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

LAKES 101

Reservoir Biological Assessment and Criteria: TVA Methods and Experiences

Presented by

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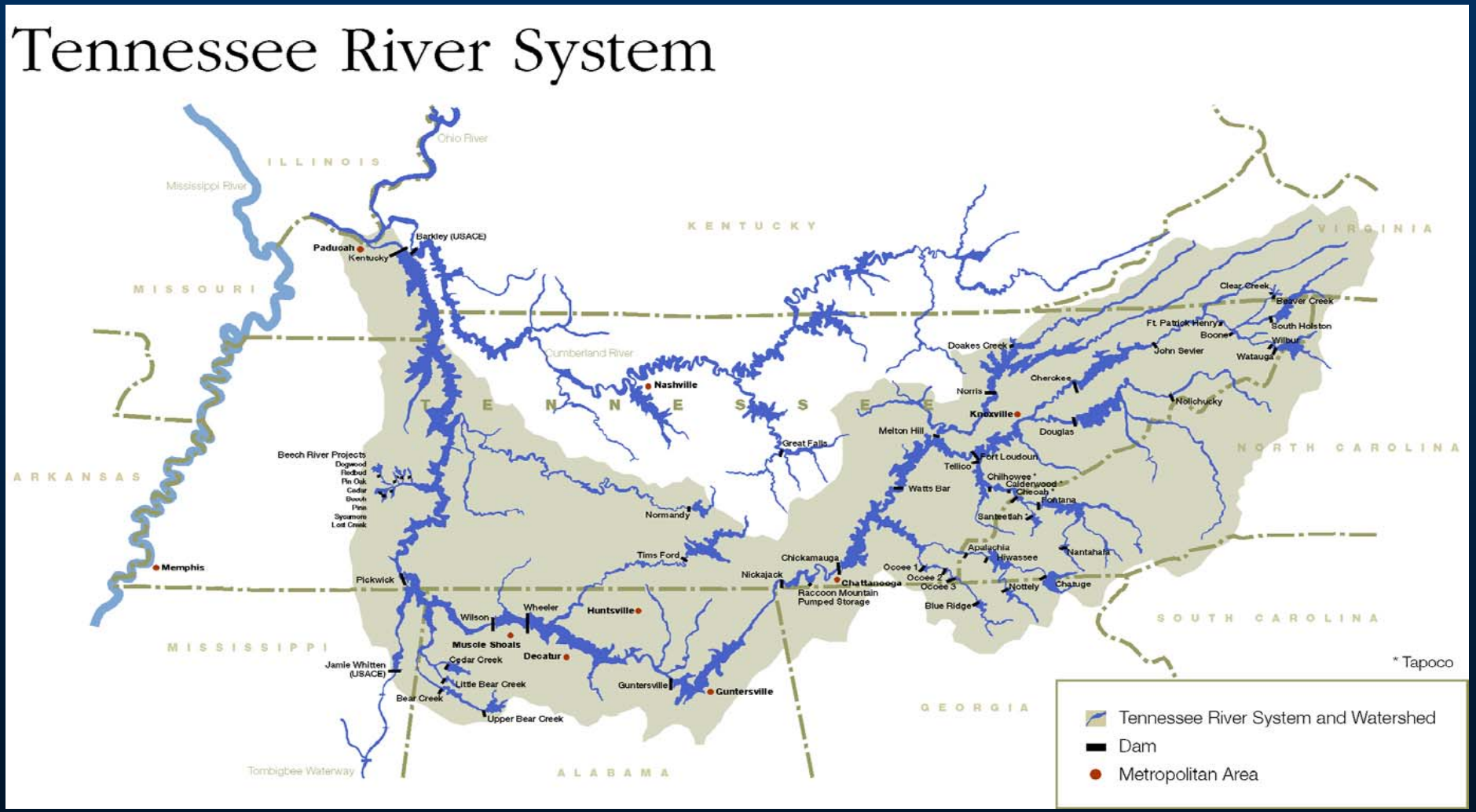
Tennessee River System



Why Is TVA Involved in Water Quality Monitoring?

- TVA's focus for its monitoring program is aimed at:
  - Stewardship responsibilities
  - Operating the reservoir system
  - Responding to stakeholders
- TVA has no regulatory authority related to water quality monitoring.
- TVA monitoring is not aimed at use attainment per sec'.

Presentation Outline – Reservoir Ecological Health

I. Monitoring Design Considerations

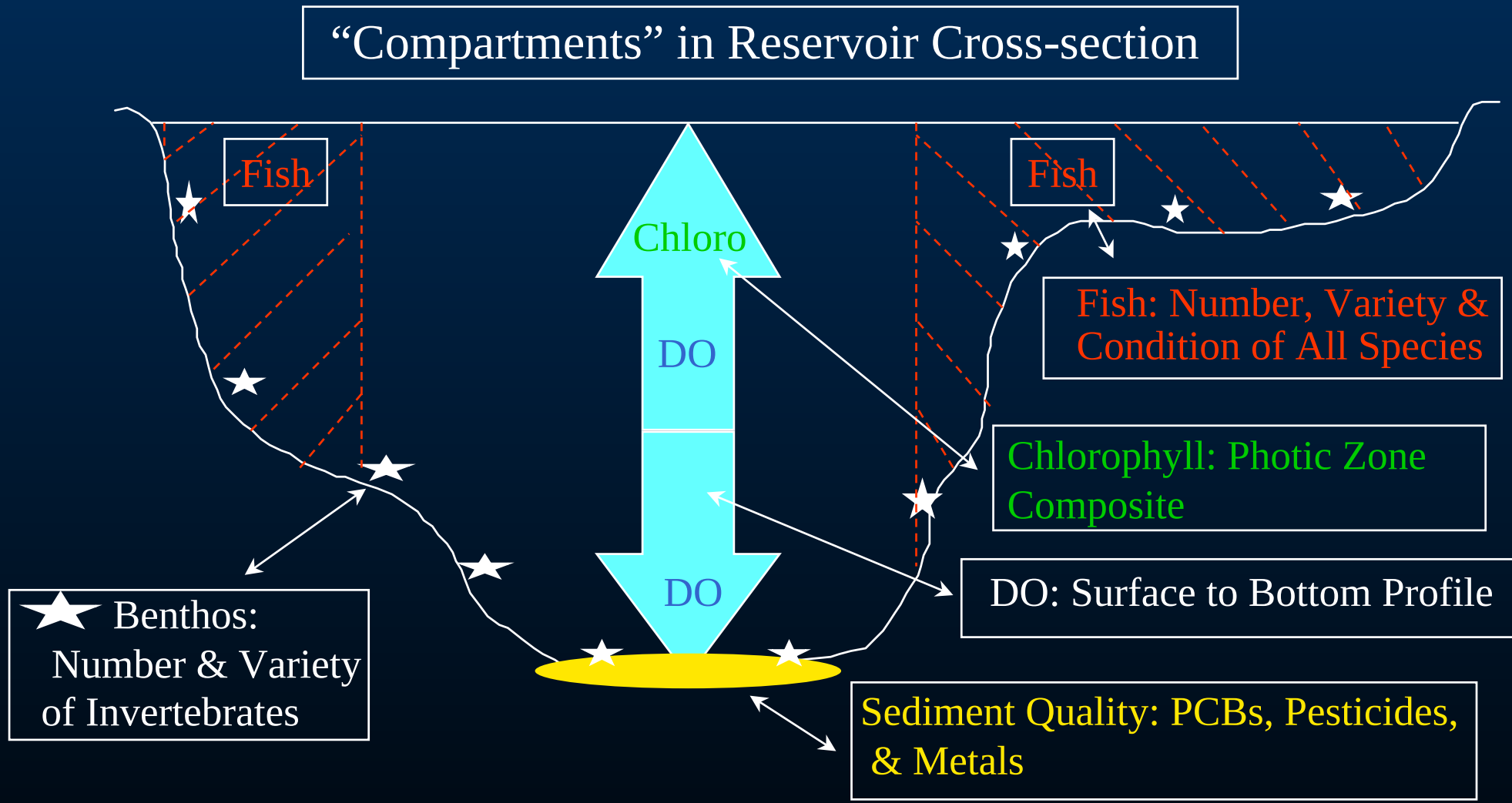
II. Data Evaluation Considerations

III. TVA Reservoir Ecological Health Rating Methods

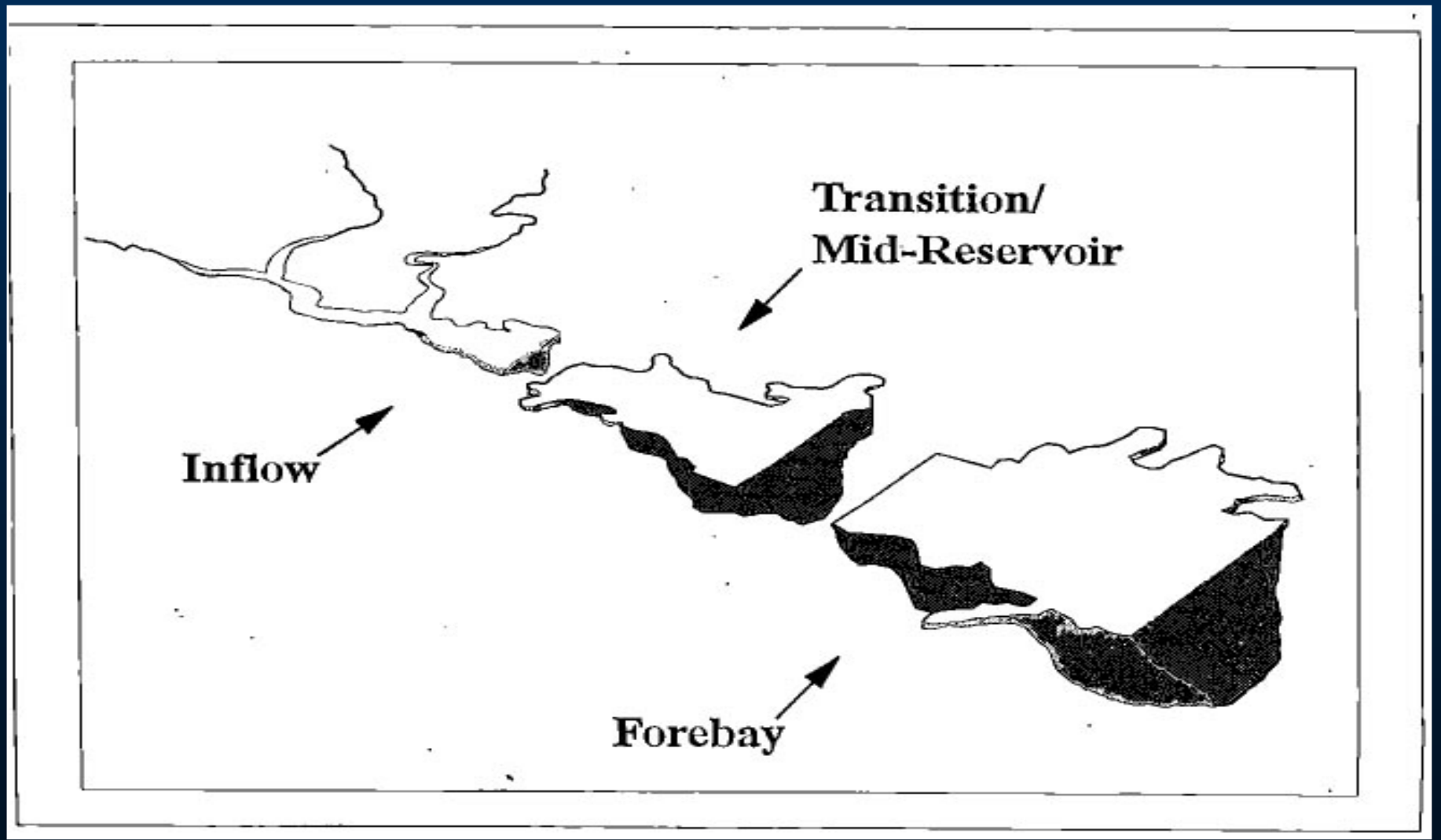
A. Monitoring Design – Selection of Indicators and Sampling Frequency

- Dissolved oxygen: Monthly (April – October)
- Trophic status (chlorophyll/nutrients): Monthly (April – October)
- Sediment quality: Annually (summer)
- Benthic macroinvertebrate community: Annually (fall)
- Fish assemblage: Annually (fall)

Ecological Indicators & Reservoir “Compartments”



B. Monitoring Design - Sample Locations



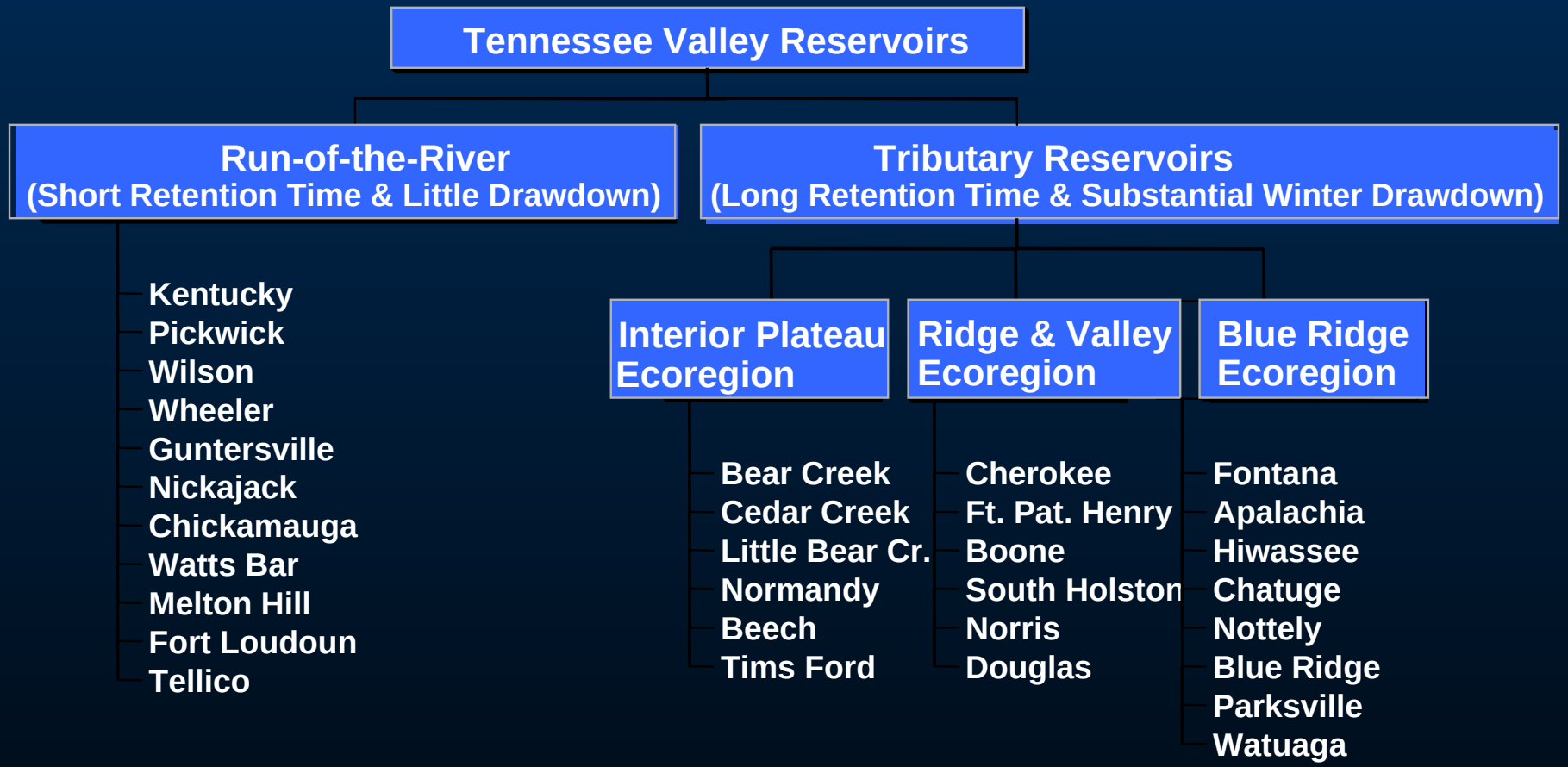
II. Data Evaluation Considerations

- Is the reservoir in good condition; must have reference or yardstick for comparison.

- Standard approaches used to determine reference conditions for streams are not appropriate for reservoirs.
  - Reservoirs lack natural reference sites.
  - Reservoirs have had little opportunity to evolve an adaptive community.
  - Not enough information available to model all indicators used in reservoir monitoring.

A. Data Evaluation – Reservoir Classification

(Important Considerations: size, gradient/depth, ecoregion, reservoir management objective, etc.)



B. Data Evaluation – A Fundamental Question To Be Answered

Should reservoir ecological health evaluations be based on:

- Ideal conditions, or
- The best conditions attainable/observed given the environmental and operational characteristics of the dam/reservoir?

Data Evaluation – TVA Response to The Fundamental Question

- Ideal Condition (Regardless of Reservoir Class)
  - DO
  - Sediment Quality
- Best Expected/Attainable Condition
  - Benthos
  - Fish Assemblage
- Combination of the Two Approaches
  - Trophic Status (Chlorophyll)

III. TVA Reservoir Ecological Health Rating Methods

Results for each indicator at each site are given a rating from 1 (poor) - 5 (good);

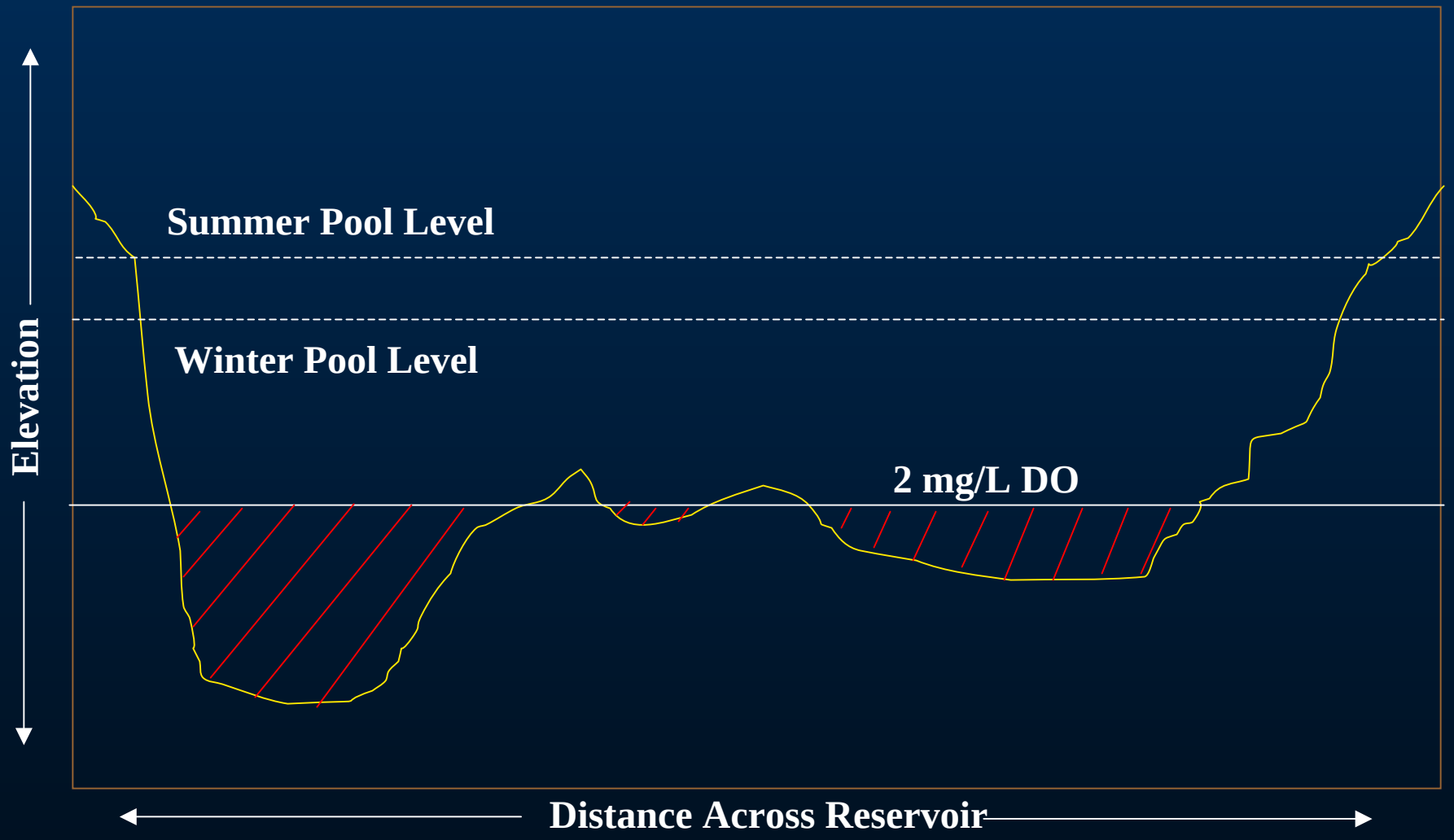
- Ratings from all sites within a reservoir are then summed;
- That sum is then divided by the maximum possible sum for the reservoir to provide a single overall score which is expressed as a %.
- Scores generally range from the low 40s (poor) to high 80s (good).

A. TVA Reservoir Ecological Health Rating Methods - DO

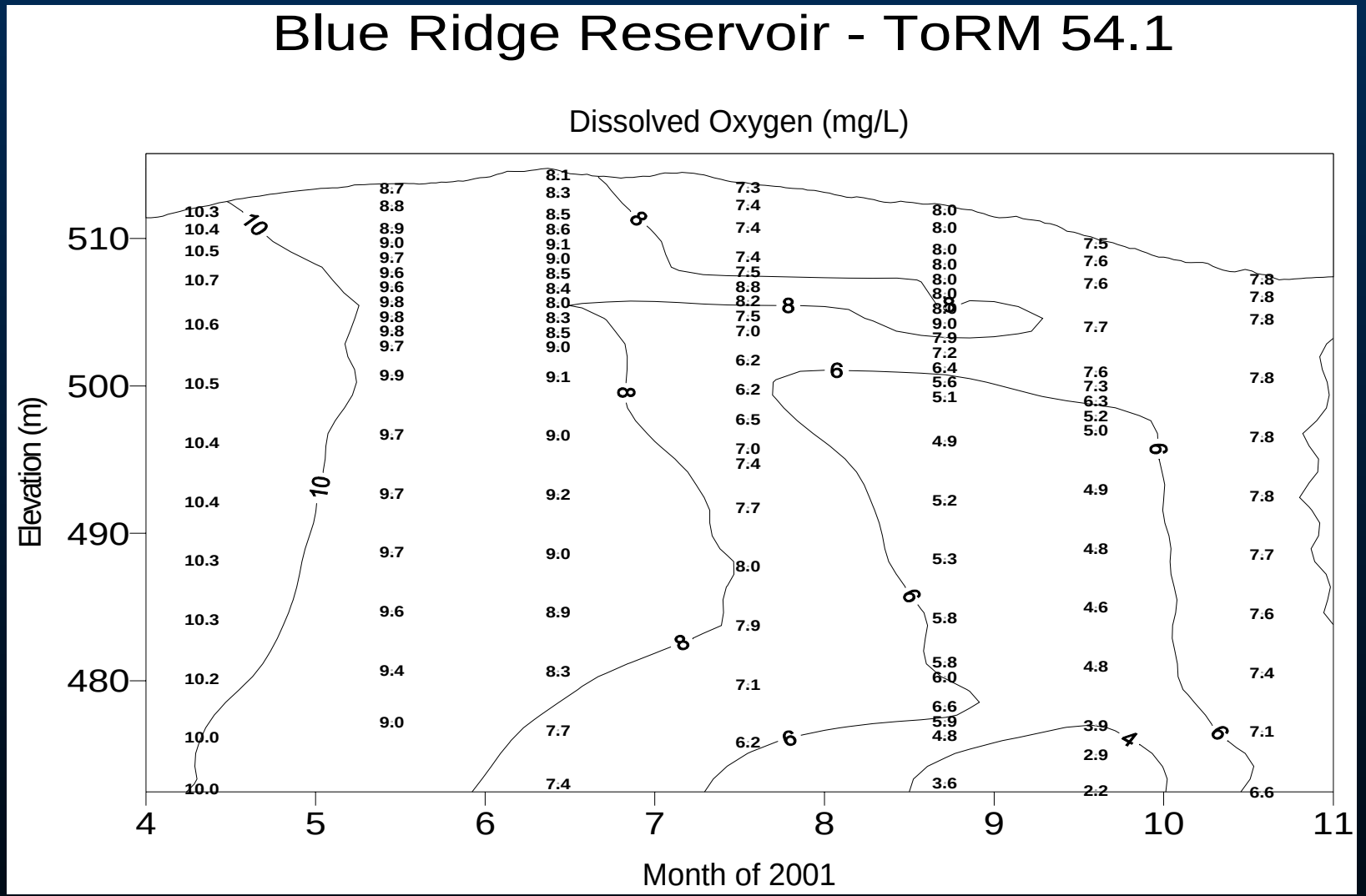
- The rating criteria represent a multidimensional approach.
  - Water column DO
  - Bottom DO

- A DO concentration ≤2.0 mg/L is the critical value.

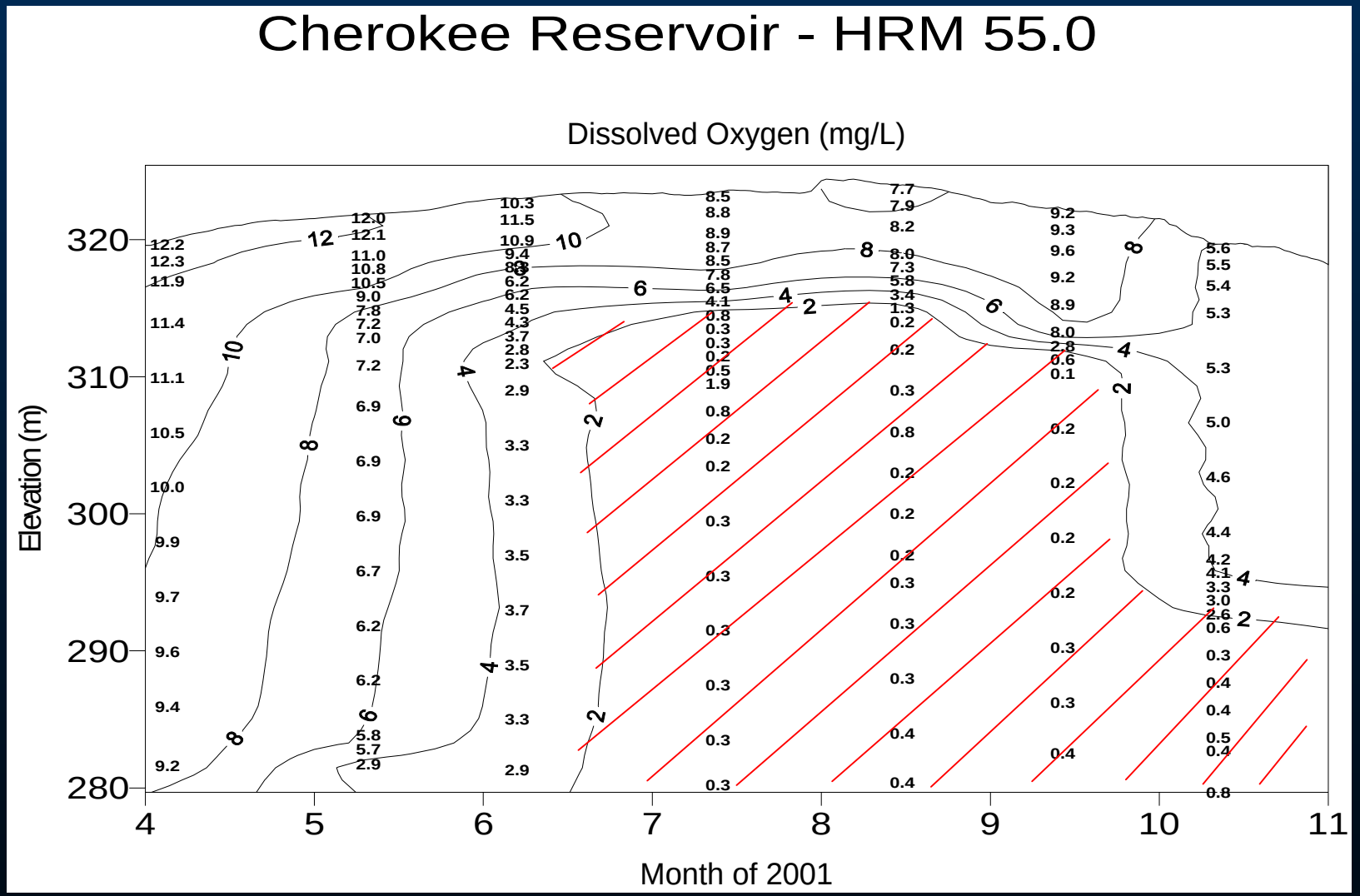
Reservoir Cross-sectional Area Showing the Area with DO Less Than 2.0 mg/L



Example of a Reservoir with a Good DO Rating



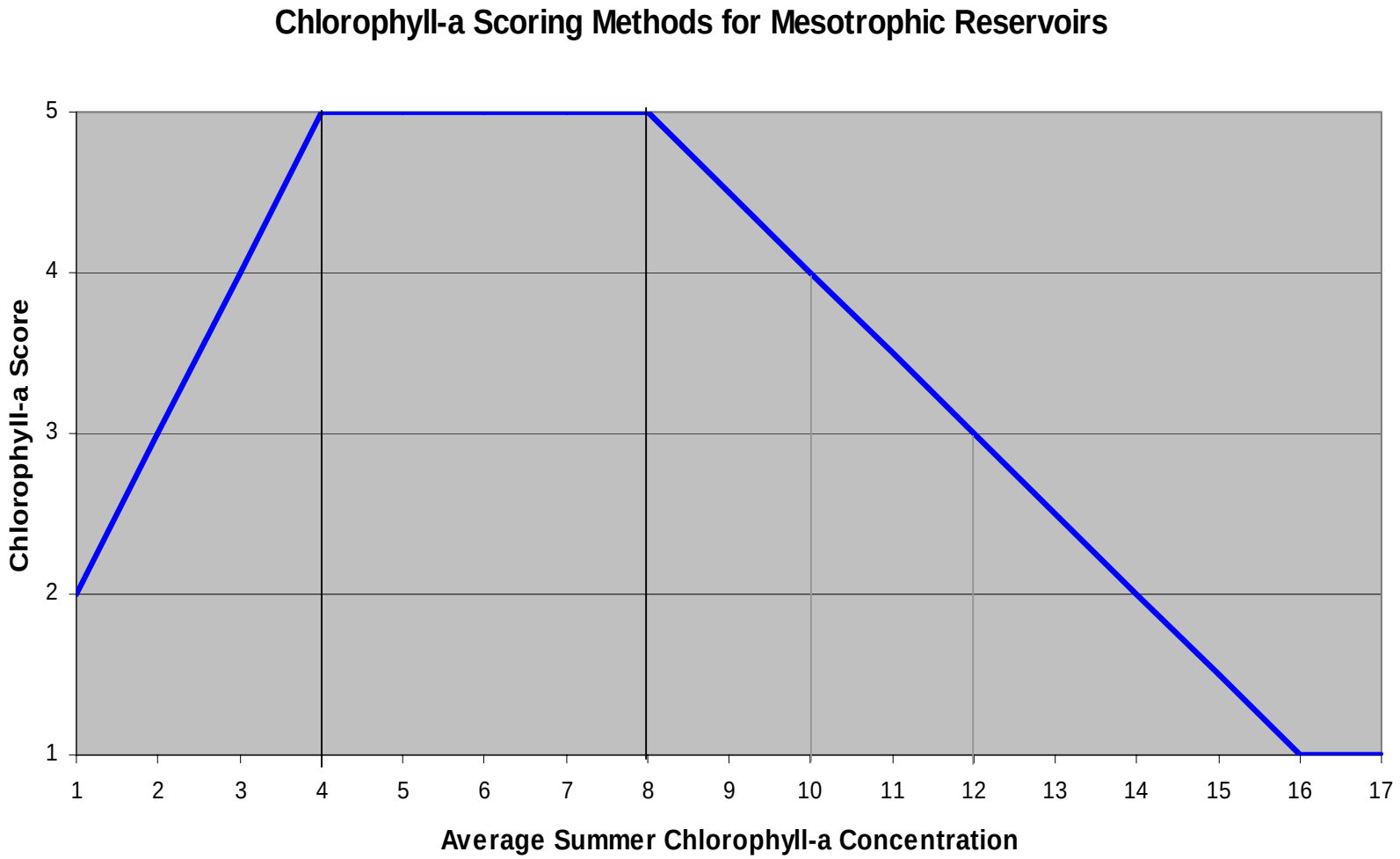
Example of a Reservoir with a Poor DO Rating



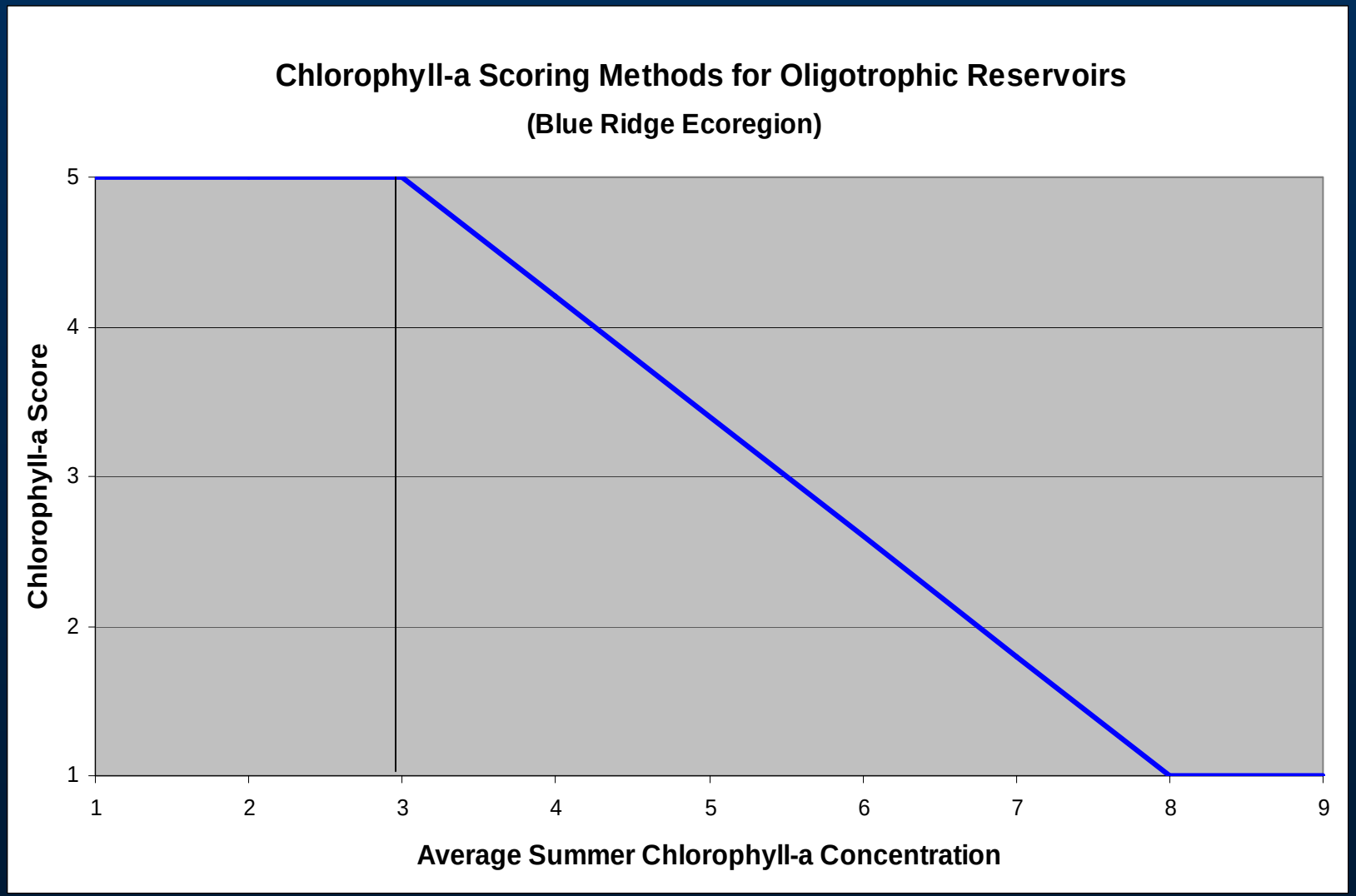
B. TVA Reservoir Ecological Health Rating Methods – Trophic Status

- Scoring criteria were developed separately for each of the two classes of reservoirs.
  - Reservoirs expected to be mesotrophic
  - Reservoirs expected to be oligotrophic
- Ratings are developed based on seasonal average concentrations compared to a sliding scale.

Trophic Status Rating for Reservoirs Expected to be Mesotrophic



Trophic Status Rating for Reservoirs Expected to be Oligotrophic



C. TVA Reservoir Ecological Health Rating Methods – Sediment Quality

- Based on chemical analysis for:
  - Metals (compared to sediment guidelines adapted from EPA Region 5 [EPA, 1977]).
  - Pesticides and PCBs (compared to laboratory detection limits)
- Rating developed as follows:
  - No analyte exceeding - highest rating= 2.5
  - One or two exceeding - medium rating= 1.5
  - Three or more exceeding - lowest rating= 0.5

D. TVA Reservoir Ecological Health Rating Methods – Benthos

- Based on 7 metrics or characteristics.
- Scoring criteria for each metric based on the trisection of data from TVA reservoirs.
- Criteria vary by reservoir class, ecoregion, and zone.
- Score is the total of these metrics (from 7 – 35).
- Scores converted to rating from 1 – 5.

Metrics Used to Evaluate Benthic Macroinvertebrate Results

Metric	R-O-R Res.	Trib Res.
Taxa Richness	X	X
EPT Taxa	X	
Long-lived Taxa	X	
Non-Chiron. / Oligo. Density	X	X
Percent Oligochaetes	X	X
Dominance	X	X
Zero Samples	X	X
Non-Chiron. / Oligo. Taxa		X
Chironomid Density		X

E. TVA Reservoir Ecological Health Rating Methods – Fish Assemblage

- Based on 12 metrics or characteristics.
- Scoring criteria for each metric is based on the trisection of data from TVA reservoirs.
- Criteria vary by reservoir class, ecoregion, and zone.
- Score is the total of these metrics (from 12 – 60).
- Scores converted to rating from 1 – 5.

Metrics Used to Evaluate Fish Assemblage Results

Species Richness and Composition Metrics

1. Total number of species
2. Number of centrarchid species
3. Number of benthic invertivore species
4. Number of intolerant species
5. Number of top carnivore species
6. Percent tolerant individuals (excluding Young-of-Year)
7. Percent non-native species
8. Percent dominance by one species

Trophic Composition Metrics

9. Percent individuals as omnivores
10. Percent individuals as top carnivores

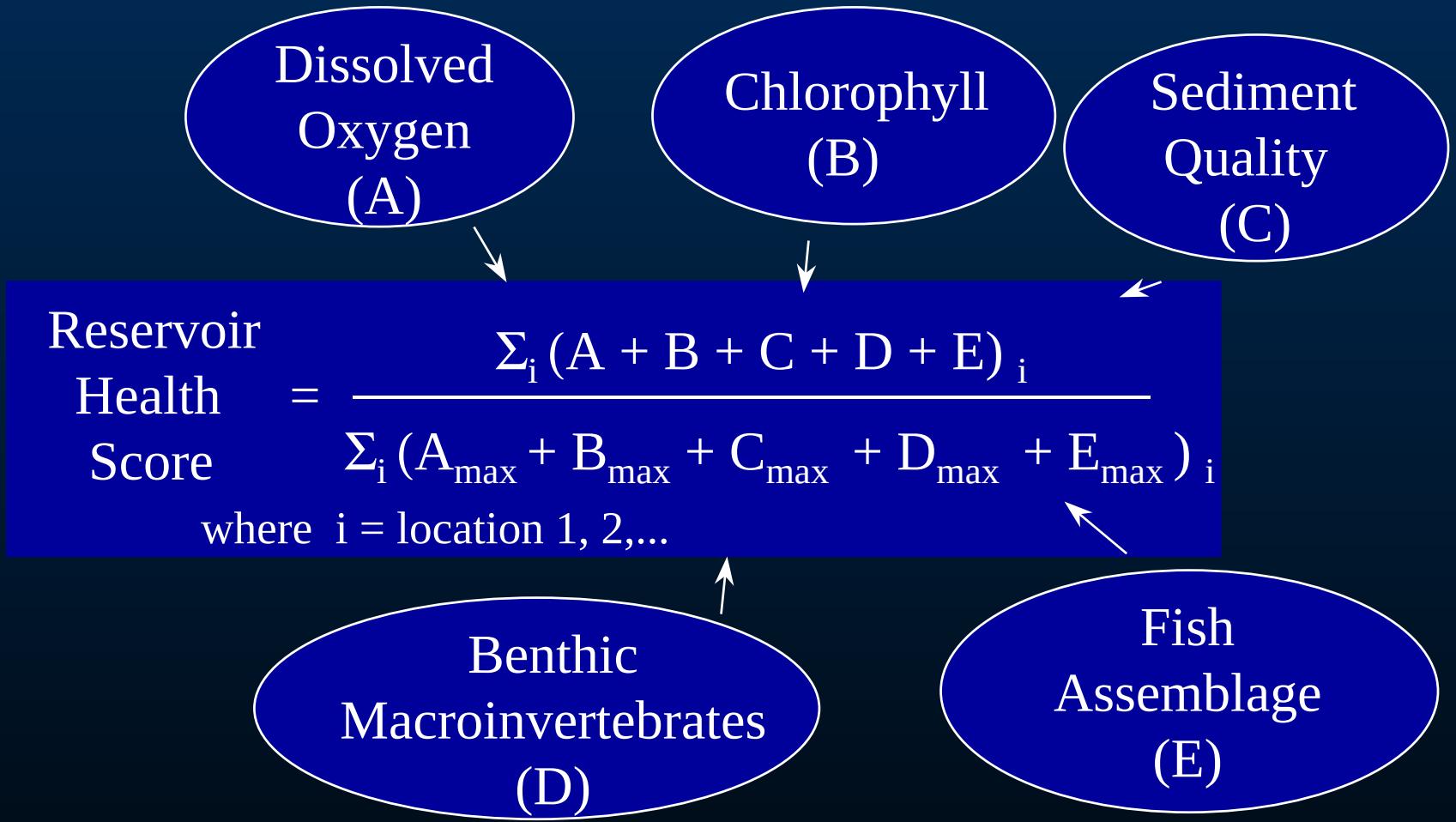
Abundance Metrics

11. Average number per run

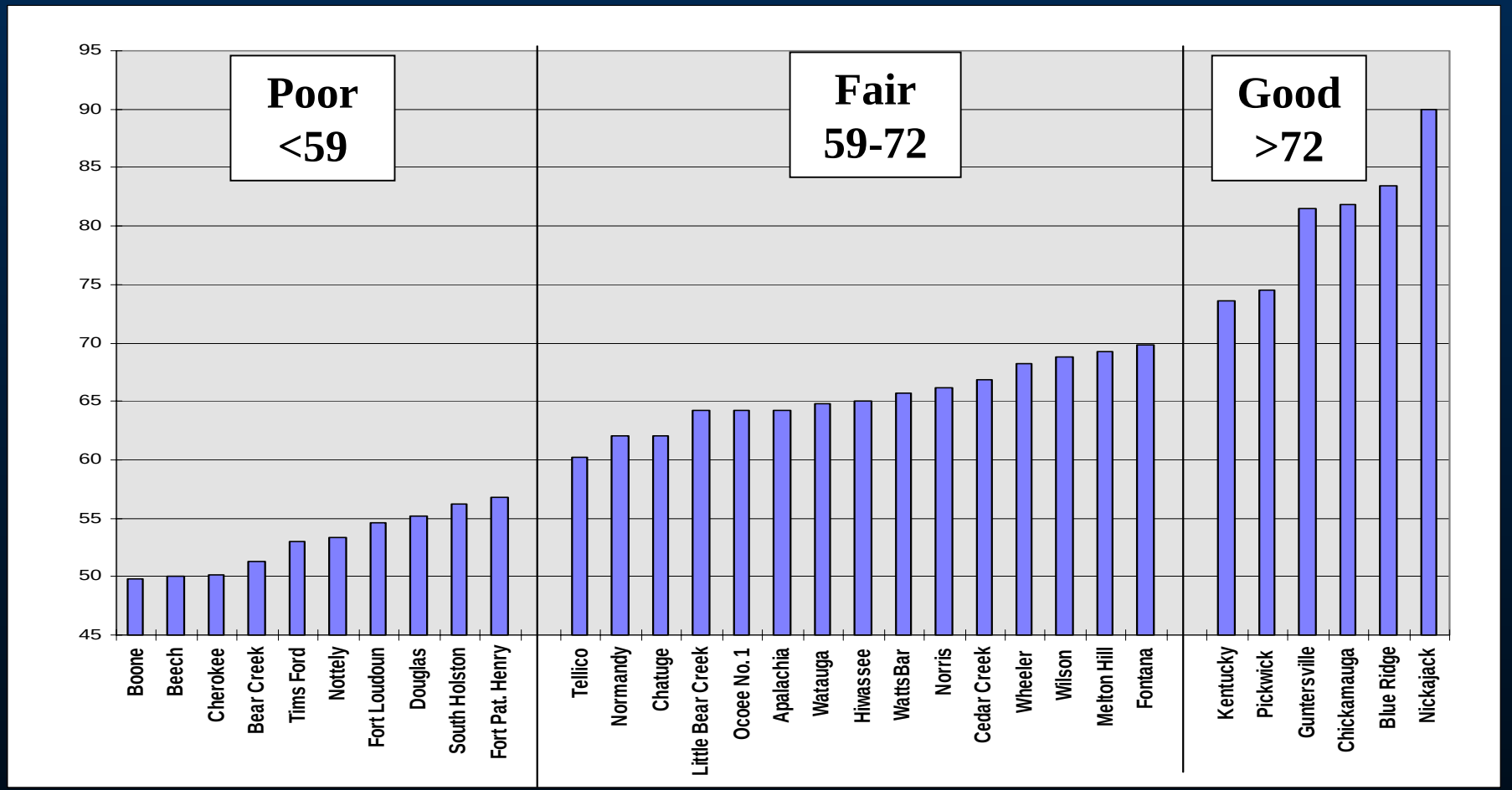
Fish Health Metrics

12. Percent individuals with anomalies

Reservoir Ecological Health Scoring Process

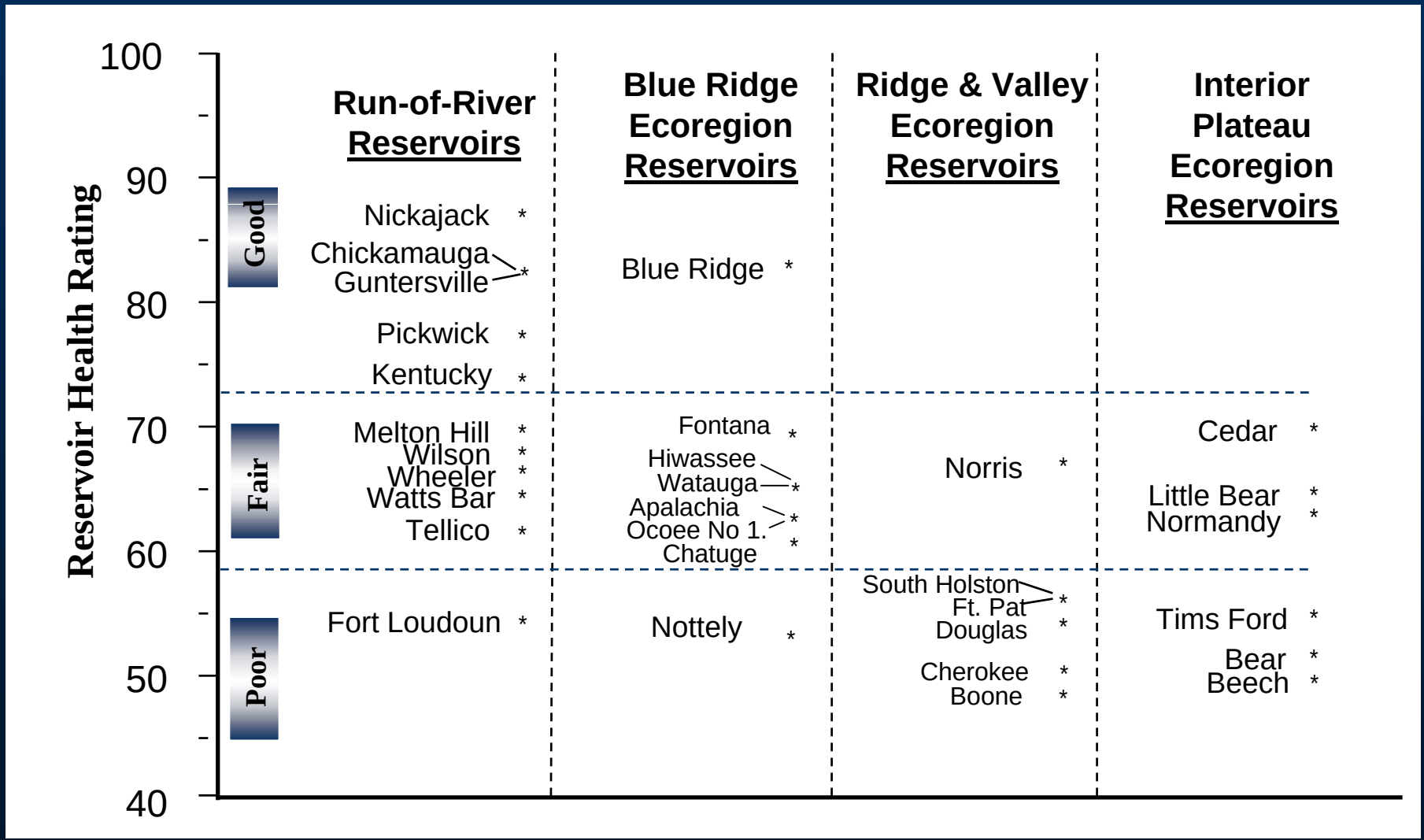


Average Reservoir Scores (1994-2001)

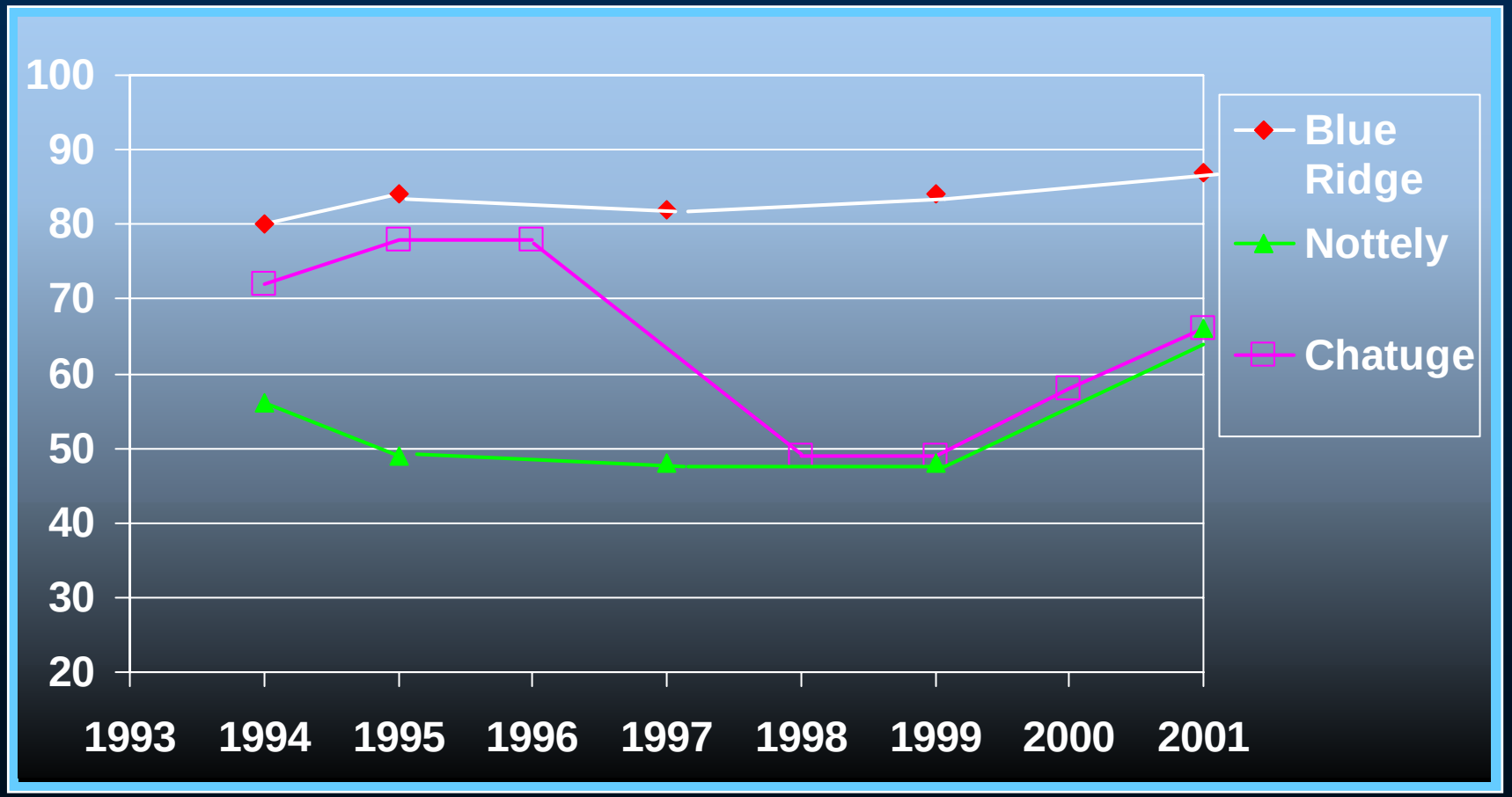


Reservoir Ecological Health

Long-Term Average Reservoir Ecological Health Scores



Long-Term Ecological Health Scores for Three Reservoirs



Most Notable Trend Is Increase In Chlorophyll

Type of Reservoir	Decreasing Trend (Negative Slope)	No Trend (Flat Slope)	Increasing Trend (Positive Slope)
Run-of-the-river	1 site	3 sites	20 sites (10 sites significant α= 0.05)
Tributary Reservoirs	0	4 sites	30 sites (16 sites significant α= 0.05)
Total	1 site	7 sites	50 sites (26 sites significant α= 0.05)

Regressions: Concentration vs Time (1990-2001)
Total of 59 locations