing peer review



Conceptual Model: Maine Coldwater Rivers

Native inland freshwater & diadromous species (Atlantic salmon, alewife, American shad, American eel, brook trout, native cyprinids, white & longnose sucker)

Same as tier 1 except: non-native salmonid species with naturalized populations may co-occur with brook trout.

Some native diadromous species are reduced in abundance; shifts towards intermediate tolerances and mesotherms; brook trout are reduced or replaced by non-native naturalized salmonid species.

6

Some native diadromous species are rare or absent; moderately tolerant species predominate; brook trout are absent; non-native mesotherms & eurytherms present; anomalies present.

Native diadromous species are absent or if present by interventions; some native cyprinids are absent, replaced by tolerant and moderately tolerant species;

brook trout are absent; non-native salmonids are non-reproducing; non-native eurytherms usually predominate; anomalies present.

Native diadromous species rare or absent; tolerant species predominate and may become numerous (enrichment); species richness reduced in some cases (toxic impacts); non-native eurytherms predominate; anomalies frequent.

LOW — Human Disturbance Gradient



Upper River & tributaries

- Oligotrophic
- Cold water (brook trout/salmon) ecosystem
- Forested
- high gradient geomorphology
- Relatively pristine

Middle river

- Mesotrophic
- warmwater ecosystem
- Alosid and eel nursery habitat
- Low gradient / floodplain geomorphology
- Urban industrial-hydropower
- Large tributaries

Tidal-Freshwater river

- Mesotrophic
- Freshwater & estuarial ecosystem
- Coastal lowland geomorphology
- Rural









Warm water and tidal freshwater assemblages

Still require further Biological Condition Gradient calibration



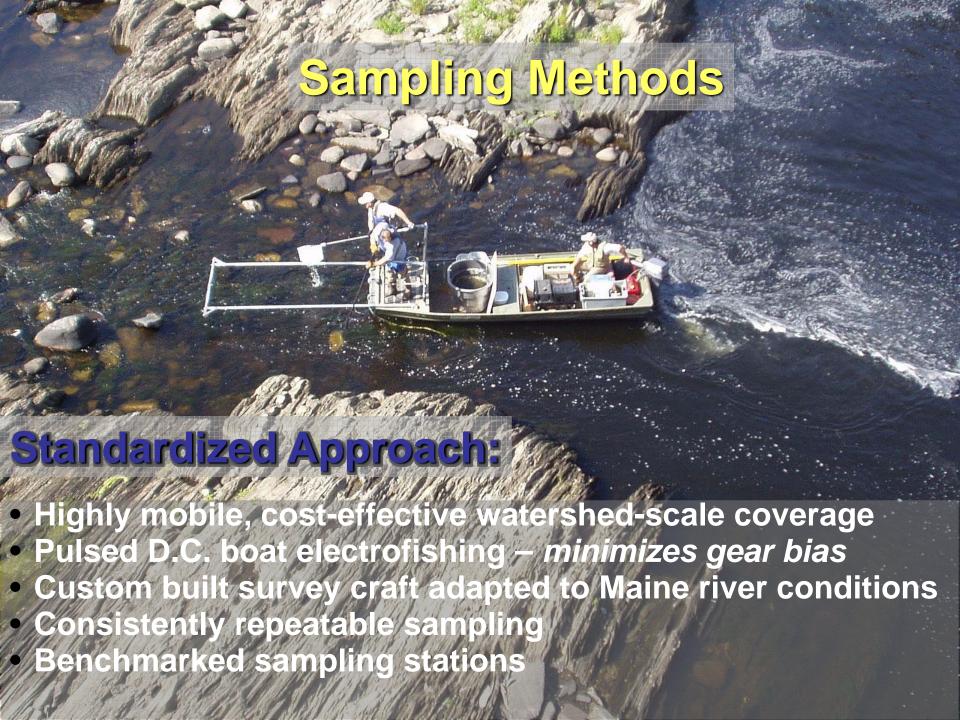


Penobscot IBI Goals

- Customize methodology for the Penobscot Restoration
- Collect data for IBI metrics & further index development
- Collect data to document ecological response to restoration
- Collateral support of other studies and management



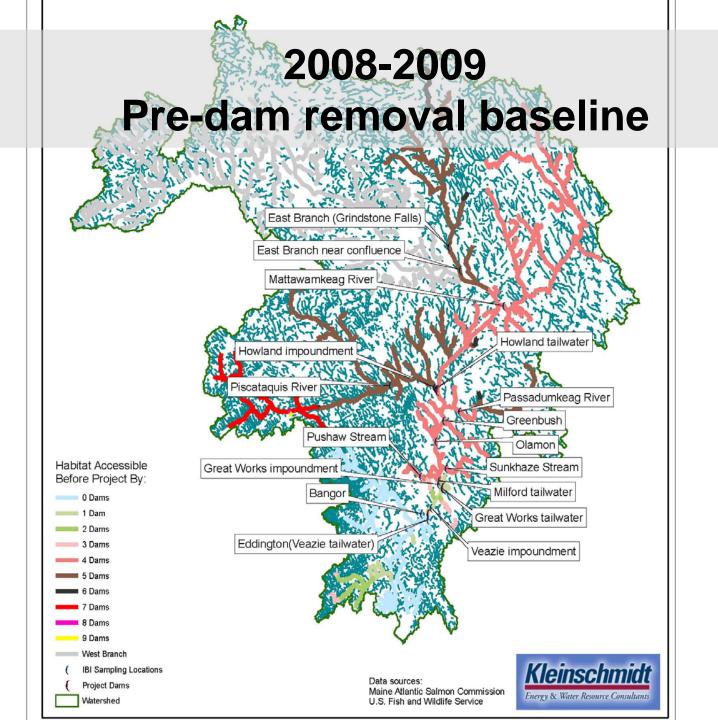






- Sampling guided by a QAPP
- Species-rich habitat types
- 1,000 m-long stations
- Boat maneuvered to thoroughly sample each site
- Geo-referenced sample site location and sample track

- Late spring and summer
- Fish identified to species and lifestage, enumerated, and weighed



Status

- Methodology Refinement:
 - Tributary vs. mainstem sampling
 - Spring and fall survey timing
 - Diurnal and tide stage issues below Veazie
 - Cathode and anode configuration
 - Site access

Data Collection

- 19 permanent monitoring stations established (2 added in 2009)
- Data gathered successfully at each station
- Collateral support for other research & management
 - Anadromous population genetics
 - Stable isotopes analysis
 - Size spectral analysis
 - Spatial distribution of American eel
 - Radio tagging of American shad
 - Monitoring for invasive species
- Abundance and distribution of restoration and invasive species





Baseline observations thus far

- Diadromous fish
 - Relict populations consistently detectable
 - Most abundant below Veazie; but detectable throughout study area
- Greatest bio-productivity and diversity
 - below Veazie
 - in fluvial vs. impounded habitats
- Constraints evident due to existing habitat fragmentation
- Non-indigenous species
 - smallmouth bass widespread
 - largemouth bass increasingly common
 - no northern pike (yet)

FUNDING AND COLLABORATION

- The Nature Conservancy
- NOAA Fisheries
- Penobscot River Restoration Trust
- US EPA
- ARRA

- Penobscot Indian Nation
- Maine DMR
- Maine DIFW
- University of Maine
- DSSRN
- Midwest Biodiversity Institute



