5.7 Aquatic Resources

5.7.1 Introduction

The three main areas of concern for aquatic resources with regard to the ROS were biodiversity, sport fisheries, and commercial fisheries. The technical ability to accurately model direct impacts of environmental change on aquatic communities (e.g., numbers of species and numbers of individuals in a population) presently is limited and therefore impractical to apply across the TVA system. Instead, environmental conditions (e.g., DO, water temperature, and flow) that potentially affected aquatic communities under the various policy alternatives were modeled and used as surrogates of population and community responses. Responses of aquatic resources were discussed at a programmatic level, and anticipated change was indicated by the direction (e.g., beneficial or adverse) and magnitude (e.g., slight or substantial) of any change.

To provide a baseline for evaluation, aquatic resources responses to the policy alternatives were evaluated against the Base Case. The Base Case is described in Chapter 3, and its relationship to present operations related to aquatic resources is explained in Section 5.4, Water Quality. The estimated value of each surrogate environmental metric under the Base Case represents existing conditions that are expected to persist if no change is made to the reservoir operations policy.

Evaluation of aquatic resource issues was performed relative to waterbody type as described in this section. Surrogate measure results are presented by reservoir or tailwater. Biodiversity evaluations were made for individual reservoirs and warm-water tailwaters for fish and invertebrate communities. Biodiversity of cold-water tailwaters was not addressed because cold-water releases yield resident communities with little diversity; therefore, no alternative would change this general condition. Sport fish population conditions were assessed at reservoirs, including fish spawning conditions, and tributary tailwaters—cold-, cool-, and warm-water. Evaluation of commercial fisheries—both mussels and fishes—was conducted using metrics for mainstem reservoirs only, where most commercial activities occur.

5.7.2 Impact Assessment Methods

Based on scientifically established relationships of environmental variation and change in aquatic resources, surrogate metrics were identified to evaluate the potential change to aquatic resources under the policy alternatives (Table 5.7-01). Projected impacts on fish spawning conditions also were evaluated. Results of the evaluations of alternatives under other resource areas also were considered, including water quality analysis (see Section 5.4, Water Quality), aquatic plants (see Section 5.9, Aquatic Plants), and sediment and erosion (see Section 5.16, Shoreline Erosion).

Table 5.7-01 Environmental Factors Used to Evaluate Potential Changes among Species or Communities by Policy Alternative

Resource Issue	Category	Type	Condition Indicator	Representative or Modeled Years
General biodiversity	Reservoir	Mainstem	Dissolved oxygen (DO) water quality metrics (see Section 5.4, Water Quality)	
			Mean maximum percent of non-acceptable habitat (as percent of total daily reservoir volume)	1990,1993,1994
			Mean number of days of water volume with DO less than 1 mg/L	1990,1993,1994
		Tributary	DO water quality metrics (see Section 5.4, Water Quality)	
			Mean yearly volume of water with ammonia > 2 mg/L	1990,1993,1994
			Mean maximum percent of non-acceptable habitat (as percent of total daily reservoir volume)	1990,1993,1994
			Mean number of days of water volume with DO less than 1 mg/L	1990,1993,1994
	Tailwater	Warm-water fisheries	Mean summer (May to October) flow, DO, and temperature	1987–1994
			Mean daily range of summer (May to October) flow, DO, and temperature	1987–1994
			Mean August/September flow, DO, and temperature	1987–1994
			Mean daily range of August/September flow, DO, and temperature	1987–1994
			Hours of water temperature less than 16 ºC and 20 ºC	1987–1994
			Tailwater water quality indicators (see Section 5.4, Water Quality)	
		Cool-water fisheries	See general biodiversity, warm-water tailwater indicators (above)	
		Cold-water fisheries	See general biodiversity, warm-water flow, DO, and temperature metrics (above)	

Table 5.7-01 Environmental Factors Used to Evaluate Potential Changes among Species or Communities by Policy Alternative (continued)

Resource Issue	Category	Type	Condition Indicator	Representative or Modeled Years
Sport fisheries	Reservoir	Mainstem	Median number of weeks at summer pool elevation	1903–2001
			Median pool elevation in winter (week 2, January)	1903–2001
			Median first week stabilized at summer pool elevation	1903–2001
			See general biodiversity mainstem indicators (above)	
		Tributary	Median number of weeks at summer pool elevation	1903–2001
			Median pool elevation in winter (week 2, January)	1903–2001
			Median first week stabilized at summer pool elevation	1903–2001
			Mean volume of acceptable cool-water habitat (temperature < 24 ºC and DO >3 mg/L)	1990,1993,1994
			Mean volume of suitable cool-water habitat (temperature < 24 ºC and DO > 5 mg/L)	1990,1993,1994
			Mean volume of acceptable cool-water habitat (temperature < 20 ºC and DO > 3 mg/L)	1990,1993,1994
			Mean volume of suitable cool-water habitat (temperature < 20 ºC and DO > 5 mg/L)	1990,1993,1994
			See general biodiversity reservoir tributary indicators (above)	
	Tailwater	Warm-water fisheries	Hours of water temperature less than 16 ºC	1987–1994
			See general biodiversity metrics, warm-water tailwater indicators (above)	
		Cool-water fisheries	See general biodiversity, warm-water tailwater indicators (above)	
		Cold-water fisheries	Hours of water temperature more than 20 ºC	1987–1994
			See general biodiversity, cold-water tailwater indicators (above)	
			Tailwater water quality indicators (see Section 5.4, Water Quality)	
		Mainstem	Change in median discharge in spring (Week 13, April)	1987–1994
			Hours of no discharge from March through May	1987–1994
Commercial fisheries	Reservoir	Mainstem	See general biodiversity mainstem indicators (above)	

Reservoir Metrics

Increasing DO concentrations generally benefits aquatic life. Although very high levels of dissolved gases in water—a condition known as supersaturation—causes harm to aquatic animals, it has not been an issue for TVA reservoirs and only rarely has been an issue in tailwaters (downstream of the Kentucky Dam). Low DO concentrations not only are stressful to aquatic life; they can increase the potential for release of toxic substances (e.g., heavy metals, hydrogen sulfide, and ammonia) in the water (see Section 5.4, Water Quality). These impacts occur in reservoirs, which then can be transferred to tailwaters through discharge. Therefore, in addition to direct impacts of predicted low concentrations of DO, these estimates can be used as a surrogate measure of indirect impacts resulting from formation of toxic substances.

To evaluate changes to environmental conditions in reservoirs under the policy alternatives, the following DO and temperature metrics were used:

- Water quality metrics from Section 5.4, Water Quality:
  - Amount of water with DO < 1 milligrams per liter (mg/L)
  - Amount of water with DO < 2 mg/L
  - Amount of water with DO < 5 mg/L

Results for these metrics are presented in Section 5.4, Water Quality (Table 5.4-2). Estimates of DO < 1 mg/L were used to evaluate alternatives for the potential formation of toxic substances such as ammonia and presence of fatal concentrations of low DO. The DO < 2 mg/L metric served as an index of amount of stressful habitat, only habitable for short periods (hours or days). The final measure, DO < 5 mg/L, represented a DO concentration indicative of conditions not suitable for long-term survival and life function such as growth and feeding. Increased volumes of low DO water indicated decreasing habitat condition and increased potential of adverse impacts on aquatic biodiversity. With DO metrics, conditions representative of healthy biodiversity were also representative of conditions good for sport fish populations and commercial fisheries.

Changes in water temperature were also evaluated, especially with respect to sport fishes. Water temperature requirements for resident cold-water, cool-water, and warm-water sport fish were used to derive water temperature metrics. For cool- and cold-water species, higher temperatures decrease their potential growth or survival. For warm-water species, lower water temperatures decrease their potential growth, which indirectly lowers survival and, if temperature becomes extremely low, it may also cause direct stress or mortality. Cold-water species prefer maximum summer temperatures less than 20 ºC. Cool-water species prefer temperatures less than 24 ºC, and temperatures less than 16 ºC during the summer/fall growth period can decrease the potential productivity of warm-water communities. Most policy alternatives would influence the volume of water in tributary reservoirs that is of a suitable temperature for cold-water and cool-water fishes with an adequate concentration of DO. Because water temperature strongly influences DO and many sport fishes have combined water temperature and DO preferences that reflect this relationship, habitat conditions for tributary sport fishes were evaluated with metrics combining temperature and DO preferences.

Metrics used to evaluate environmental changes on fishes in tributary reservoirs were estimated using the water quality model (Table 5.7-01):

- Cold-water habitat

  Critical

  Mean volume-days (million m^3) with water temperature less than 20 ºC and DO > 3 mg/L for a dry, wet, and normal year.

  Preferable

  Mean volume-days (million m^3) with water temperature less than 20 ºC and DO > 5 mg/L for a dry, wet, and normal year.

- Cool-water habitat

  Critical

  Mean volume-days (million m^3) with water temperature less than 24 ºC and DO > 3 mg/L for a dry, wet, and normal year.

  Preferable

  Mean volume-days (million m^3) with water temperature less than 24 ºC and DO > 5 mg/L for a dry, wet, and normal year.

While other fishes are more tolerant of warmer water, metrics for cool-water habitat were used to serve as general indices to changes in the environment for warm-water fishes.

The hydrodynamics of reservoirs are also important to biodiversity of communities, sport fishes, and commercial fishes. Certain aspects of reservoir hydrodynamics affect water quality, as described in detail in Sections 4.4 and 5.4, Water Quality. Reservoir hydrodynamic metrics specifically used in this section included the first week of attainment of summer pool levels, elevation of winter pool levels, and the number of weeks at full pool levels. Specific to tributary reservoirs, the date of attainment of summer pool levels relates to spawning success of sport fishes. When summer pool levels have been attained earlier in the year, spring flow (and dam discharge) has been higher. Reaching summer pool levels earlier allows important shoreline areas to be flooded, providing good spawning and important nursery habitat. Due to flood risk issues, early attainment of summer pool levels is not possible; therefore, use of the median first week at summer pool is not applicable. However, as noted in Section 4.7, it is also important that tributary reservoir water levels be stabilized as much as possible during the spawning period. These stabilizations would continue under each alternative, but the stabilization would be initiated at 60 °F instead of 65 °F.

In addition, early attainment of full pool increases recolonization of formerly dewatered habitat by aquatic insect communities (fish prey). Because there is a much smaller difference between summer and winter pool levels in mainstem reservoirs (Ploskey et al. 1984), the benefit to fishes in mainstem reservoirs is considerably less and has not been included in this analysis. Attaining summer pool levels earlier in tributary reservoirs, especially in conjunction with extending the drawdown dates, increases the duration of quality habitat for young fishes, hence increasing the growing season. Irwin et al. (1997) found that increased growth of young-of-year largemouth bass *(Micropterus salmoides)* led to increased winter survival of juveniles, which ultimately improved largemouth bass catch by anglers in later years. One concern of annual extended pool levels relates to existing available habitat. The existing available habitat would decrease with years of extended pool levels as exposed reservoir bottom areas would not be dewatered for sufficient time under adequate growing conditions to redevelop the desirable vegetative growth that provides the nutrient boost and good spawning and nursery habitat.

The final measure of reservoir hydrodynamics used as a metric for aquatic communities was winter pool elevations. Raising winter pool levels reduces the area dewatered annually to increase flood storage capacity in winter, thereby increasing the amount of area inundated year-round. This would benefit both fishes and macroinvertebrate communities in tributary reservoirs, but in mainstem reservoirs the effect would be minimal. During dry years, maintaining higher winter pool levels would also increase late winter and early spring discharges (February through March 15) because less inflow would be needed to fill reservoirs to summer pool levels. Increasing discharges during this period also would benefit tailwaters by resembling pre-dam conditions of higher late winter and early spring flows, which would benefit migratory spawning fish such as sauger *(Stizostedian canadense)*, white bass *(Morone chrysops)*, paddlefish *(Polyodon spathula)*, and most suckers.

Tailwater Metrics

To evaluate aquatic resources in tailwaters, the following environmental metrics were estimated using the TVA water quality model (Table 5.7-01):

- Mean flow (cubic feet per second [cfs]) in summer (May through October);
- Mean flow (cfs) during August and September combined;
- Mean DO (mg/L) in summer (May through October);
- Mean DO (mg/L) during August and September combined;
- Mean water temperature (ºC) in summer (May through October);
- Mean water temperature (ºC) during August and September combined; and,
- The mean daily maximum change of all metrics listed above.

For cold-water tailwaters:

- Hours of water temperature greater than 20 ºC from May to October.

For cool-water/warm-water tailwaters:

- Hours of water temperature less than 16 ºC from May to October.

For tailwaters, changes to water temperature, DO, and habitat were of primary interest for evaluating proposed operations. Flow is a controlling factor of river habitat. Because flow was more easily modeled than habitat condition, it was used as a surrogate to describe changes. For all metrics, both the mean level and the range of variation were important. Hydropower operations may cause large hourly fluctuations in all three metrics, which can disrupt important behaviors such as feeding or spawning activity and cause harmful stress on organisms.

Conditions of flow, water temperature, and DO concentrations are particularly important in flowing sections during spring, summer, and autumn. Spring and summer are important because this is when most reproduction of aquatic organisms occurs—especially spring. In early spring, some fishes migrate to spawning locations, with flow and temperature being important triggers. Appropriate flow levels during spring also help transport mussel larvae, maintain buoyant fish eggs in the water column, and keep fish nests free of suffocating fine sediments. Very low flows may limit available spawning habitat for species that require naturally clean-swept substrate for successful spawning, and very high flows may limit spawning—and even destroy eggs/larvae and nests of nest-building species. In late summer, a natural period of typically low flow, habitat and water quality become critical for aquatic organisms. Low flows limit habitat diversity, which limits the number of organisms (e.g., fishes and mussels). Low flows also result in higher water temperatures and lower DO concentrations. Therefore, higher mean flow is considered to increase available habitat. Generally, a decrease in daily flow fluctuations (less extreme variation) increases the health of aquatic communities, especially those that require stable or static conditions. The number of hours of no flow from March through May for mainstem dams was evaluated as a surrogate metric for spawning success of migratory sport and commercial fishes, such as walleye *(Stizostedion vitreum)*, sauger, paddlefish, and suckers in mainstem flowing areas.

Although late summer water quality is a critical issue, conflicts exist between requirements for cold-water and warm-water communities. Temperature changes that would benefit cold-water communities decrease potential of warm-water communities, and vice versa. Cold-water river communities primarily support trout fisheries and exhibit low biodiversity, while cool-water/warm-water rivers support more types of sport fish and show higher overall biodiversity. Cool-water communities respond to temperature changes in a mixed manner because the community contains some species that prefer colder water and others that prefer warmer water. Minor water temperature changes would simply shrink locations for one group and expand those of the other group (less cold-water habitat if water temperatures rise and less warm-water habitat if water temperatures decrease). Because cool-water communities are in the middle, the length of river classified as cool-water would not change unless temperature changes are substantial.

Basic changes in DO concentrations are evaluated in Section 5.4, Water Quality. More detailed metrics describing water quality changes specific to aquatic resources are listed in Table 5.7-01, and changes in their status under the policy alternatives are summarized in Tables 5.7-02 through 5.7-09. Dissolved oxygen in tributary and upper mainstem dam releases would be mitigated to Lake Improvement Plan targets through the RRI Program; therefore, no changes in minimum tailwater DO conditions were anticipated or addressed in these areas.

Representative Waterbodies

Representative waterbodies were selected to typify the affected environment and assess the policy alternatives for key issues. Waterbodies were selected based on several factors, including their importance to resource areas, potential for environmental change in the waterbody, available information, and location within the TVA system. Links among EIS components were integrated when possible.

Representative waterbodies were selected as follows:

Mainstem reservoirs	Kentucky, Guntersville, and Pickwick Reservoirs
Tributary reservoirs	Tims Ford, Douglas, Norris, Nottely, Hiwassee, South Holston, Watauga, Boone, and Melton Hill Reservoirs
Cool/cold tailwaters	South Fork Holston River (one location)
Cool-to-warm tailwaters	Elk River (one location), Holston River (one location)
Warm tailwaters	French Broad River (one location), Elk River (one location), Holston River (one location)

Water Quality Models

Metrics were estimated using one of two TVA models. The TVA Water Quality Model and the reservoir hydrodynamic, or Weekly Scheduling Model, are described in Appendix C. Metric values could not be calculated for the Summer Hydropower Alternative because drier years could not be successfully calibrated and run with the Water Quality Model. Water quality reservoir metrics for this section were evaluated using years classified according to annual rainfall amounts by TVA as normal (1990), dry (1993), and wet (1994). Metrics were averaged across these representative years. Reservoir hydrodynamic metrics were calculated as the statistic (e.g., mean) condition for a given week using a policy alternative simulated for years 1903 to 2001. For tailwaters, metrics for DO, water temperature, and flow were modeled on an hourly time step for the period from 1987 to 1994.

Change in each metric was evaluated against the Base Case. Metrics were classified by the percent of change and direction of change as follows:

- ↑** ↓** +/- greater or equal to 51 percent
- ↑* ↓* +/- 26.0-50.9 percent
- ↑ ↓ +/- 11.0-25.9 percent
- **o** +/- 0.0-10.9 percent
- ↑∞ ↓∞ Values for metrics were very small, causing artificially large change, or the baseline value was zero; arrows then indicate direction of change only.

Table 5.7-02 Comparison of Reservoir Dissolved Oxygen Metrics by Policy Alternative

Alternative	Reservoir	Mean Number of Days with Water Volume Having Dissolved Oxygen Less Than 1 mg/L	Peak Daily Volume of Non-Acceptable Habitat as Percent of Total Daily Volume
Reservoir Recreation A	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑	↑*
	Kentucky	↓*	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o
Reservoir Recreation B	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑**	↑*
	Kentucky	↓**	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o

Table 5.7-02 Comparison of Reservoir Dissolved Oxygen Metrics by Policy Alternative (continued)

Alternative	Reservoir	Mean Number of Days with Water Volume Having Dissolved Oxygen Less Than 1 mg/L	Peak Daily Volume of Non-Acceptable Habitat as Percent of Total Daily Volume
Equalized Summer/Winter Flood Risk	Boone	↑∞	o
	Douglas	o	o
	Guntersville	↑*	↑*
	Kentucky	↓**	↑**
	Pickwick	o	↑
	South Holston	↓	o
	Tims Ford	o	o
Commercial Navigation	Boone	↑∞	o
	Douglas	o	o
	Guntersville	o	o
	Kentucky	↓**	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o
Tailwater Recreation	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑*	↑*
	Kentucky	↓**	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o
Tailwater Habitat	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑**	o
	Kentucky	↓*	↑**
	Pickwick	o	↑
	South Holston	↑	o
	Tims Ford	o	o

Table 5.7-02 Comparison of Reservoir Dissolved Oxygen Metrics by Policy Alternative (continued)

Alternative	Reservoir	Mean Number of Days with Water Volume Having Dissolved Oxygen Less Than 1 mg/L	Peak Daily Volume of Non-Acceptable Habitat as Percent of Total Daily Volume
Preferred	Boone	↑∞	o
	Douglas	o	o
	Guntersville	↓*	o
	Kentucky	o	o
	Pickwick	↑	o
	South Holston	o	o
	Tims Ford	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-03 Comparison of Reservoir Hydrology Metrics

Alternative	Reservoir	Median Elevation for Week 2 (January)	Median First Week of Year at Summer Pool	Weeks at Summer Pool
Reservoir Recreation A	Douglas	↑∞	o	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↓∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↓∞	o
	Tims Ford	↑∞	o	o
Reservoir Recreation B	Douglas	↑∞	o	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↓∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↓∞	↑∞
	Tims Ford	↓∞	o	↑∞
Equalized Summer/Winter Flood Risk	Douglas	↑∞	↑∞	o
	Guntersville	o	o	↑∞
	Kentucky	↑∞	↑∞	↑∞
	Norris	↑∞	↑∞	↑∞
	Pickwick	↑∞	↑∞	↑∞
	South Holston	↑∞	↑∞	o
	Tims Ford	↓∞	↑∞	o
Commercial Navigation	Douglas	↑∞	o	o
	Guntersville	o	o	o
	Kentucky	↑∞	o	o
	Norris	↑∞	o	o
	Pickwick	↑∞	o	o
	South Holston	↑∞	o	o
	Tims Ford	↓∞	o	o
Tailwater Recreation	Douglas	↑∞	↑∞	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↑∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↓∞	↑∞
	Tims Ford	o	o	o

Table 5.7-03 Comparison of Reservoir Hydrology Metrics (continued)

Alternative	Reservoir	Median Elevation for Week 2 (January)	Median First Week of Year at Summer Pool	Weeks at Summer Pool
Tailwater Habitat	Douglas	↑∞	↓∞	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↓∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↑∞	↑∞
	Tims Ford	↑∞	o	o
Preferred	Douglas	↑**	o	↑∞
	Guntersville	o	o	↑**
	Kentucky	o	o	↓
	Norris	↑**	↑∞	↑**
	Pickwick	o	o	↑**
	South Holston	↑*	↓∞	↑∞
	Tims Ford	o	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-04 Comparison of Summer Tailwater Metric Values for Tailwaters by Policy Alternative

Alternative	River Segment (Upstream Reservoir)	Mean Flow in Summer (cfs)	Mean Daily Range of Flow in Summer (cfs)	Mean Dissolved Oxygen in Summer (mg/L)	Mean Daily Range of Dissolved Oxygen in Summer (mg/L)	Mean Summer Temperature (°C)	Mean Daily Range of Summer Temperature (°C)
Reservoir Recreation A	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓	o	↓	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	o	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	o
Reservoir Recreation B	Elk River Mile 125 (Tims Ford)	o	↓	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓*	o	↓	↓	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	↑	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	o
Equalized Summer/ Winter Flood Risk	Elk River Mile 125 (Tims Ford)	↓	↓**	o	o	↑	↓*
	Elk River Mile 73 (Tims Ford)	↓	↓*	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓*	o	↓	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	↑	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o
Commercial Navigation	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	o	o	o	o	o	o
	Holston River Mile 48 (Cherokee)	o	o	o	o	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o

Table 5.7-04 Comparison of Summer Tailwater Metric Values for Tailwaters by Policy Alternative (continued)

Alternative	River Segment (Upstream Reservoir)	Mean Flow in Summer (cfs)	Mean Daily Range of Flow in Summer (cfs)	Mean Dissolved Oxygen in Summer (mg/L)	Mean Daily Range of Dissolved Oxygen in Summer (mg/L)	Mean Summer Temperature (°C)	Mean Daily Range of Summer Temperature (°C)
Tailwater Recreation	Elk River Mile 125 (Tims Ford)	o	↓	o	o	↓	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	↓	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓	o	↓	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	↑	o	o
	South Fork Holston River Mile 43 (South Holston)	↓	↓	o	o	o	o
Tailwater Habitat	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓**	o	↓*	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓**	↑	↓**	↓	↓
	Holston River Mile 48 (Cherokee)	↓*	↓**	o	↓*	↓	↓*
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	o
Preferred	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓	o	o	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	o	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o

Notes: Values could not be calculated for the Summer Hydropower Alternative because severely dry years dried portions of the system, crashing the water quality model. See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-05 Comparison of August–September Tailwater Metric Values by Policy Alternative

Alternative	River Segment (Upstream Reservoir)	Mean Flow for August and September (cfs)	Mean Daily Range of Flow in August and September (cfs)	Mean Dissolved Oxygen in August and September (mg/L)	Mean Daily Range of Dissolved Oxygen in August and September (mg/L)	Mean Temperature in August and September (°C)	Mean Daily Range of Temperature in August and September (°C)
Reservoir Recreation A	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	o	o	o	↓	↓	↑
	Holston River Mile 48 (Cherokee)	o	o	↑	o	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓*	o	o	o	o	↑
Reservoir Recreation B	Elk River Mile 125 (Tims Ford)	o	↓	o	o	o	↓
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓*	↑	↓	↓	↑
	Holston River Mile 48 (Cherokee)	↓*	↓*	↑	↑	↓*	o
	South Fork Holston River Mile 43 (South Holston)	↓*	↓	o	o	o	↑
Equalized Summer/ Winter Flood Risk	Elk River Mile 125 (Tims Ford)	↑	↓*	o	o	o	↓*
	Elk River Mile 73 (Tims Ford)	o	↓	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓*	↑	↓*	↓	↑
	Holston River Mile 48 (Cherokee)	↓*	↓*	↑	↑	↓	↑
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	↑
Commercial Navigation	Elk River Mile 125 (Tims Ford)	↑**	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	↑*	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	o	o	o	o	o	o
	Holston River Mile 48 (Cherokee)	o	o	o	o	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o

Table 5.7-05 Comparison of August–September Tailwater Metric Values by Policy Alternative (continued)

Alternative	River Segment (Upstream Reservoir)	Mean Flow for August and September (cfs)	Mean Daily Range of Flow in August and September (cfs)	Mean Dissolved Oxygen in August and September (mg/L)	Mean Daily Range of Dissolved Oxygen in August and September (mg/L)	Mean Temperature in August and September (°C)	Mean Daily Range of Temperature in August and September (°C)
Tailwater Recreation	Elk River Mile 125 (Tims Ford)	o	↓	o	o	o	↓
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓*	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓*	↑	↓	↓	↑
	Holston River Mile 48 (Cherokee)	↓*	↓*	↑	↑	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓*	↓	o	↓	o	o
Tailwater Habitat	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓*	↓**	↑	↓*	o	o
	Holston River Mile 30 (Cherokee)	↓**	↓**	↑*	↓**	↓*	o
	Holston River Mile 48 (Cherokee)	↓**	↓**	↑	↓	↓*	↓*
	South Fork Holston River Mile 43 (South Holston)	↓*	o	o	o	o	↑
Preferred	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	o	o	o	↓	o
	Holston River Mile 48 (Cherokee)	↓	o	o	o	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	↓	o	o

Notes: Values could not be calculated for the Summer Hydropower Alternative because severely dry years dried portions of the system, crashing the water quality model. See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-06 Comparison of Water Temperature Metric Values for Tailwaters by Policy Alternative

Alternative	River Segment (Upstream Reservoir)	Warm Tailwaters (Summer Hours of Water Temperature Less Than 16 ºC)	Cool-to Warm-Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)	Cool/Cold Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)
Reservoir Recreation A	Elk River Mile 125 (Tims Ford)		o	
	Elk River Mile 73 (Tims Ford)	o		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	↑		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↑*
Reservoir Recreation B	Elk River Mile 125 (Tims Ford)		↑	
	Elk River Mile 73 (Tims Ford)	↑		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	↑		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↑**
Equalized Summer/Winter Flood Risk	Elk River Mile 125 (Tims Ford)		↑**	
	Elk River Mile 73 (Tims Ford)	↑		
	French Broad River Mile 18 (Douglas)	↓**		
	Holston River Mile 30 (Cherokee)	↓		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↑**
Commercial Navigation	Elk River Mile 125 (Tims Ford)		o	
	Elk River Mile 73 (Tims Ford)	o		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	o		
	Holston River Mile 48 (Cherokee)		o	
	South Fork Holston River Mile 43 (South Holston)			↑**

Table 5.7-06 Comparison of Water Temperature Metric Values for Tailwaters by Policy Alternative (continued)

Alternative	River Segment (Upstream Reservoir)	Warm Tailwaters (Summer Hours of Water Temperature Less Than 16 ºC)	Cool-to Warm-Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)	Cool/Cold Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)
Tailwater Recreation	Elk River Mile 125 (Tims Ford)		↑	
	Elk River Mile 73 (Tims Ford)	↑		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	↑		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↓*
Tailwater Habitat	Elk River Mile 125 (Tims Ford)		o	
	Elk River Mile 73 (Tims Ford)	o		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	↑**		
	Holston River Mile 48 (Cherokee)		↓**	
	South Fork Holston River Mile 43 (South Holston)			↑*
Preferred	Elk River Mile 125 (Tims Ford)		o	
	Elk River Mile 73 (Tims Ford)	o		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	o		
	Holston River Mile 48 (Cherokee)		↓	
	South Fork Holston River Mile 43 (South Holston)			↓**

Notes: Values could not be calculated for the Summer Hydropower Alternative because severely dry years dried portions of the system, crashing the water quality model.

See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-07 Comparison of Cool-Water Habitat Reservoir Metrics by Policy Alternative

Alternative	Reservoir	Mean Percent Yearly Volume of Critical Cool-Water Habitat	Mean Percent of Yearly Volume of Preferable Cool-Water Habitat
Reservoir Recreation A	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Reservoir Recreation B	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Equalized Summer/Winter Flood Risk	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Commercial Navigation	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o

Table 5.7-07 Comparison of Cool-Water Habitat Reservoir Metrics by Policy Alternative (continued)

Alternative	Reservoir	Mean Percent Yearly Volume of Critical Cool-Water Habitat	Mean Percent of Yearly Volume of Preferable Cool-Water Habitat
Tailwater Recreation	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Tailwater Habitat	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	↑
	Nottely	o	o
	Tims Ford	o	o
Preferred	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	o	o
	Nottely	o	o
	Tims Ford	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-08 Comparison of Cold-Water Habitat Reservoir Metrics by Policy Alternative

Alternative	Reservoir	Mean Percent of Yearly Volume of Critical Cold-Water Habitat	Mean Percent of Yearly Volume of Preferable Cold-Water Habitat
Reservoir Recreation A	South Holston	o	o
	Watauga	o	o
Reservoir Recreation B	South Holston	o	o
	Watauga	o	o
Equalized Summer/Winter Flood Risk	South Holston	o	o
	Watauga	o	o
Commercial Navigation	South Holston	o	o
	Watauga	o	o
Tailwater Recreation	South Holston	o	o
	Watauga	o	o
Tailwater Habitat	South Holston	o	o
	Watauga	o	o
Preferred	South Holston	o	o
	Watauga	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-09 Estimated Values for Flowing Mainstem Waterbodies

Alternative	Flowing Mainstem Reach (Upstream Reservoir)	Hours of No Discharge from March through May
Reservoir Recreation A	Fort Loudoun	o
	Guntersville	o
	Pickwick	o
Reservoir Recreation B	Fort Loudoun	↓
	Guntersville	↓
	Pickwick	o
Equalized Summer/Winter Flood Risk	Fort Loudoun	↓*
	Guntersville	o
	Pickwick	o
Commercial Navigation	Fort Loudoun	o
	Guntersville	o
	Pickwick	o
Tailwater Recreation	Fort Loudoun	↓
	Guntersville	↓
	Pickwick	o
Tailwater Habitat	Fort Loudoun	↓**
	Guntersville	↓**
	Pickwick	↓**
Preferred	Fort Loudoun	↓
	Guntersville	↓
	Pickwick	↓

Note: See explanation on page 5.7-9 for metric symbols used in the table.

5.7.3 Base Case

The status of aquatic resources under the Base Case is characterized for present operations and ongoing projects in the discussions below.

General Biodiversity

Reservoirs

In reservoirs, environmental conditions under the Base Case were generally more favorable for general biodiversity than under other policy alternatives—except the Commercial Navigation Alternative, which exhibited similar conditions to the Base Case. In tributary storage reservoirs, under the Base Case, the benthic aquatic insect and mussel communities would remain strongly affected by seasonal thermal stratification and resulting low DO concentration and large water level fluctuations. Aquatic insect communities would be low in diversity and comprised of only tolerant taxa. Reservoir Fish Assemblage Index values for tributary reservoirs were not projected to change more than the standard annual variation under the Base Case.

In mainstem reservoirs, aquatic insect communities would remain fair, and the status of mussels in flowing portions would remain poor for riverine mussel species and favorable for pool-adapted species. Reservoir Fish Assemblage Index values for mainstem reservoirs were not projected to change more than the standard annual variation under the Base Case.

Sport Fisheries

Reservoirs

Sport fishes in mainstem reservoirs would remain generally good under the Base Case. Recruitment would vary with reservoir hydrology as determined by climatic conditions; wet years produce more recruitment. Because mainstem pool levels have less fluctuation than tributary storage reservoirs, inter-annual changes in sport fish populations would vary less in mainstem reservoirs than in tributary reservoirs. Sport fish populations are also highly managed by state resource agencies, and Sport Fish Index scores could vary based on changes in management objectives.

Tailwaters

Variable recruitment for sport fishes in the flowing mainstem (e.g., sauger and white bass) would continue, largely related to flow during spring—with improved conditions during years with wet March-through-May periods. Achieving target DO concentrations in tailwater releases under the RRI Program would continue to benefit tributary tailwater fisheries. Late summer water quality (temperature) would continue to stress cold-water fisheries at some sites (e.g., below Hiwassee Dam) during dry years or warm summers.

Commercial Fisheries

Reservoirs

Commercial fisheries for fish and mussels occur primarily in mainstem reservoirs. Reservoirs benefit commercial fisheries by providing increased habitat for commercial fish species that are generally adapted to pool conditions. In dry years, with reduced flow through the mainstem, low DO may adversely affect mussel fisheries, but this impact would be determined more by climatic patterns than reservoir operations. Overall, commercial species should not vary more than changes currently experienced due to variation in climatic conditions.

5.7.4 Reservoir Recreation Alternative A

General Biodiversity

Reservoirs

In tributary reservoirs, results described in Section 5.4, Water Quality, indicated that Reservoir Recreation Alternative A would increase poor water quality in reservoirs. On the worst day for water quality, this alternative would increase the volume of water with poor quality for Boone Reservoir, with no changes in other tributary reservoirs (Table 5.7-02). Pool levels in winter would be raised, reducing the amount of bottom habitat dewatered during drawdown (Table 5.7-03), which would improve some benthic habitat conditions. In mainstem reservoirs, Reservoir Recreation Alternative A would increase the potential for reduced biodiversity because it would increase the volume of DO-depleted water and the potential amount of toxic substances in the water during summer. In tributary reservoirs, there was relatively no change relative to Base Case conditions in water quality metrics related to general biodiversity. Mainstem response would be slightly adverse.

Tailwaters

Summer flow decreased, except at sites below Tims Ford (Elk River) which did not change (Table 5.7-04). Conditions of summer DO and temperature would be similar to Base Case conditions. Mean August/September DO concentrations below Douglas (French Broad River), Cherokee (Holston River), and South Holston (South Fork Holston River) Dams increased, with no change observed at other sites (Table 5.7-05). Mean temperature during late summer dropped at both sites in the Holston River, with no change in temperature estimated for other rivers. Decreases in water temperature would slightly benefit cold-water sport fishes below Cherokee Dam (Table 5.7-06) but would be slightly adverse to downstream warm-water communities (potentially decreasing biodiversity). Therefore, the overall projected impact of Reservoir Recreation Alternative A on tailwater biodiversity is no change to slightly adverse.

Water temperature criteria for all years indicated similar trends. More cold water occurred in the Holston River, less in the South Fork Holston River, and no change at other sites. Again, cold-water sport fishes may benefit at some sites under this alternative, and conditions for warm-water species in cool-water rivers would be slightly adverse.

Sport Fisheries

Reservoirs

Under Reservoir Recreation Alternative A, conditions of water quality potentially influencing sport fisheries would not change from the Base Case in tributary reservoirs (Tables 5.7-07 and 5.7-08). On the other hand, if aquatic plants become more abundant in tributary reservoirs under this alternative (as projected in Section 5.9, Aquatic Plants), resident warm-water fish and aquatic insects would slightly benefit. Because there are more warm-water than cold- or cool-water fish in most tributary reservoirs, the overall influence of Reservoir Recreation Alternative A is no change to slightly beneficial.

Water quality conditions in mainstem reservoirs would decrease slightly over the Base Case as summer stratification would be extended for approximately 30 days. The increase in the number of weeks at summer pool levels would increase the volume of water with low DO during summer, possibly adversely influencing cool-water species such as white crappie *(Pomoxis annularis)*, sauger, and striped bass *(Morone saxatilis*) (Table 5.7-03). Growth and survival of warm-water fishes (e.g., bass [*Micropterus* sp.], catfish [*Ictalurus* sp.], and sunfish [mainly *Lepomis* sp.]) in mainstem reservoirs would benefit from longer pool levels because these species are tolerant of less suitable water quality. In mainstem reservoirs, the estimated response would be no change to slightly adverse.

Tailwaters

In the mainstem, there would be no change in discharge hours from mainstem dams (Table 5.7-09) from March through May. Water temperature criteria below most reservoirs indicate no change, except at the two sites in the Holston River below Cherokee (cool-to-warm and warm), where more cold-water would be present and the number of hours with water temperatures $\geq$20 ^{o}C below South Holston Dam would increase (Table 5.7-06). Cold-water fishes would slightly benefit from increased cold-water releases, but warm-water species would incur slightly adverse conditions. Cool/cold tailwaters are projected to incur slightly adverse impacts, no change was anticipated for other warm tailwaters, and cool-to-warm tailwaters would likely have variable responses.

Commercial Fisheries

All representative mainstem reservoirs—Pickwick, Guntersville, and Kentucky—were projected to be degraded by increased volume of water with poor quality. Kentucky Reservoir would see the most change. As a result, commercial fisheries, especially for freshwater mussels, would experience adverse habitat conditions under this alternative.

5.7.5 Reservoir Recreation Alternative B

General Biodiversity

Reservoirs

In tributary reservoirs, DO metrics showed more volume of water with low DO than under Reservoir Recreation Alternative A (Section 5.4, Water Quality). This would increase the potential for slightly adverse conditions in tributary reservoirs. For mainstem reservoirs, the number of days experiencing low DO varies by reservoir. Generally, the volume of water with DO concentrations less than 2 mg/L and 5 mg/L would increase, as well as the maximum volume of water with poor water quality on the most challenging day of the year. Biodiversity could be expected to decrease slightly under these conditions.

Tailwaters

Conditions for summer tailwater metrics showed relatively little change, except below Cherokee Dam (Holston River) (Table 5.7-04). In the Holston River, mean water temperature, flow, and range of flow exhibited slight decreases. During August and September, mean flow and range of flow decreased at all sites except those below Tims Ford (Elk River), which had no change (Table 5.7-05). Mean DO increased in the Holston River, with no change in DO or water temperature projected for other tailwaters assessed. Further, water quality metrics (see Section 5.4, Water Quality) indicated no change relative to the Base Case for DO in tailwaters due to Lake Improvement Plan targets. Therefore, due to projected decreases in water temperature in warm-water tailwaters and reductions in summer flow patterns, Reservoir Recreation Alternative B is projected to result in no change or a slightly adverse impact on biodiversity.

Sport Fisheries

Reservoirs

Reservoir Recreation Alternative B would increase the weeks at full pool level and increase winter pool levels but would not change the first week when full pool level was reached. These aspects would benefit aquatic insects and shoreline spawning sport fish, such as bass, crappie, and bluegill. More days at summer pool would increase the potential for establishment of aquatic vegetation. Release of only minimum flows from June 1 to Labor Day would increase the average volume of water with low DO and low water temperature in tributary reservoirs slightly more than projected under Reservoir Recreation Alternative A. This would have minimal impact on resident warm-water fish species due to their mobility and sufficient remaining volume of water with suitable water quality. Reductions in cool-water habitat (DO concentrations) would be more important for species such as white crappie, walleye, and white and striped bass. Overall, water quality conditions preferred by sport fishes showed minimal change under this alternative in tributary reservoirs. Reduced flow from tributary reservoirs would increase the volume of water with low DO in mainstem reservoirs, thus decreasing habitat availability.

A slightly beneficial change in sport fish populations of tributary reservoirs may be anticipated due to the longer period at summer pool. Due to decreased water quality, no change to slightly adverse change would be anticipated in mainstem reservoirs.

Tailwaters

Metric changes during August and September mostly indicated no change as discussed above for tailwater biodiversity. However, specific temperature metrics for tailwater sport fishes indicated that more temperatures above 20 ºC would be experienced below Tims Ford (cool-to-warm) and South Holston (cool/cold) Dams (Table 5.7-06). The apparent conflict of metric results was due to the difference in the time frame of evaluation. Average temperatures would be cooler in the Elk River below Tims Ford during August and September. In cool-to-warm tailwaters, cold-water species would slightly benefit; but warm-water species would experience a slight adverse impact. In the South Fork Holston River, cold-water species would experience a slightly adverse impact. Warm-water species would experience some decrease in water temperature quality in downstream areas but would benefit from more stable flows while summer pool levels were maintained. Stable flows would be more important than the temperature changes for warm-water species. The hours of zero discharge from mainstem reservoirs in early spring would also decrease under this alternative, slightly benefiting sport fish spawning there. No change to slight benefits would be the impact on warm-water tailwaters.

Commercial Fisheries

Because of increased volume of water with low DO under Reservoir Recreation Alternative B, commercial fisheries—especially freshwater mussels—would experience adverse habitat conditions under this alternative. The limited ability of mussels to move out of affected areas increases their potential for decline.

5.7.6 Summer Hydropower Alternative

The Summer Hydropower Alternative would maximize summer hydropower. Water quality output for this alternative was not completed because under this alternative the model would not run for severely dry years (1986, 1987, and 1988). Therefore, outcomes for this alternative were subjective and should be accepted with caution.

General Biodiversity

Reservoirs

In mainstem reservoirs, a slight benefit may be achieved because this alternative increased mainstem flow, which would decrease the amount of water with low DO occurring during summer. For mainstem reservoirs, the number of days during summer the projected daily water volume had less than 1 and/or 2 mg/L DO decreased more than 50 percent. Increased mainstem flow would increase water levels in flowing mainstem areas, maintaining more habitats for fish, and especially aquatic insects and mussels. In tributary reservoirs, the

Summer Hydropower Alternative would decrease stratification, improving water quality, but water level fluctuation would adversely affect available shoreline habitat. Some reservoirs may reach extremely low pool levels under this alternative in very dry years. Overall, biodiversity would be adversely affected in tributary reservoirs.

Tailwaters

The Summer Hydropower Alternative would potentially extend the number of days under minimum flow targets from the Lake Improvement Plan; and unrestricted drawdown would mean more peaking flows, decreasing the stability of daily water elevations and water quality in warm-water tailwaters. The Summer Hydropower Alternative would adversely affect the potential for biodiversity.

Sport Fisheries

Reservoirs

Water quality results (Section 5.4, Water Quality) indicate that the Summer Hydropower Alternative was projected to reduce the volume of water with low concentrations of DO in some tributary reservoirs and increase it in others. Variation in suitable habitat available for cool-water and cold-water sport fish would result in variable responses by these sport fish populations in different reservoirs. The extended period of dewatering of the drawdown zone during the growing season (summer/early fall), would allow plants such as buttonbush *(Cephalanthus occidentalis)*, willows *(Salix sp.)*, and cockleburs *(Xanthium spinosum)* to thrive in the drawdown zone. This vegetation growth would enhance the potential for development of suitable habitat for spawning, a good media for aquatic insect production, and provide protection for enhanced juvenile survival and growth for warm-water species. If this habitat is not flooded for a sufficiently long period following inundation (through August), however, benefits would be generally reduced. The increased flow from tributary dams would tend to decrease the volume of water with low DO in mainstem reservoirs, which should increase the potential for better cool-water sport fish populations. Therefore, the potential for improvement for mainstem sport fish populations would slightly increase.

Tailwaters

Below mainstem dams, this alternative would not alter discharges in spring relative to the Base Case, and no change is expected for migratory fishes spawning below mainstem dams. Water temperatures from tributary reservoirs would be higher due to less cold water in storage in the late summer. Consequently, cold-water tailwater sport fishes would be adversely affected from decreasing water quality (raised water temperatures), and warm-water species would slightly benefit.

Commercial Fisheries

Increased flow through the mainstem reservoirs would improve water quality and benefit commercial fisheries.

5.7.7 Equalized Summer/Winter Flood Risk Alternative

General Biodiversity

Reservoirs

In tributary reservoirs, relatively no change in water quality condition for sport fishes was predicted (Tables 5.7-08 and 5.7-09). Mainstem DO conditions would be slightly degraded (see Section 5.4, Water Quality, and Table 5.7-02). The volume of water with critically low DO (<1 mg/L) is projected to increase considerably in Guntersville Reservoir and yet decline considerably in Kentucky Reservoir. Percent of non-acceptable habitat is projected to increase in both reservoirs. General biodiversity is expected to decrease slightly in mainstem reservoirs, with no appreciable change anticipated for tributary reservoirs.

Tailwaters

Relatively no change in late summer water temperatures is anticipated, except at sites in the Holston River, where temperature would decrease slightly. Dissolved oxygen in the Holston River below Cherokee Dam would increase slightly (Table 5.7-05). Reductions in temperature would result in a slightly adverse effect on biodiversity in the Holston River, but no change was estimated for other rivers. August/September flow under this alternative would be reduced slightly below Douglas, South Holston, and Cherokee Dams, but the daily mean range of flows, which provides more stable habitat and water quality, would be reduced— offsetting the loss of habitat from lower flows. No change in biodiversity is anticipated under this policy alternative.

Sport Fisheries

Reservoirs

Under the Equalized Summer/Winter Flood Risk Alternative summer pool levels would be achieved later in the year (Table 5.7-03) and, for most reservoirs, it would lower median summer pool levels. These aspects would result in negative impacts on shoreline species spawning and nursery habitat. Winter pool levels would be raised, except at Tims Ford, which would be lowered. Summer pool levels would be maintained longer than under the Base Case. In tributary reservoirs—except at Norris, where the mean percent of yearly volume of critical cool-water habitat would increase—relatively no change in water quality conditions for sport fishes was predicted (Table 5.7-07). Changes in pool levels under this alternative would result in a slightly adverse effect on tributary reservoir sport fisheries relative to the Base Case. As noted in Section 5.4, Water Quality, mainstem DO conditions would be degraded. Fort Loudoun Reservoir would decrease the hours of no discharge during spring, but no change was estimated for Kentucky and Pickwick Reservoirs (Table 5.7-09). This alternative would result in slightly adverse conditions for sport fishes in mainstem reservoirs.

Tailwaters

Metrics for sport fish concerns of tailwaters showed a mixed pattern of change (Tables 5.7-04 and 5.7-05). Both the cool-to-warm and warm-water tailwater sites in the Holston River below Cherokee Dam would be colder (Table 5.7-06) and with more DO, which would benefit the trout fishery immediately below the dam. Impacts on warm-water species would be slightly adverse. Estimated conditions for both the cool-to-warm and warm-water tailwater sites in the Elk River (Tims Ford) and the South Holston River cool/cold site showed a decrease in flow during August and September. No changes in summer flow or water temperature were projected. Number of hours with water temperature greater than 20 °C substantially increased in the cool/cold tailwater site below South Holston River, indicating adverse conditions. Fewer hours of water temperatures less than 16 ºC are projected to occur below Douglas Dam (French Broad River), indicating improved conditions for warm-water fish species (Table 5.7-06). However, no change was projected in summer mean water temperatures or during the August/September period (Tables 5.7-04 and 5.7-05). Under this alternative, flow from mainstem reservoirs would not change from March through May (Table 5.7-09). The response of sport fishes in warm and cool-to-warm tailwaters would be variable, with slightly adverse conditions projected for cool/cold tailwaters.

Commercial Fisheries

Mainstem reservoirs would experience an increase in yearly volumes of water with poor DO concentrations. Conditions for mussels would decrease more than those for fishes because DO is depleted in benthic areas first and, because mussels are not mobile, they cannot escape. Impacts on commercial fisheries under the Equalized Summer/Winter Flood Risk Alternative are anticipated to be slightly adverse to adverse.

5.7.8 Commercial Navigation Alternative

Estimated conditions for the Commercial Navigation Alternative were similar to those under the Base Case. See the description of conditions for the Base Case for this alternative. The only anticipated difference is the potential for a slight benefit in biodiversity of mainstem reservoirs due to projections for substantially fewer days with DO <1 mg/L in Kentucky Reservoir. However, since the peak daily volume of non-acceptable habitat in this reservoir was projected to increase substantially, the overall projected impact on mainstem reservoirs is only slightly beneficial. This also may improve slightly the potential for sport fish in mainstem reservoirs. The slight increases in winter pool elevations (Table 5.7-03) in tributary reservoirs may also slightly aid sport fish populations in these systems.

5.7.9 Tailwater Recreation Alternative

Estimated conditions for the Tailwater Recreation Alternative were similar to those for Reservoir Recreation Alternative B (described in Section 5.7.5). For details on conditions under this alternative, see Reservoir Recreation Alternative B.

5.7.10 Tailwater Habitat Alternative

General Biodiversity

Reservoirs

Increasing volumes of water with low DO were estimated for some tributary and especially for mainstem reservoirs (Table 5.7-02). These conditions would reduce suitable habitat for cool-water and cold-water fish species, aquatic insects, and mussels. Consequently, this alternative is anticipated to incur slightly adverse effects on biodiversity in both tributary and mainstem reservoirs.

Tailwaters

The Tailwater Habitat Alternative lowered mean summer and August/September flows, substantially in the Holston River (Cherokee Dam), slightly in the French Broad River (Douglas Dam) and South Fork Holston River, and not at all in the Elk River (Tims Ford Dam) (Table 5.7-05). In fact, there was no change to conditions relative to the Base Case for Elk River sites for flow, DO, or water temperature. Mean water quality conditions for the French Broad and South Fork Holston Rivers also did not change. Temperature was slightly lowered in the Holston River (Tables 5.7-04 and 5.7-05). A drop in temperature in the Holston River (cool-water) would decrease the potential biodiversity at the most downstream site, but the site nearest the dam (Cherokee) already has low diversity due to cold-water releases. Reductions in the daily mean range of DO and temperature across rivers were relatively small. Results suggest no change to slightly adverse conditions for biodiversity under this alternative.

Sport Fisheries

Reservoirs

The Tailwater Habitat Alternative would not change the date of attainment of summer pool levels (Table 5.7-03). It would increase the weeks at full pool levels and would increase winter pool levels. These changes would improve conditions for sport fishes. However, tributary reservoirs would experience a substantial increase in low DO concentrations (see Section 5.4, Water Quality), and mainstem reservoirs would similarly experience decreases in water quality metrics. Tributary reservoirs would experience a slightly adverse impact under this alternative, and mainstem reservoirs would be adversely affected based on changes to DO concentrations (Section 5.4).

Tailwaters

Reductions of water temperature below Cherokee Dam (Holston River) would provide a slight benefit to the trout fishery in the cool-to-warm section of the tailwater close to the dam (Table 5.7-06); in downstream warm-water areas, however, impacts on resident species would be slightly adverse. No change was predicted to mean condition in either the cool-to-warm or warm sections of the Elk River (Tims Ford Dam) or the French Broad River (Douglas Dam—warm tailwater) (Table 5.7-06). In the cool/cold tailwater below South Holston River, summer hours of water temperature >20 ^{o}C (unsuitable for cold-water species) would increase (Table 5.7-06), but no change in mean summer or August/September metrics was indicated (Tables 5.7-04 and 5.7-05). A large portion of the decline occurred in summer months other than August and September (July and October) but not enough to affect the full summer (May to October). Mean flow in the South Fork Holston River was reduced slightly and could decrease habitat area. Under this alternative, hours of no discharge below mainstem reservoirs would be substantially reduced (Table 5.7-09), providing a substantial benefit to sport fishes spawning below mainstem reservoirs. However, poor mainstem reservoir water quality under the Tailwater Habitat Alternative may adversely affect the same sport fishes at later life stages. Overall, metrics under this alternative indicate an adverse response from cool/cold tailwater trout populations due to increased hours with water temperatures >20 ^{o}C. A variable environmental response for sport fishes is projected in warm (no change to slightly adverse for warm-water species) and cool-to-warm (cold-water species would benefit and warm-water species would be adversely affected) tailwater types.

Commercial Fisheries

Water quality indicators for mainstem reservoirs indicated adverse changes for the commercial fisheries. The amount of low DO present in the mainstem reservoirs would increase under this alternative.

5.7.11 Preferred Alternative

General Biodiversity

Reservoirs

For tributary reservoirs, results described in Section 5.4, Water Quality, indicate that the Preferred Alternative would marginally affect water quality. This alternative would slightly increase the volume of water with DO < 1 mg/L and the volume of unacceptable habitat (DO < 2 mg/L) for Boone Reservoir, with relatively no changes in other tributary reservoirs (Table 5.7-02). Raising pool levels in winter in most tributary reservoirs (no change at Tims Ford Dam) would reduce the amount of bottom habitat dewatered during drawdown (Table 5.7-03), which would improve some benthic habitat conditions. However, low DO in summer would still affect these areas in most tributary reservoirs and would continue to restrict benthic communities. Tributary reservoir biodiversity is not anticipated to change under the Preferred Alternative.

In mainstem reservoirs, the Preferred Alternative, relative to Base Case conditions, would result in mixed impacts on the potential to reduce biodiversity, with no change in the volume of DO-depleted water in Kentucky Reservoir, a decrease in Guntersville Reservoir, and a slight increase in Pickwick Reservoir. As discussed in Section 5.4, Water Quality, Guntersville Reservoir results could have been overly influenced by the unusually dry conditions of 1988. No changes are projected for the mean peak daily volume of unacceptable habitat. Winter pool levels would not change on any of these representative mainstem reservoirs. Mainstem reservoir biodiversity impacts would be variable, with conditions in some reservoirs improving and declining in others.

Tailwaters

Summer flow would decrease at both the cool-to-warm and warm tailwater sites below Cherokee Dam. No change in flow relative to the Base Case is projected at other sites (Table 5.7-04). Conditions of summer DO and temperature would be similar to Base Case conditions. Late summer (August-September) water temperatures at both Holston River sites declined (~4 °C), which is projected to result in a slight adverse impact on these sites (Table 5.7-05). Water temperatures in other tailwaters are not projected to change. Therefore, the overall impact of the Preferred Alternative on tailwater biodiversity would be no change to slightly adverse.

Sport Fisheries

Reservoirs

Under the Preferred Alternative, conditions of water quality potentially influencing sport fisheries would not change from the Base Case in tributary reservoirs (Tables 5.7-07 and 5.7-08). On the other hand, if aquatic plants become slightly more abundant in tributary reservoirs under this alternative (as projected in Section 5.9, Aquatic Plants), resident warm-water fish and aquatic insects would slightly benefit. However, projected negative impacts on scrub/shrub plants such as buttonbush (as stated in Section 5.8, Wetlands), due to increased length of time covered by water, would result in slightly adverse impacts. Increasing the length of time at full pool under this alternative would provide additional shallow-water habitat, in the form of flooded vegetation such as grasses, during the first couple of years. This vegetation would result in additional cover, which is beneficial for survival of young fishes; however, this habitat would actually decrease with years of extended pool levels—except during dry years. Exposed reservoir bottom areas would not be dewatered for sufficient time under adequate growing conditions to redevelop the desirable vegetative growth that provides the nutrient boost and good spawning and nursery habitat. Summer pools would be extended at Douglas, Norris, and South Holston Reservoirs under this alternative, but not at Tims Ford. The volume of water with suitable cool-water habitat during summer was projected to not change in any of the representative reservoirs (Table 5.7-07). Increases in winter pool elevations (Table 5.7-03) in tributary reservoirs, except for Tims Ford, would also slightly aid sport fish populations in these systems. Overall, influence of the Preferred Alternative on tributary reservoir sport fisheries is projected to be no change to slightly beneficial.

Water quality conditions in most mainstem reservoirs would decrease slightly over Base Case conditions, as summer stratification would be extended for approximately 10 days. The number of weeks at summer pool levels would increase in Pickwick and Guntersville Reservoirs but decline slightly at Kentucky Reservoir (Table 5.7-03). Projected impacts on growth and survival of warm-water fishes (e.g., bass [*Micropterus* sp.], catfish [*Ictalurus* sp.], and sunfish [mainly *Lepomis* sp.]) in mainstem reservoirs would be variable. The increased duration at full pool would result in minimal increases in submersed aquatic vegetation (as noted in Section 5.9, Aquatic Plants). This would result in a slightly positive influence on benthic invertebrate and most fish species. Projected negative impacts on plants such as buttonbush (as stated in Section 5.8, Wetlands), due to increased length of time covered by water, would be slightly adverse in mainstem reservoirs.

<u>Tailwaters</u>

For cool/cold tailwaters, the number of summer hours with water temperatures greater than 20 °C (too warm for cold-water species) was projected to substantially decline below South Holston (South Fork Holston River Mile 43), suggesting a benefit at this location (Table 5.7-06). However, neither mean summer water temperature nor flows were projected to change relative to the Base Case at this site (Table 5.7-04). Most of the decline would occur in summer months other than August and September (June and July) but not enough to affect the full summer (May to October). During August/September, flows would slightly decrease, but water temperatures would not change from the Base Case (Table 5.7-05). Therefore, conditions for sport fish in cool/cold tailwaters are expected to be slightly beneficial.

A slight decrease in hours with water temperatures greater than 20 °C projected at the cool- to warm-water site in the Holston River below Cherokee Dam (Holston River Mile 48), with no change anticipated for the Elk River site below Tims Ford Dam (Table 5.7-06). This change would enhance the habitat for cold-water species (trout) but would negatively affect cool- and warm-water species. Mean summer water temperatures were not projected to change relative to the Base Case at either site (Table 5.7-04). During August/September, flows and water temperatures would slightly decrease at the Holston River site, but no change for either metric is projected at the Elk River site (Table 5.7-05). Conditions for cool- to warm-water tailwaters are predicted to vary, depending on the species group (cold-water species would slightly benefit, and cool- and warm-water species would experience slightly adverse conditions).

For warm tailwaters, no change in the number of summer hours (May through October) with temperatures less than 16 °C was projected for the lower Holston River, lower Elk River, or the French Broad River sites under this alternative (Table 5.7-06). Mean summer water temperatures also indicate no changes at any of these sites (Table 5.7-04). However, August/September mean water temperatures would decline at the lower Holston River site, creating slightly adverse conditions for warm-water species during this period (Table 5.7-05). Summer and August/September flows below Douglas (French Broad River Mile 18) and Tims Ford (Elk River Mile 125) Dams would not change relative to the Base Case. Flows at the lower Holston River site would decrease slightly in both summer and August/September periods (Tables 5.7-04 and 5.7-05). Mainstem reservoirs would have slightly less potential for hours of no discharge during March and April but marginally higher potential during May (Table 5.7-09). Overall, conditions for mainstem tailwater fisheries are expected to be no change to slightly beneficial. Therefore, conditions for sport fishes in warm tailwaters would be variable.

Commercial Fisheries

Based on water quality modeling, Guntersville Reservoir is projected to have fewer days with low DO (<1 mg/L) and thus improved conditions; no change at Kentucky and Douglas Reservoirs; and slight increases at Pickwick Reservoir, resulting in slightly degraded conditions under the Preferred Alternative compared to Base Case conditions (Table 5.7-02). Conditions for commercial mussels are not projected to change (the main harvest occurs in Kentucky Reservoir), while those for commercial fish are projected to vary under the Preferred Alternative.

5.7.12 Summary of Impacts

Assessment of conditions for each area of aquatic resources is summarized in Table 5.7-10. The amount of flow through the TVA system represents a driving factor on the status of aquatic organisms. In wet years, more flow through the system generally reduces the impacts of reservoir operations on aquatic organisms. In dry years, the condition of the environment is more challenging because reduced flow through the system exacerbates any adverse change induced by reservoir operations. Assessments of aquatic resources were made using the mean response of selected surrogate metrics. The response of metrics across years showed a similar pattern for the policy alternatives as the Base Case, which implies that the status of most metrics would be relatively worse in dry years and better in wet years for aquatic resources, as compared to the results stated in sections above. In many cases, however, the variations among mean metric values among policy alternatives was less than the inter-annual variation of metric values under the Base Case.

The biodiversity of mainstem reservoirs would be adversely or slightly adversely affected under all alternatives, except the Summer Hydropower Alternative and the Commercial Navigation Alternative, which would have slight benefits based on modeled changes in water quality. The Preferred Alternative would have variable results, with some reservoirs slightly benefiting from lower levels of unsuitable habitat and others experiencing slightly adverse increases in low DO conditions. Tributary reservoirs would experience no change or a slightly adverse change in metrics representing biodiversity; generally, however, no change in condition is expected because biodiversity was already affected under present operating conditions (see Section 4.7). Biodiversity in warm-water tailwaters would generally be adversely or slightly adversely affected under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Summer Hydropower Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative. No change is anticipated under the Equalized Summer/Winter Flood Risk Alternative or the Commercial Navigation Alternative. Cold-water tailwater biodiversity would not change from present conditions under any alternative. Overall, policy alternatives would result in minimal impacts on biodiversity over existing conditions.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative

Alternative	Description of Impacts
Biodiversity – Tributary Reservoirs	
Base Case	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Reservoir Recreation A	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Reservoir Recreation B	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat for cool-water species.
Summer Hydropower	Adverse – Shoreline fluctuation would adversely affect shoreline habitat.
Equalized Summer/ Winter Flood Risk	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Commercial Navigation	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Tailwater Recreation	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat for cool-water species.
Tailwater Habitat	Slightly adverse – Increasing volumes of water with low DO in some reservoirs would reduce suitable habitat for cool-water and cold-water fish species, aquatic insects, and mussels.
Preferred	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Biodiversity – Mainstem Reservoirs	
Base Case	No change – Aquatic insect communities would remain fair; status of mussels in flowing portions would remain poor for riverine species and favorable for pool-adapted species.
Reservoir Recreation A	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Reservoir Recreation B	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Summer Hydropower	Slightly beneficial – Increased flow would decrease the amount of water with low DO during summer.
Equalized Summer/ Winter Flood Risk	No change to slightly adverse – Increase in volume of water with low DO in Guntersville Reservoir, yet considerable decrease in Kentucky Reservoir, would increase percent of non-acceptable habitat.
Commercial Navigation	Slightly beneficial – Although fewer days with DO <1 mg/L in Kentucky Reservoir, the peak volume of non-acceptable habitat in Kentucky is projected to increase substantially.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Biodiversity – Mainstem Reservoirs (continued)	
Tailwater Recreation	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Tailwater Habitat	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Preferred	Slightly adverse to slightly beneficial – Changes in DO concentrations and flows would result in some reservoirs improving (Guntersville), some staying the same (Kentucky), and some declining (Pickwick).
Biodiversity – Warm Tailwaters[2]	
Base Case	No change – Biodiversity would continue to be limited due to the restraints of a regulated system.
Reservoir Recreation A	No change to slightly adverse – Lower flow, DO concentrations, and temperature would result in slightly adverse conditions for Cherokee tailwater and no change in others.
Reservoir Recreation B	No change to slightly adverse – Decrease in water temperatures and reduced summer flow would adversely affect biodiversity, no change in water quality.
Summer Hydropower	Adverse – Decrease in the stability of daily water elevations and water quality would adversely affect biodiversity.
Equalized Summer/ Winter Flood Risk	No change – Biodiversity would continue to be limited due to the restraints of a regulated system.
Commercial Navigation	No change – Biodiversity would continue to be limited due to the restraints of a regulated system.
Tailwater Recreation	No change to slightly adverse – Decrease in water temperatures and reduced summer flow; no change in water quality.
Tailwater Habitat	No change to slightly adverse – Decrease in mean flows in Holston and French Broad, with no change in the Elk; slightly lower water temperatures in Holston; no other changes in water quality.
Preferred	No change to slightly adverse – Decreased flows and water temperatures in Holston River would adversely affect biodiversity; no change in Elk or French Broad Rivers.
Sport Fish – Tributary Reservoirs	
Base Case	No change – Conditions would continue to be stressful for cool-water species and favorable for warm-water species.
Reservoir Recreation A[2]	No change to slightly beneficial – Water quality would be similar to Base Case, but warm-water fish and aquatic insects would slightly benefit if aquatic plants become more abundant.
Reservoir Recreation B[2]	Slightly beneficial – Longer duration of high summer pool level and higher winter pool level would slightly increase aquatic habitat.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Sport Fish – Tributary Reservoirs (continued)	
Summer Hydropower	Slightly adverse to slightly beneficial – Volume of water with low DO would be reduced in some reservoirs and increased in others.
Equalized Summer/ Winter Flood Risk	Slightly adverse – Full summer pool level would be lower and achieved later in the year.
Commercial Navigation	No change to slightly beneficial – Slight increases in winter pool elevations may slightly aid sport fish populations.
Tailwater Recreation[2]	Slightly beneficial – Longer duration of high summer pool level and higher winter pool level would slightly increase aquatic habitat.
Tailwater Habitat	Slightly adverse – Low DO concentrations would increase.
Preferred	No change to slightly beneficial – Longer duration of high summer pool level would slightly increase potential for establishment of aquatic vegetation, which would increase aquatic habitat, as would increased winter pool levels.
Sport Fish – Mainstem Reservoirs	
Base Case	No change – Communities would continue to vary based on environmental conditions.
Reservoir Recreation A	No change to slightly adverse – Slight increase in volume of water with low DO during summer could adversely affect cool-water fish species; conditions for warm-water fish species would not change.
Reservoir Recreation B	No change to slightly adverse – Slight increase in volume of water with low DO in Guntersville would decrease cool-water fish habitat availability; no change in Pickwick, and slight decrease in Kentucky.
Summer Hydropower	No change to slightly beneficial – Slightly decreased volume of water with low DO would slightly increase suitable habitat.
Equalized Summer/ Winter Flood Risk	Slightly adverse – Slightly increased volume of water with low DO would slightly decrease suitable habitat.
Commercial Navigation	No change to slightly beneficial – Slightly fewer days with DO <1 mg/L.
Tailwater Recreation	No change to slightly adverse – Slight increase in volume of water with low DO in Guntersville would decrease cool-water fish habitat availability; no change in Pickwick, and slight decrease in Kentucky.
Tailwater Habitat	Adverse – Lower DO would result in less available habitat.
Preferred	Slightly adverse – Slightly increased volume of water with low DO would slightly decrease suitable habitat.
Sport Fish – Warm Tailwaters	
Base Case	No change – Communities would continue to vary based on environmental conditions.
Reservoir Recreation A	No change – Communities would continue to vary based on environmental conditions.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Sport Fish – Warm Tailwaters (continued)	
Reservoir Recreation B	No change to slightly beneficial – Decrease in hours of zero discharge from mainstem reservoirs in early spring would slightly enhance spawning conditions for migratory spawners.
Summer Hydropower	Slightly beneficial – Temperatures higher in tributary tailwaters due to less cold water storage in late summer would result in slightly adverse impact on cold-water fish species and slight benefit to warm-water species.
Equalized Summer/ Winter Flood Risk	Slightly adverse to slightly beneficial – Flows and temperatures would vary among reservoirs, benefiting cold-water fish species and resulting in slightly adverse impact on warm-water species.
Commercial Navigation	No change – Communities would continue to vary based on environmental conditions.
Tailwater Recreation	No change to slightly beneficial – Decrease in hours of zero discharge from mainstem reservoirs in early spring would slightly enhance spawning conditions for migratory spawners.
Tailwater Habitat	Slightly adverse to slightly beneficial – Decrease in water temperature would benefit cold-water fish species and result in slightly adverse impact on warm-water species.
Preferred	Slightly adverse to slightly beneficial – Slight decreases in water temperatures and flows below Cherokee Dam would result in slightly adverse impact on warm-water habitat; reduced hours of zero discharge from mainstem reservoirs in early spring would slightly enhance spawning conditions for migratory spawners.
Sport Fish – Cool-to-Warm Tailwaters	
Base Case	No change – Improvements would continue due to Reservoir Release Improvement (RRI) initiatives; warm-water species would continue to be limited.
Reservoir Recreation A	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Reservoir Recreation B	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Summer Hydropower	Slightly beneficial – Temperatures higher in tributary tailwaters due to less cold water storage in late summer would result in slightly adverse impact on cold-water fish species and slight benefit to warm-water species.
Equalized Summer/ Winter Flood Risk	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Commercial Navigation	No change – Improvements would continue due to RRI initiatives; warm-water species would continue to be limited.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Sport Fish – Cool-to-Warm Tailwaters (continued)	
Tailwater Recreation	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Tailwater Habitat	Slightly adverse to slightly beneficial – Decrease in water temperature would benefit cold-water fish species and result in slightly adverse impact on warm-water species.
Preferred	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Sport Fish – Cool/Cold Tailwaters	
Base Case	No change – Improvements would continue due to RRI initiatives.
Reservoir Recreation A	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Reservoir Recreation B	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Summer Hydropower	Adverse – Increased hours with temperatures greater than 20 °C would be undesirable for trout.
Equalized Summer/ Winter Flood Risk	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Commercial Navigation	No change – Improvements would continue due to RRI initiatives.
Tailwater Recreation	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Tailwater Habitat	Adverse – Increased hours with temperatures greater than 20 °C would be undesirable for trout.
Preferred	Slightly beneficial – Decrease in number of hours with water temperatures greater than 20 °C would be slightly beneficial for trout.
Commercial Fisheries – Reservoirs	
Base Case	No change – Communities would continue to vary based on environmental conditions.
Reservoir Recreation A	Adverse – Volume of water with poor water quality would increase due to delayed summer drawdown.
Reservoir Recreation B	Adverse – Volume of water with poor water quality would increase due to delayed summer drawdown.
Summer Hydropower	Beneficial – Increase of flow through mainstem reservoirs would increase the water quality.
Equalized Summer/ Winter Flood Risk	Slightly adverse to adverse – Yearly volumes of water with poor DO conditions would increase.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Commercial Fish – Reservoirs (continued)	
Commercial Navigation	No change – Communities would continue to vary based on environmental conditions.
Tailwater Recreation	Adverse – Volume of water with poor water quality would increase due to delayed summer drawdown.
Tailwater Habitat	Adverse – Volume of water with low DO would increase in mainstem reservoirs.
Preferred	Slightly adverse to slightly beneficial – Number of days with DO <1 mg/L would decrease in Guntersville, increase in Pickwick, and not change in Kentucky and Douglas Reservoirs.

[1] Cold-water tailwaters are not included because resident communities are minimal due to the cold-water releases, and no alternative would change this general condition.

[2] Slight increase in volume of water with low DO during summer/fall would result in slightly adverse conditions for reservoir cold-water and cool-water species.

For sport fish concerns, there was no expected change or slight improvement in tributary reservoirs under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Preferred Alternative. Under the Summer Hydropower Alternative, results for tributary reservoirs would be more variable, depending on species, and slightly adverse under the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative. Mainstem reservoirs would experience slightly adverse impacts on sport fish under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Preferred Alternative. Slightly beneficial results are anticipated under the Summer Hydropower Alternative and the Commercial Navigation Alternative, and adverse impacts are projected under the Tailwater Habitat Alternative. Overall, response of sport fish in tributary and mainstem reservoirs differs, and results depend more on water temperature preference in tributary reservoirs and DO requirements in mainstem reservoirs. Variable results were achieved when metrics indicated change, but changes were not consistent across all reservoir waterbodies assessed.

Metrics for warm-water tailwaters indicated that no change in status is anticipated under Reservoir Recreation Alternative A and the Commercial Navigation Alternative. No change to slightly beneficial results may occur under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, with variable results under the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative. The Summer Hydropower Alternative would adversely affect warm-water sport fish. Cool/cold tailwaters would experience no change or slight benefits under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Preferred Alternative from decreasing water temperatures in cool-water waterbodies during late summer. Impacts under the Tailwater Habitat Alternative would be variable, as metric responses were mixed across waterbodies. Under the Summer Hydropower and Tailwater Habitat Alternatives, impacts on cold-water tailwaters would be adverse, and slightly adverse under the Equalized Summer/Winter Flood Risk Alternative. In cool-to-warm tailwaters, the Commercial Navigation Alternative is projected to result in no change in sport fisheries, while Reservoir Recreation Alternative B, the Summer Hydropower Alternative, and the Tailwater Recreation Alternative would result in no change to a slightly beneficial change in status. Reservoir Recreation Alternative A, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would cause variable results as cold-water species (trout) slightly benefit from cooler water temperatures in the late summer that would cause slightly adverse conditions for warm-water species.

Commercial fisheries would experience no change under the Commercial Navigation Alternative. Adverse or slightly adverse conditions may be achieved under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative from water quality changes in mainstem reservoirs, particularly Kentucky Reservoir. Under the Summer Hydropower Alternative, commercial fisheries would benefit from increased mainstem flow and improved summer water quality. Under the Preferred Alternative, conditions for commercial mussels are not projected to change, while those for commercial fish are projected to vary. Some areas are projected to experience slight improvements to water quality (DO concentrations), and others slight declines.

In conclusion, no policy alternative represents a clear benefit to aquatic resources. Metrics indicated that the Commercial Navigation Alternative would cause little change from the Base Case, with possibly some benefits. Biodiversity would generally not benefit under any alternative. Sport fish would experience the most potential benefits under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative. The Preferred Alternative projects some benefits to tributary reservoir and cool/cold tailwater sport fish. Variable results are anticipated for mainstem reservoir biodiversity, warm and cool-to-warm tailwaters, and commercial fishing. Commercial fisheries would generally experience adverse impacts under most alternatives due to decreased water quality (DO concentrations) and spring flows in mainstem reservoirs. Generally, impacts on commercial fisheries would be concentrated on mussels, as commercial fish species are mobile while mussels cannot behaviorally escape decreasing water quality conditions. Under the Preferred Alternative, no change is projected for commercial mussels. Commercial fish species in some areas would slightly benefit; in other areas, habitat conditions (DO concentrations) would decline slightly.

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