Appendix D3

Aquatic Resources

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D3.1   Fish Index of Biotic Integrity (Used in Tailwaters)

An Index of Biotic Integrity (IBI) is used to assess environmental quality by applying ecologically based metrics to resident aquatic communities. TVA uses a 12-metric fish IBI to assess tailwater quality. Each metric rates the condition of one aspect of the community. Metrics are scored against the expected condition of regional un-impacted stream communities. Potential scores are 1-poor, 3-intermediate, or 5-best condition.

The 12 metrics used in the fish IBI are as follows:

1. Number of native species

2. Number of native darter species

3. Number of sunfish species

4. Number of native sucker species

5. Number of intolerant species

6. Percentage of fish as tolerant species

7. Percentage of fish as omnivores and stoneroller species

8. Percentage of fish as specialized insectivores

9. Percentage of fish as piscivores

10. Catch rate (average number per standardized sampling effort)

11. Percentage of fish as hybrids

12. Percentage of fish with disease, tumors, body damage, or other anomalies

To produce a site rating, scores for the 12 metrics are summed. Sites attain 1 of 6 possible ratings: (1) no fish, (2) very poor (12-22), (3) poor (28-34), (4) fair (40-44), (5) good (48-52), or (6) excellent (58-60) (Karr et al. 1986).

The worst rating, no fish, indicates that repetitive sampling fails to turn up any fish. Sites rating very poor have few fish present, fish tend to be introduced or tolerant species, hybrids are common, and disease and anomalies occur regularly on fish. Poor sites are dominated by omnivores (fish that eat plants, animals, and sometimes detritus), fish are tolerant of pollution and are habitat generalists, few top piscivores are present, and hybrids and disease are present.   Sites attaining a fair rating have lowered species diversity, few intolerant forms, skewed trophic structure (increasing number of omnivores), and older age classes of top predators may be rare. Good ratings are attained when species richness is only slightly below regional expectations, mostly due to loss of most sensitive species, abundances or size distribution is not quite optimal, and trophic structure shows some signs of stress (more omnivores than usual and fewer piscivores than natural conditions). The highest rating, excellent, is attained by sites that are comparable to the best natural situations without influence of humans. Excellent sites have all regionally expected species for the habitat and stream size,

including tolerant forms, a normal age-size distribution, all sex classes, and a balanced trophic structure.

D3.2   Benthic Index of Biotic Integrity (Used in Tailwaters)

TVA uses a Benthic Index of Biotic Integrity (BIBI) to monitor the benthic invertebrate community in tailwaters. The BIBI follows the standard methodology of an IBI as described for the fish IBI (Karr et al. 1986), except that it uses 10 metrics to assess benthic invertebrates.

TVA uses the following benthic metrics to monitor resident benthic communities:

1. Taxa richness

2. Number of intolerant snail and mussel species

3. Number of mayfly taxa

4. Number of caddisfly taxa

5. Number of stonefly taxa

6. Percent of individuals as oligochaetes

7. Percent of individual taxa that feed as collector-filterers

8. Percent of individuals that are predators (excluding chironomids and flatworms)

9. Percent of individuals in the top two dominant taxa

10. Total abundance

Sites can attain a BIBI score of 10 to 60, with higher scores representing higher quality communities and environmental conditions.

D3.3   Reservoir Fish Assemblage Index

The Reservoir Fish Assemblage Index (RFAI) is one component of the Vital Signs monitoring program (see Section 4.4, Water Quality). This index evaluates the status of resident fish populations in reservoirs. The method is similar to the Reservoir Benthic Index.

For classification purposes, reservoirs were divided into upper and lower mainstem or tributary reservoirs, with tributary reservoirs further classified by physiographic region. Within reservoirs, sites were classified into three zones: inflow, transition, and forebay. In cases where sample information was gathered with different types of gear, scoring criteria were adjusted to account for the difference.

There are 12 fish community metrics represented by four categories (species richness and composition, trophic composition, abundance, and fish health). There are eight species richness metrics, including:

1. Total number of species

2. Number top carnivores

3. Number of sunfish (excluding *Micropterus*)

4. Number of benthic invertivores

5. Number of intolerant species

6. Percentage of tolerant individuals

7. Percentage of dominance by one species

8. Number of non-native species

The two trophic composition metrics are:

1. Percentage of individuals as omnivores

2. Percentage of individuals as top carnivores

Abundance is evaluated using total catch per effort (number of individuals captured per electrofishing or gill net sample). Fish health is evaluated using the percentage of individuals with anomalies (disease, lesions, tumors, external parasites, deformities, and natural hybrids).

Sample results were compared to reference criteria and assigned a corresponding value: most degraded-1, moderate-3, or least degraded-5. A fish community was rated by summing the scores for all metrics. Conditions of the fish community at a sample location were rated as follows:

RFAI Score	12-21	22-31	32-40	41-50	51-60
Community Rating	Very Poor	Poor	Fair	Good	Excellent

D3.4   Reservoir Benthic Index

TVA monitors resident benthic invertebrate communities in 31 reservoirs as part of the Vital Signs monitoring program described in Section 4.4, Water Quality. Benthic communities are rated using seven metrics. The seven metrics used to classify reservoirs vary depending between reservoir type, either mainstem or tributary reservoir. Within tributary reservoirs, the scoring system varies by physiographic region (Blue Ridge, Ridge and Valley, or Interior Plateau). Further, in each reservoir, the benthic community varies with the amount of flow. Communities at the inflow of the reservoir pool are different than those in the mid-reservoir (transition area) or in the forebay.

The seven metrics used to assess mainstem reservoirs include the following:

1. Number of taxa (species or varieties)

2. Diversity of a sensitive taxa group (EPT)

3. Presence or absence of long-lived species

4. Percent of oligochaetes (tolerant organisms)

5. Percentage of dominant taxa (presence of diversity or not)

6. Density excluding chironomids and oligochaetes

7. Zero samples (proportion of samples with no organisms)

For tributary reservoirs, metrics number 2 and 3 are not used. Instead, they are replaced by two different metrics, the number of non-chironomid and oligochaete taxa (more is better), and chironomid density (again, more is better).

Each metric is worth a maximum of 5 points. Points are given in increments of most degraded-1, moderate-3, or least degraded-5. Sample results were compared to reference conditions which varied based upon, in tributary reservoirs, physiographic provinces and within reservoir zones discussed in Section D3.3. Similarly, mainstem reservoirs support different communities than tributary reservoirs and they have their own scoring criteria. Only inflow areas were evaluated for mainstem reservoirs. All metrics scores for a particular site are summed to obtain the Reservoir Benthic Index score. Benthic communities were rated as very poor (7-12), poor (13-18), fair (19-23), good (24-29), and excellent (30-35).

D3.5   Sport Fishing Index

The Sport Fishing Index (SFI) measures quantity and quality of angler success and fish population characteristics using four metrics (Hickman 2000). Two metrics measure quantity, and two indicate quality.

Metrics used to evaluate quantity of the fish population include:

1. Angler success

2. Catch-per-effort of sampling by biologists

Population quality metrics include:

1. Angler pressure

2. A group of five population quality indicators used by fishery biologists, including such aspects as the proportion of preferred, memorable, and trophy individuals, and fish weight relative to length (plump or thin)

For each fish sample, an individual species was scored on all four metrics. Metric scores were rated as a 5-low, 10-moderate, or 15-high with higher scores meaning a higher quality sport fishery. For a metric comprised of more than one part, the value of a scoring category was divided by the total number of parts to give its score. If one part of a five-part metric scored in the low category (5), it received 1 point (5 points/five parts); if scored in the moderate category, it was worth 2 points (10 points/five parts); and so on. Overall, each of the four metric groups was worth a total of 20 points. Consequently, SFI scores range from 20 (minimum) to 80 (maximum). Sometimes information was available from both TVA and state agency fish samples. In that case, state data were used for catch rate statistics and both data sets were used for population quality aspects. When data were not available for a particular aspect (e.g., angler catch statistics) or the value of one part of a multi-part metric was unknown, the scores of known parts were given more weight so that the total for each metric still equaled 20 points.

To determine the SFI for a particular reservoir, multiple samples are taken in that reservoir. TVA has monitored fish populations with the SFI method since 1996.

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