National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

Coeur d'Alene, Idaho
31 March – 4 April, 2003

RFC 101
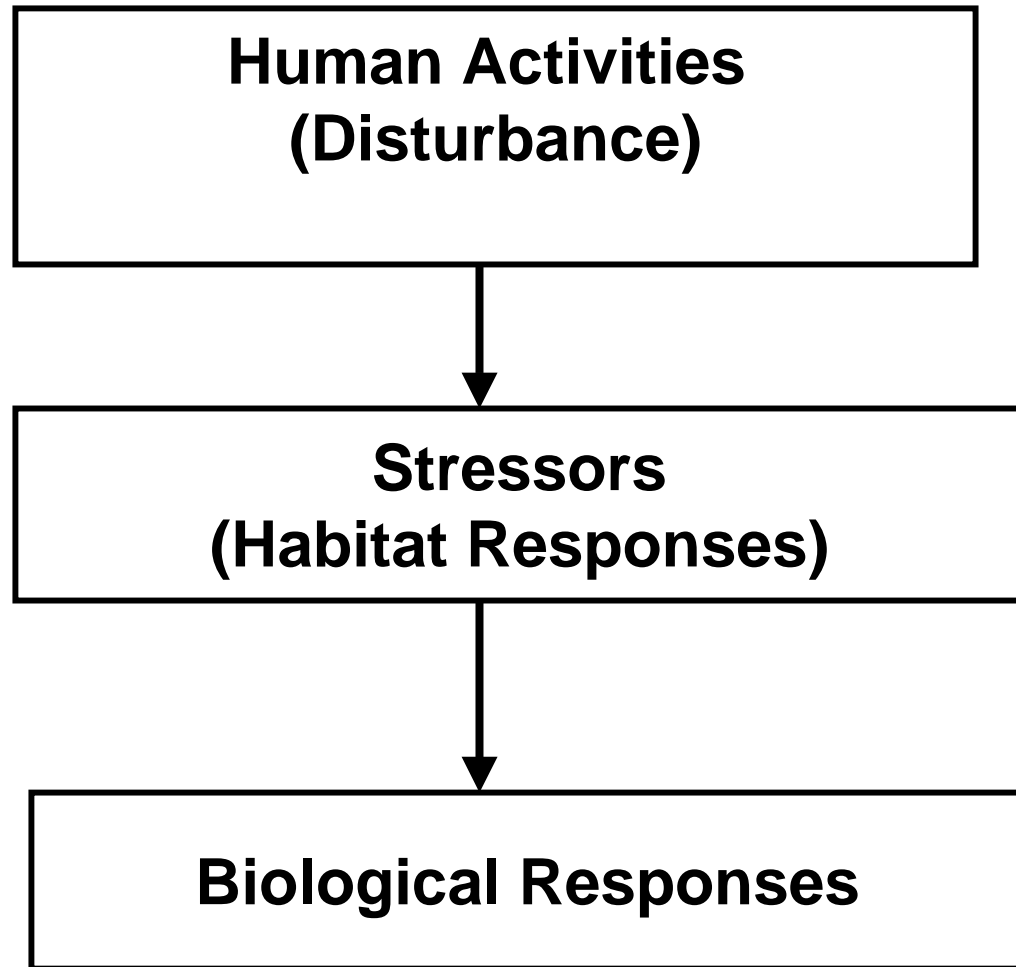
Reference Site Selection: Overview and a Framework

Presented by
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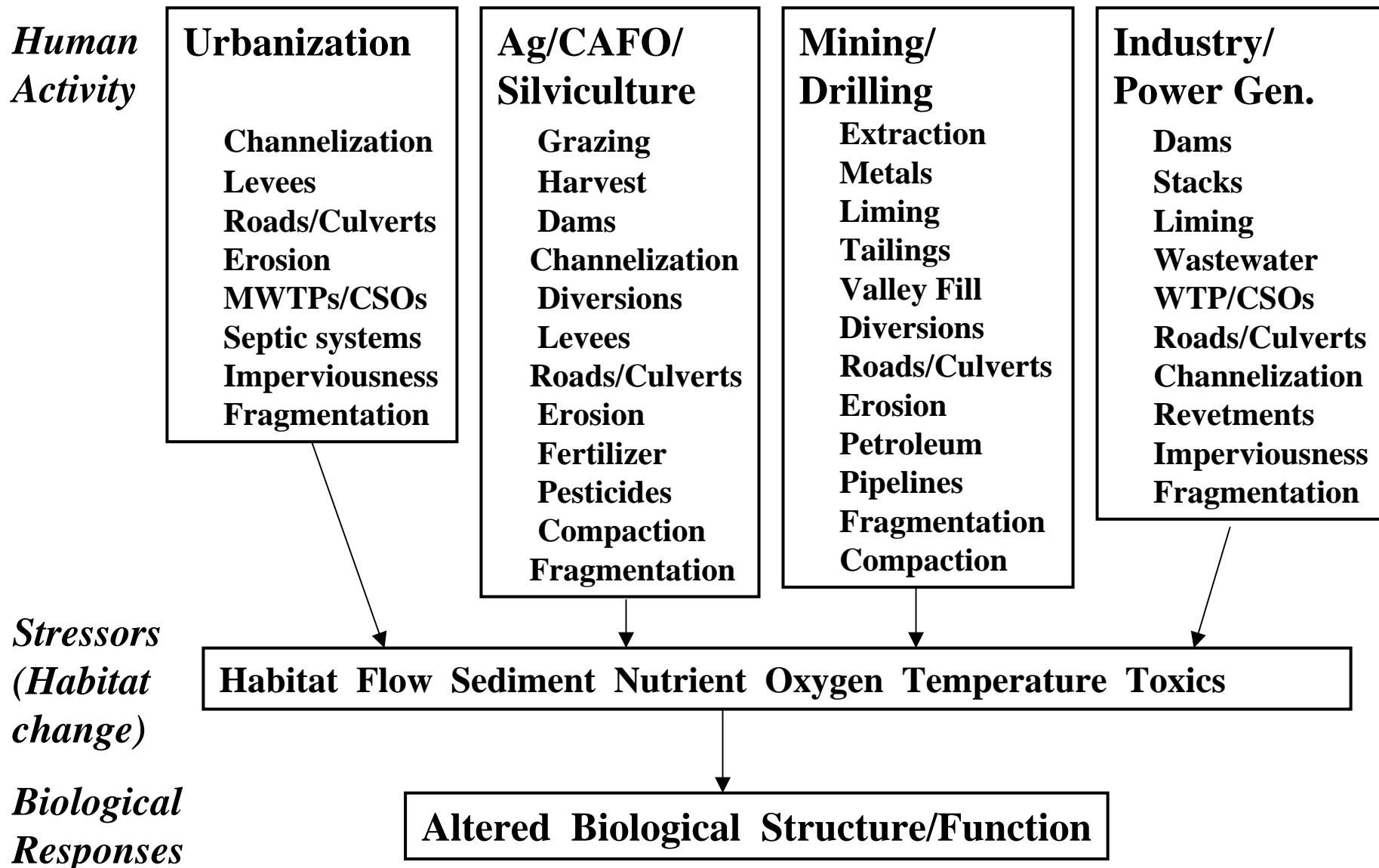
Reference site selection is

- An iterative screening process for selecting sites
  - That are minimally or least disturbed by human activities and resultant stressors
  - That are representative of the aquatic resource in the region of interest

- Guided by indicators of human disturbance/stress
  - In the atmosphere
  - In the landscape/watershed
  - In the riparian corridor or near the site
  - In the channel
  - In the water
  - In the biota

- Available at different spatial scales

A simple conceptual model:
Human activity > stressors > responses

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┌─────────────────────────────┐
│      Human Activities       │
│       (Disturbance)         │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│          Stressors          │
│     (Habitat Responses)     │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│     Biological Responses    │
└─────────────────────────────┘
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A more complex conceptual model

Human Activity

Urbanization	Ag/CAFO/ Silviculture	Mining/ Drilling	Industry/ Power Gen.
Channelization	Grazing	Extraction	Dams
Levees	Harvest	Metals	Stacks
Roads/Culverts	Dams	Liming	Liming
Erosion	Channelization	Tailings	Wastewater
MWTPs/CSOs	Diversions	Valley Fill	WTP/CSOs
Septic systems	Levees	Diversions	Roads/Culverts
Imperviousness	Roads/Culverts	Roads/Culverts	Channelization
Fragmentation	Erosion	Erosion	Revetments
	Fertilizer	Petroleum	Imperviousness
	Pesticides	Pipelines	Fragmentation
	Compaction	Fragmentation	
	Fragmentation	Compaction	

Stressors (Habitat change)

Habitat Flow Sediment Nutrient Oxygen Temperature Toxics

Biological Responses

Altered Biological Structure/Function

The Five Major Factors that Determine the Integrity of Aquatic Resources (from OHIO EPA)

Solubilities

Alkalinity

Temperature

D.O.

Adsorption

Chemical Variables

pH

Nutrients

Turbidity

Organics

Hardness

Velocity

Land Use

Flow Regime

High/Low Extremes

Ground Water

Precipitation & Runoff

INTEGRITY OF THE WATER RESOURCE

"Principal Goal of the Clean Water Act

Parasitism

Disease

Reproduction

Biotic Factors

Feeding

Competition

Predation

Nutrients

Sunlight

Energy Source

Seasonal Cycles

Organic Matter Inputs

1° and 2° Production

Riparian Vegetation

Width/Depth

Bank Stability

Siltation

Habitat Structure

Channel Morphology

Sinuosity

Gradient

Current

Substrate

Instream Cover

Canopy

Increasing Disturbance

Agriculture	Urbanization/Mining	Flow	Tier
	Industrial Mines Dominant Urban Dominant	Extreme Flows Only Inter-basin Transfers	F
Irrigated Rowcrops CAFOs; Crop Processors	Suburban Mines Common	Regulated Flows Only Intra-basin Transfers	E
Intense Riparian Grazing Irrigated Forage	Small Cities Industrial Mines Present	Dammed Local Transfers	D
Constant Grazing Dryland Agriculture	Large Lot Residential Small Metal/Aggregate Mines	Slightly Flashier	C
Light/Rotated Grazing	Rural Residential Hand Mines	Natural Flow	B
Natural Vegetation	Transients	Natural Flow	A

Overview of process: Preliminary steps

- Select Region/aquatic resource of interest
- Identify the important natural gradients in the region (size? elevation? slope? geology? Lake or channel type?…)
- Identify human activities/stressors likely to be encountered in the region (local effects? Regional effects?)
- Establish criteria by which to rank disturbances
- Identify/locate sources of information that will be used in the sorting process

Hierarchical Screening Process

SOURCES OF SITES

- Digital stream maps
- Lists

- Surveys
  - probability
  - other

- Best professional judgement

SCREENING BASIS

Thousands of Reaches

Hundreds of Coarse Filtered Reaches

Tens of Fine Filtered Reaches

Tens of Candidate Reference Reaches

Tens of Reference Reaches

Extensive Data

Office Data

Recon

Site Measures
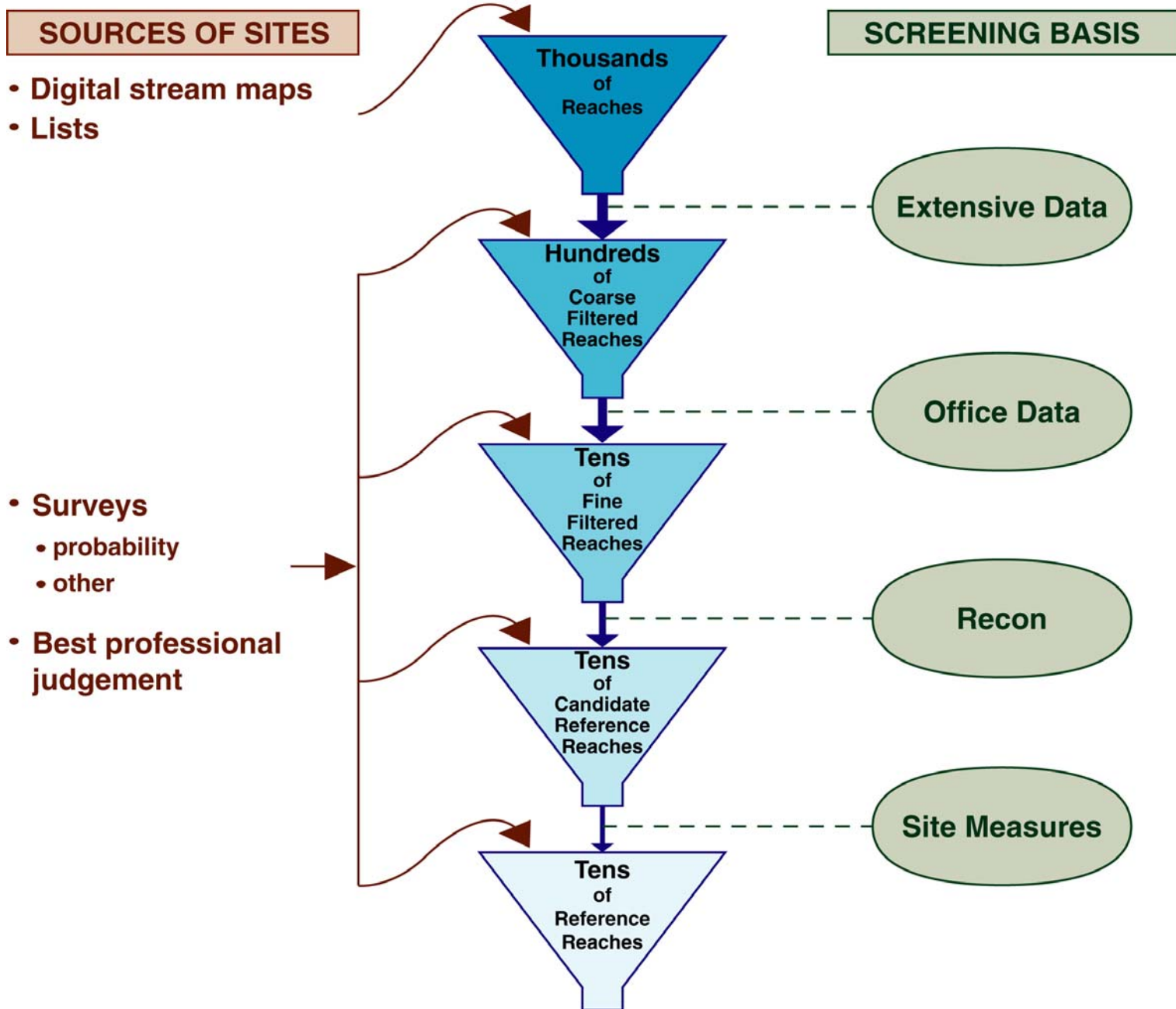
Extensive data

- Identify sources of complete coverages
  - GIS resources?
  - GeoReferenced databases?

- Sources of data
  - Landscape screens
    - Land use/cover (TM imagery; other satellite imagery)
    - Roads
    - Population density/points sources
    - Mines
    - Feedlots
    - …

Office Data

- Identify sources of candidate sites
  - Air photos, digital orthophoto quads, maps
- Sources of data
  - Terraserver
  - USGS topo maps/local maps
  - National High Altitude Photography (NHAP)
  - Satellite imagery

Recon sites

- By air

- By ground site visit

- ID disturbances missed by the coarser filters

Site measurements

- Apply routine field protocol
  - EMAP
  - USGS
  - STATE

- To identify disturbances missed by coarser screens:
  - Riparian habitat
  - Physical habitat
  - Water quality
  - Biota

Is the use of biological data circular? The case against:

- Circularity Problem

Biology is Great ➜ ✗ ➜ Reference Site

Multimetric is High

High metric scores
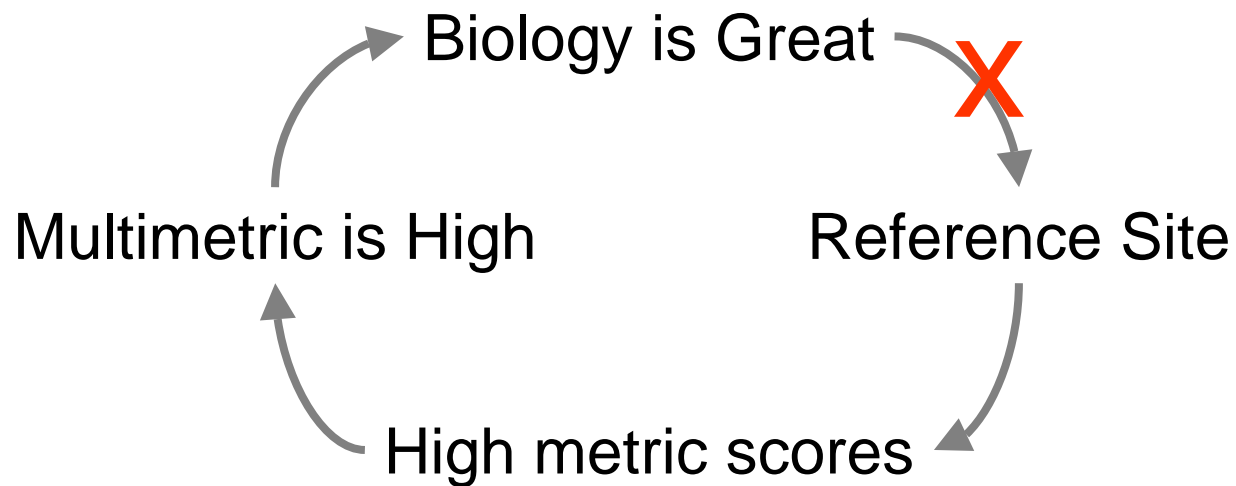
Need an independent measure of what "undisturbed by humans" means.

Is the use of biological data circular? The case for:

- Lesions/anomalies?

- Alien species dominate?

- Expert knowledge about biology of systems under consideration?

Criteria for Candidate Reference Sites (Georgia, Alabama, S. Carolina)

		Stream Gradient	
		High	Low
1.	Natural vegetation, i.e., forest/grassland/wetland (% in catchment)	> 65%	> 50%
2.	Minimum overall habitat score (% of maximum)	> 70%	> 70%
3.	Minimum riparian zone width (m)	> 15 m	> 15 m
4.	Riparian zone in catchment (% of stream length)	> 60%	> 60%
5.	Agriculture (% in catchment)	< 20%	< 30%
6.	Urban land (% in catchment)	< 15%	< 15%
7.	Silviculture (active [within 5 years] in catchment)	none	none
8.	Road density (length/area of catchment)	?	?
9.	Point source discharges (% of flow at 7Q10)	< 5%	< 5%
10.	Channel alteration in catchment	none	none

Criteria for Alaska Reference Sites (Must meet all criteria)

➢ no channelization

➢ no upstream impoundments

➢ no known point source dischargers

➢ dissolved oxygen greater or equal to 5 ppm

➢ urban land use less than 15% in catchment

➢ mining and/or logging affecting less than 15% in catchment

➢ forest land use (or other natural wetland, grassland) greater than 70% in catchment

➢ riparian buffer width greater or equal to 18 m

Sources of candidate reference sites

- Digital maps of the aquatic resource
  - RF3/NHD
  - National Wetlands inventory
- BPJ supplied
- Available from existing surveys
  - Probability surveys
  - Other surveys
- In any case, the screening criteria should be applied to all sites in the candidate pool, however obtained

Selecting Reference sites: Repeatable outcome?

- Two sets of criteria, independently applied should give us the same outcome

Criteria set # 1

- Drainage: entirely within subregion
- Land use: >80% forest; no ag/urban; no recent disturbance, e.g., construction; clearcutting
- Habitat: No cattle in w/s; no disturbances
- Channel: Characteristic of region
- Riparian veg: > 30m buffer for most of w/s
- Instream substrate: no significant siltation or embeddedness
- Water Quality: No point sources; no recent spills; pH>6.

Criteria set # 2

''Filters'': exclude all sites with:

- sulfate over 400 ueq/L (mine drainage)
- acid neutralizing capacity less than 50 ueq/L (acid rain)
- average RBP habitat score less than 16 (habitat)
- total phosphorus over 100 ug/L (nutrient enrichment)
- total nitrogen over 750 ug/L (nutrient enrichment)
- chloride over 100 ueq/L (general watershed disturbance
- total benthic count less than 100 individuals (inadequate sample)
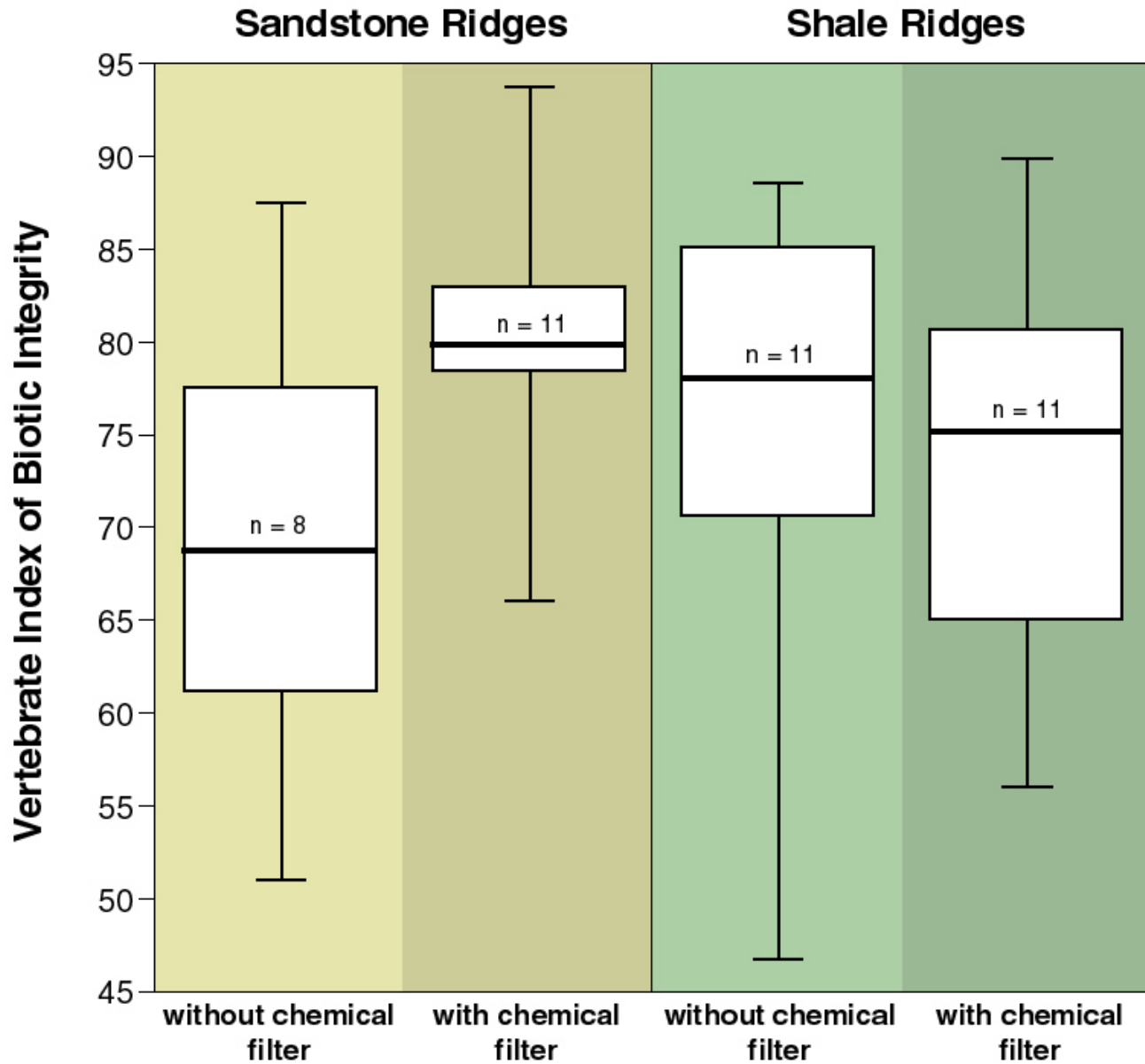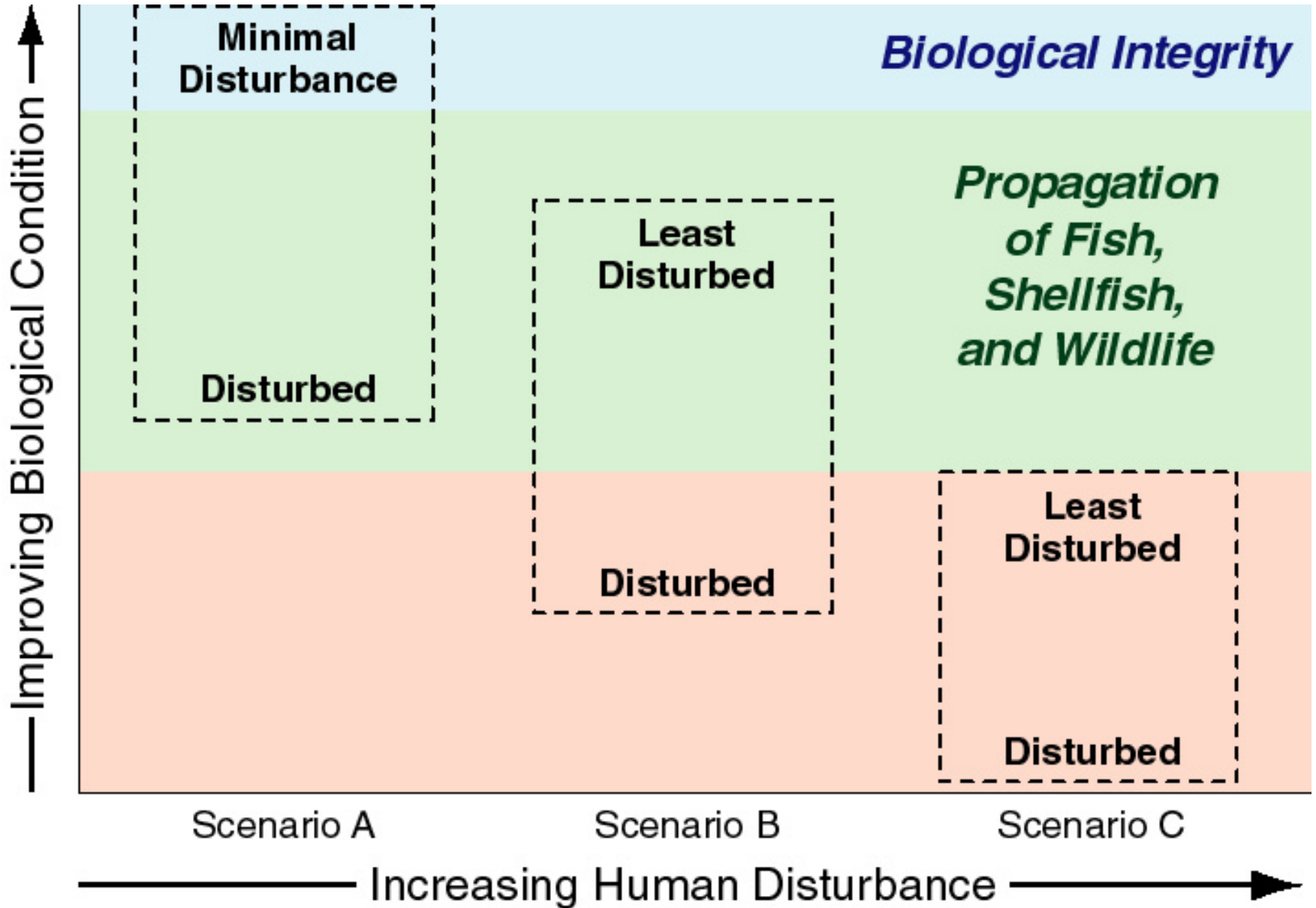
Are Reference Sites Representative?

- Reference sites should be representative of the natural gradients in the region of interest, e.g.,
  - Elevation
  - Latitude
  - Longitude
  - Stream gradient
  - …
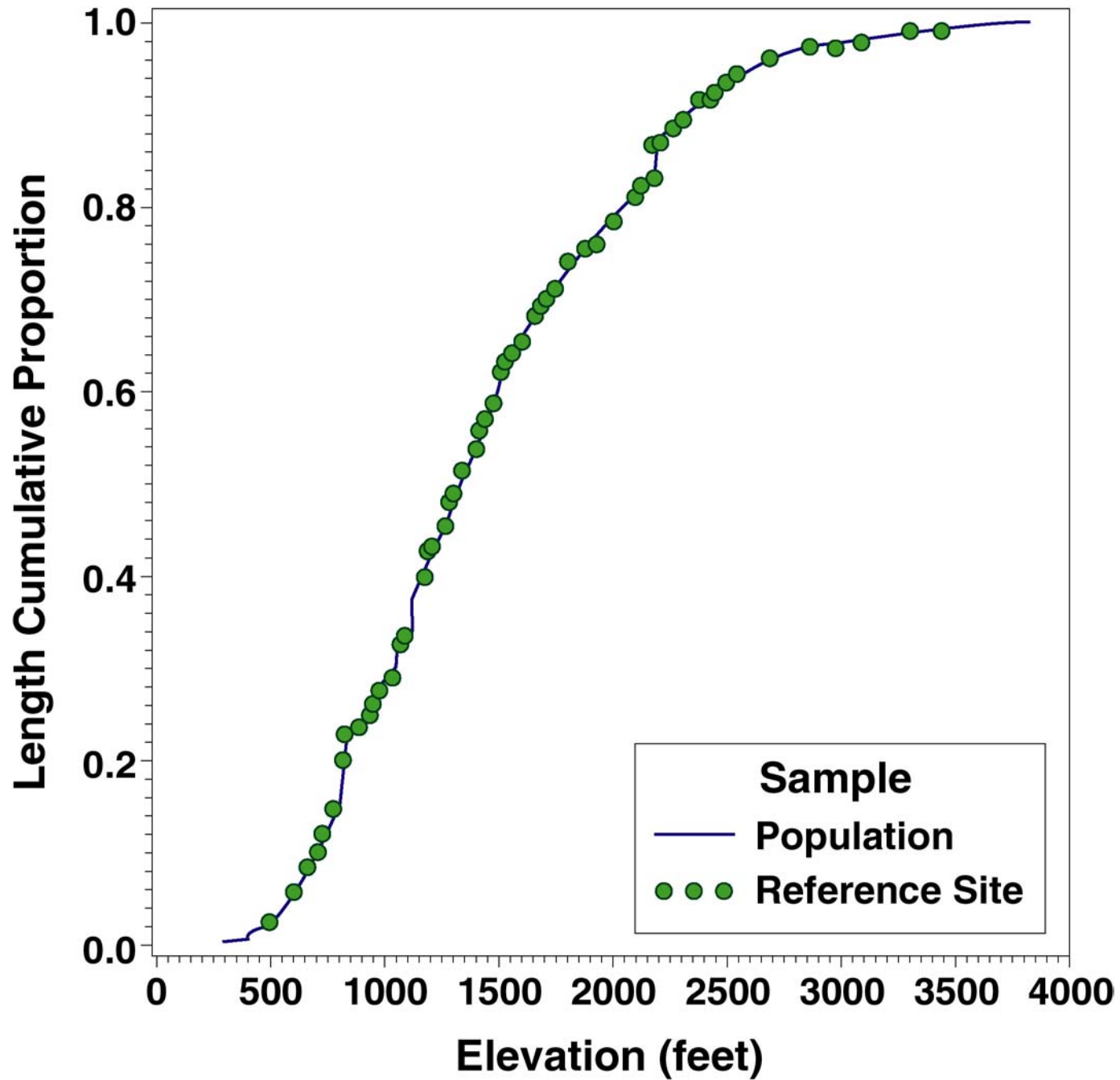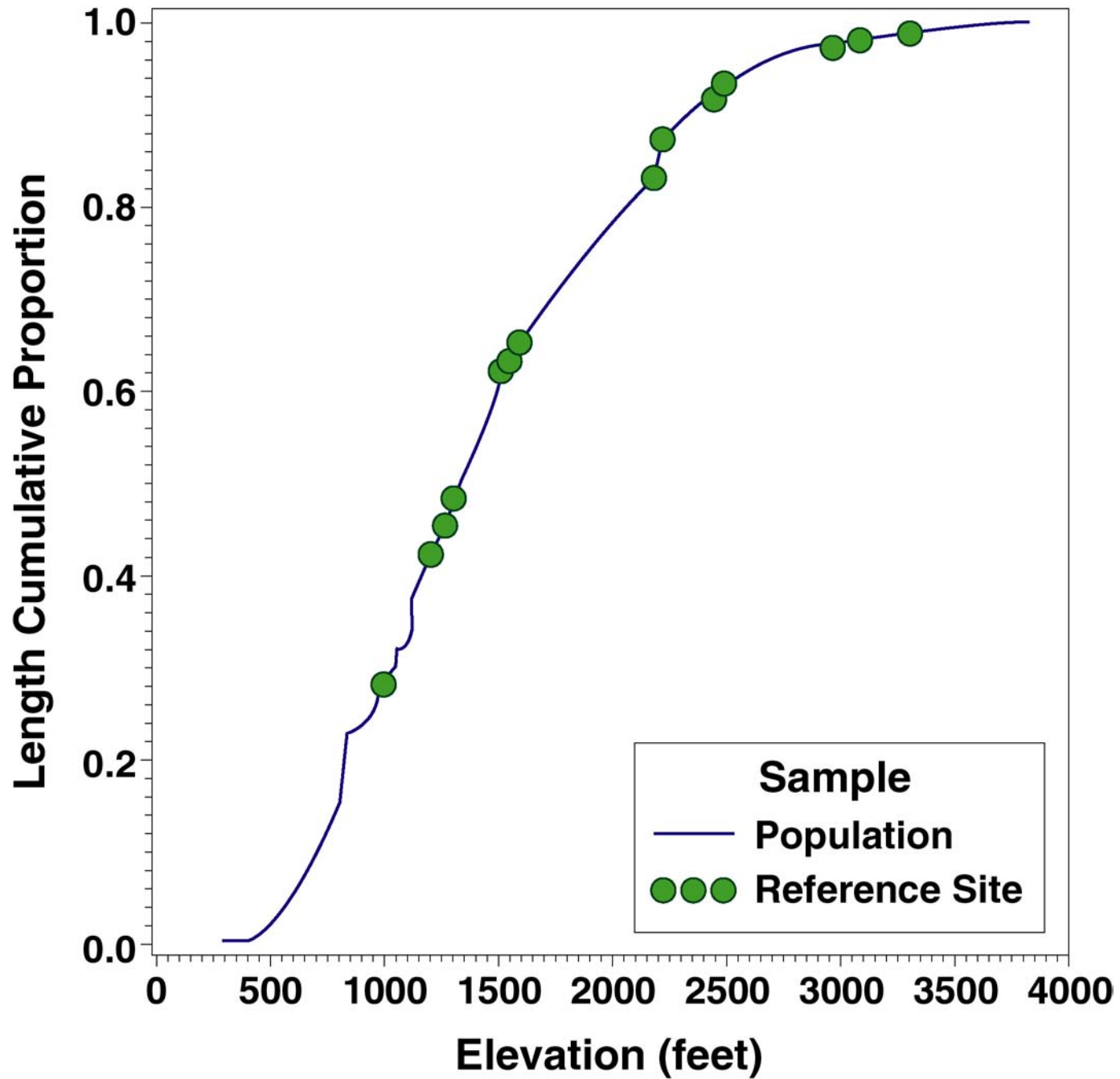
Revisiting minimally and least disturbed

Minimally Disturbed Condition (MDC)

- Condition in absence of significant, or with minimal, human disturbance

- MDC changes little over time, due to natural processes

- Stable benchmark

- Derived from minimally disturbed reference sites

Least Disturbed Condition (LDC)

- Best available given today's state of the landscape

- Can change over time as land use and management practices change

- Derived by characterizing least disturbed reference sites

Concluding remarks

- Establish a framework for reference site screening

- Identify some key concepts to be kept in mind

- Illustrations of the process in subsequent "lectures" and in RFC201 and RFC202.

- Use framework as a guide in your evaluation/applicability of courses to follow with respect to your unique situation

Concluding remarks

- After Break:
    - Ed Rankin (Tuesday morning) or
      Dave Courtemanch (Tuesday afternoon)
    - Mike Edmondson
    - Jeffrey Schuldt
    - Break/Questions