5.13 Threatened and Endangered Species

5.13.1 Introduction

The information about endangered, threatened, and other types of protected species presented in Section 4.13 and Appendix D6a indicates that 526 protected species are known from within the 1-mile buffers around the reservoir and stream waterbodies covered by the scope of the ROS evaluation. Of that total, 172 species are known from within the 200-foot buffers around the waterbodies. The remainder of the discussion presented in Section 4.13 provides two general conclusions about the occurrence of protected species as they relate to the evaluation of the policy alternatives. Most protected species known from within or immediately adjacent to the waterbodies where ROS activities could occur typically exist in aquatic habitats along the least-modified stream reaches (warm tributary tailwaters, flowing mainstem reaches, some pooled mainstem reaches, and cool-to-warm tributary tailwaters). Relatively few protected species exist in or adjacent to any tributary reservoir, in any cool/cold tributary tailwaters, or in the drier terrestrial habitats that exist within 200 feet of any waterbody. These observations indicate that warm tributary tailwaters, flowing mainstem reaches, some pooled mainstem reaches, and cool-to-warm tributary tailwaters are the waterbody categories where most of the direct effects of the policy alternatives on protected species could occur. The information presented in Section 4.13 also suggests that at least a few of the 526 protected species known from the ROS waterbody areas can occur in just about any habitat present within 1 mile around almost any reservoir or tailwater included in this evaluation. This observation indicates that the evaluation of indirect and cumulative effects associated with the policy alternatives should consider all of the protected species known from the 1-mile buffers around the potentially affected waterbodies. These conclusions form the basis for the evaluation of threatened and endangered species described in this section.

The information presented in the following discussion is a general summary of the evaluation that has been conducted with regard to threatened and endangered species. Details of the evaluation concerning protected species living in flowing-water habitats are presented in Appendix D6b. Results of the species-specific evaluation concerning federal-protected animals and plants are presented in the USFWS Biological Opinion (Appendix G).

5.13.2 Impact Assessment Methods

Direct Effects

The information presented in Section 4.13 indicates that 172 protected species are known from within the 200-foot buffers around the ROS waterbodies—the area where any direct effects of the policy alternatives would be most likely to occur. Information about the typical habitats and known occurrences of these species was used to associate them into clusters that would be affected in similar ways by various operational changes. The seven evaluation clusters are identified in Table 5.13-01, along with the numbers of species in each major taxonomic group that were assigned to them. The species included in each cluster are identified in the following

paragraphs. In addition, the "Direct Effects Analysis" column in Appendix D6a presents the evaluation cluster in which each species is addressed.

Excluded Areas

Information presented in Section 3.4.1 indicates that none of the alternatives would include changes in the operations policy at Normandy Dam in the Duck River watershed or at any of the four dams in the Bear Creek watershed (Bear Creek, Upper Bear Creek, Little Bear Creek, and Cedar Creek Dams). Therefore, the following evaluation excludes any discussion about the 23 protected species that occur only within the 200-foot buffers around the 13 waterbodies in the Duck River and Bear Creek watersheds. Each of these excluded species is identified in the "Direct Effects Analysis" column in Appendix D6a. Any potential for the various alternatives to affect these species is discussed below under Indirect Effects.

Flowing-Water Habitats

The largest cluster of protected species identified in Table 5.13-01 consists of 58 species that typically occur in flowing-water habitats, including at least some parts of the impounded mainstem Tennessee and Cumberland Rivers. Nearly all of these species are mollusks and fish; however, the flowing-water habitats cluster also includes two turtles and a large, completely aquatic, salamander (the hellbender). All of these species are typically found in habitats out in the river or stream, where the water is obviously moving.

Holding water in reservoirs can modify habitat conditions important to flowing-water species because temperature and DO concentrations stratify in reservoirs during late spring, summer, and early fall, and those changes affect the water released from the dams. As described in Section 3.3, the various types of changes that could be made in the reservoir operations policy focus on when reservoir elevations would be raised or lowered, and when and how much water would be released from the dams. TVA aquatic biologists used these basic concepts to help identify specific evaluation measures (metrics) that would indicate any differences in direct effects between the Base Case and each policy alternative. The metrics were designed to focus on specific locations and specific times of the year that are important to the reproduction and survival of species living in flowing-water habitats. Metrics were developed for each of the four waterbody categories in which direct effects of the alternatives could affect protected species populations (warm tributary tailwaters, flowing mainstem reaches, pooled mainstem reaches, and cool-to-warm tributary tailwaters). These metrics are listed in Table 5.13-02. Details about why each metric is pertinent to specific waterbody types and the results of the comparisons between various alternatives and the Base Case are presented in Appendix D6b.

Table 5.13-01 Number of Protected Species Included in Each Part of the Direct Effects Evaluation

Direct Effects Analysis Category	Numbers of Species within Major Taxonomic Groups								Category Totals
	Plants	Mollusks	Arthropods	Fish	Amphibians	Reptiles	Birds	Mammals	
Excluded areas	8	5	0	11	0	0	0	0	23
Flowing-water habitats	0	44	0	11	1	2	0	0	58
Shoreline and lowland habitats	29	0	0	2	1	1	4	0	37
Upland habitats	30	0	0	0	0	0	1	0	31
Apalachia Bypass reach	4	3	0	1	0	0	0	0	8
Wide-ranging species	0	0	0	0	0	0	3	4	7
Reservoir inflow areas	1	1	0	2	0	0	0	0	4
Cave aquifers	0	0	1	2	0	0	0	0	3
Group totals	**72**	**53**	**1**	**29**	**2**	**3**	**8**	**4**	**172**

Note: The part of this evaluation in which each individual protected species is addressed is indicated in the "Direct Effects Evaluation" column in Appendix D6a.

Table 5.13-02 Flowing-Water Habitat Evaluation Metrics

Metric No.[1]	Waterbody Category and Metric Description
Pooled Mainstem Waterbodies	
1	The total volume of water in a reservoir with dissolved oxygen (DO) < 2 mg/L during the year
Flowing Mainstem Waterbodies	
2	The amount of time when the water downstream from a dam would contain DO < 2 mg/L during the summer period (July through October)
3	The minimum water level that would be achieved 90 percent of the time during the year at a given point downstream from a dam
Warm Tributary Tailwaters (4–9) and Cool-to-Warm Tributary Tailwaters (10–15)	
4 & 10	The minimum water level achieved 90 percent of the time during the year at the selected sites
5 & 11	The difference between the 90- and 10-percent instantaneous flow rates at the selected sites during the second and third weeks in June
6 & 12	The average water temperature at the selected sites during the second and third weeks in June
7 & 13	The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the second and third weeks in June
8 & 14	The average water temperature at the selected sites during the third and fourth weeks in August
9 & 15	The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the third and fourth weeks in August

[1] These metrics are specific evaluation measures developed by TVA aquatic biologists to compare the effects of the policy alternatives at specific locations and during specific times of the year that are important to the reproduction and survival of species living in flowing-water habitats.

Results of the three metric comparisons concerning the effects of the policy alternatives on protected species living in mainstem reservoirs and tailwaters (pooled mainstem reaches and flowing mainstem reaches, respectively) are summarized in Table 5.13-03. Most of the policy alternatives would produce substantially higher minimum water elevations (substantially more potential habitat for protected aquatic species) downstream from the mainstem dams (Metric # 3). The exceptions to this pattern are the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative, both of which would typically produce minimum water elevations similar to those produced under the Base Case. Few of the policy alternatives would produce any differences in the number of hours with DO < 2 mg/L released from the mainstem dams (Metric # 2). The major exception to this pattern was the expectation of more hours of low DO discharges (substantially adverse habitat conditions) downstream from Watts Bar Dam under the Preferred Alternative; however, TVA has committed to providing a minimum of 4 mg/L DO in the discharge from this dam.

Table 5.13-03 Summary of Direct Effects on Threatened and Endangered Species for Mainstem Reservoirs and Tailwaters

Metric No.	Affected Waterbody	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
1	Kentucky	N	N		N	N	N	SA	N
1	Guntersville	N	N		N	N	N	N	N
1	Chickamauga	N	N		N	N	N	SA	N
Mainstem Tailwaters									
2	Pickwick discharge	N	SA		N	N	N	N	N
2	Wilson discharge	N	N		N	N	N	SA	N
2	Guntersville discharge	SA	N		N	N	N	N	N
2	Watts Bar discharge	N	N		N	N	N	N	SSA
3	Pickwick—RM 190	SB	SSB		N	SSB	SSB	SSB	N
3	Wilson—RM 256	SSB	SSB		N	SSB	SSB	SSB	N
3	Guntersville—RM 349	SB	SB		N	N	SB	SB	N
3	Watts Bar—RM 530	SSB	SSB		SA	SB	SSB	SSB	N

Notes:

RM = River mile.

Evaluation abbreviations:

A = Adverse changes with regard to protected aquatic species.
B = Beneficial changes with regard to protected aquatic species.
N = Not statistically different from the Base Case.
S = Slightly (80 – 95 percent confidence level).
SS = Substantially (95 percent confidence level or higher).

[1] No statistical analysis data are available for this alternative.

Other exceptions were more hours of low DO discharges (slightly adverse conditions) downstream from Guntersville Dam under Reservoir Recreation Alternative A, downstream from Pickwick Dam under Reservoir Recreation Alternative B, and downstream from Wilson Dam under the Tailwater Habitat Alternative. Only the Tailwater Habitat Alternative would result in more water volume with DO < 2 mg/L in at least some of the downstream reservoirs (Metric # 1); that alternative yielded indications of more water with low DO (slightly adverse habitat conditions) in Kentucky and Chickamauga Reservoirs.

Overall, only the Tailwater Habitat Alternative would result in decreased DO concentrations in mainstem reservoirs (slightly adverse habitat conditions) in comparison to what would occur under the Base Case, and only the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative would result in minimum water levels as low as what would occur under the Base Case. All of the other alternatives would yield higher minimum water levels (providing slightly or substantially more habitat for protected aquatic species). The Preferred Alternative could result in more hours of low DO water downstream from Watts Bar Dam (substantially adverse habitat conditions); however, TVA would ensure that the discharge from Watts Bar Dam continued to meet its existing 4 mg/L DO target.

Table 5.13-04 summarizes the results of the 12 metric comparisons concerning the effects of the policy alternatives on protected species living in warm and cool-to-warm tributary tailwaters. With regard to the minimum water level metrics (Metrics # 4 and # 10), only the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would produce effects different from what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would result in higher minimum water levels (slightly more minimum wetted area) at the (warm) French Broad River site. The Tailwater Habitat Alternative would result in higher minimum water levels at the site on the French Broad River (slightly beneficial habitat conditions) and at both sites on the Holston River (substantially beneficial conditions).

With regard to the mid-June flow range metrics (Metrics # 5 and # 11), only the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would produce effects different from what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would produce less variation in mid-June flow ranges at both sites on the Holston River (substantially beneficial habitat conditions for protected species) and at the cool-to-warm site on the Elk River (slightly beneficial conditions for protected species). The Tailwater Habitat Alternative would produce less variation in flow ranges (substantially beneficial conditions) at the sites on the Holston, French Broad, and Hiwassee Rivers but would not result in flow ranges any different from those under the Base Case at either site on the Elk River.

The four average temperature metrics (Metrics # 6 and # 12 concerning mid-June and Metrics # 8 and # 14 concerning late August) tend to follow consistent patterns—at least on the individual rivers. All of the policy alternatives would produce higher (substantially beneficial) average temperatures than under the Base Case at the Hiwassee River site during both time periods. All of the policy alternatives except the Commercial Navigation Alternative would produce lower (substantially adverse) average temperatures than under the Base Case at both Holston River sites in late August (Metric # 14). The Equalized Summer/Winter Flood Risk Alternative would produce higher (substantially beneficial conditions) average temperatures at the cool-to-warm site on the Elk River during both time periods, higher (slightly beneficial) average temperatures at the warm site on the Elk River in mid-June, and higher (substantially beneficial) average temperatures at both Holston River sites in mid-June.

Table 5.13-04 Summary of Direct Effects Metrics Related to Protected Species for Warm and Cool-to-Warm Tributary Tailwaters

Metric	Location	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Warm Tributary Tailwaters									
4	Holston RM 30	N	N		N	N	N	SSB	N
4	Fr. Broad RM 18	N	N		SB	N	N	SB	N
4	Elk RM 73	N	N		N	N	N	N	N
5	Holston RM 30	N	N		SSB	N	N	SSB	N
5	Fr. Broad RM 18	N	N		N	N	N	SSB	N
5	Elk RM 73	N	N		N	N	N	N	N
6	Holston RM 30	N	N		SSB	SB	N	N	N
6	Fr. Broad RM 18	N	N		SSB	N	N	N	N
6	Elk RM 73	N	N		SB	N	N	N	N
7	Holston RM 30	N	N		N	N	N	SB	N
7	Fr. Broad RM 18	N	N		SSA	N	N	N	N
7	Elk RM 73	N	N		N	N	N	N	N
Cool-to-Warm Tributary Tailwaters									
10	Holston RM 48	N	N		N	N	N	SSB	N
10	Hiwassee RM 48	N	N		N	N	N	N	N
10	Elk RM 125	N	N		N	N	N	N	N
11	Holston RM 48	N	N		SSB	N	N	SSB	N
11	Hiwassee RM 48	N	N		N	N	N	SSB	N
11	Elk RM 125	N	N		SB	N	N	N	N
12	Holston RM 48	N	N		SSB	N	N	N	N
12	Hiwassee RM 48	SSB	SSB		SSB	SSB	SSB	SSB	SSB
12	Elk RM 125	N	N		SSB	N	N	N	N
13	Holston RM 48	N	N		SSA	N	N	N	N
13	Hiwassee RM 48	N	N		N	N	N	SB	N
13	Elk RM 125	N	N		SSB	N	N	N	N

Table 5.13-04 Summary of Direct Effects Metrics Related to Protected Species for Warm and Cool-to-Warm Tributary Tailwaters (continued)

Metric	Location	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Warm Tributary Tailwaters (continued)									
8	Holston RM 30	SSA	SSA		SSA	N	SSA	SSA	SSA
8	Fr. Broad RM 18	N	N		SSB	N	N	N	N
8	Elk RM 73	N	N		N	N	N	N	N
9	Holston RM 30	N	N		N	N	N	SSB	N
9	Fr. Broad RM 18	N	N		SB	N	N	N	N
9	Elk RM 73	N	N		N	N	N	N	N
Cool-to-Warm Tributary Tailwaters (continued)									
14	Holston RM 48	SSA	SSA		SSA	N	SSA	SSA	SSA
14	Hiwassee RM 48	SSB	SSB		SSB	SSB	SSB	SSB	SSB
14	Elk RM 125	N	SB		SB	N	SB	N	N
15	Holston RM 48	SB	SSB		SB	N	SSB	SSB	N
15	Hiwassee RM 48	N	N		N	N	N	N	N
15	Elk RM 125	N	SSB		SSB	N	SSB	N	N

Notes:

Fr = French.
RM = River mile.

Evaluation abbreviations:

A = Adverse changes with regard to protected aquatic species.
B = Beneficial changes with regard to protected aquatic species.
N = Not statistically different from the Base Case.
S = Slightly (80 – 95 percent confidence level).
SS = Substantially (95 percent confidence level or higher).

[1] No statistical analysis data are available for this alternative.

Concerning the four temperature range metrics, the policy alternatives would produce very few differences from the ranges under the Base Case at the warm tailwater sites during either mid-June (Metric # 7) or late August (Metric # 9). Two of the exceptions to this pattern would occur under the Tailwater Habitat Alternative, which would produce less temperature variation at the warm reach site on the Holston River during both mid-June (slightly beneficial habitat conditions) and in late August (substantially beneficial conditions). The other exceptions would occur at the French Broad River site under the Equalized Summer/Winter Flood Risk Alternative, which would produce more temperature variation (substantially adverse conditions) in mid-June and less variation (slightly beneficial conditions) in late August than would occur under the Base Case.

In the cool-to-warm tailwater reaches, the effects of the alternatives on the temperature range metrics would differ, depending on which month was being examined. During mid-June (Metric # 13), the Tailwater Habitat Alternative would produce less variation (slightly beneficial conditions) at the Hiwassee River site. Also during mid-June, the Equalized Summer/Winter Flood Risk Alternative would produce more temperature variation (substantially adverse habitat conditions) at the Holston River site and less temperature variation (substantially beneficial conditions) at the Elk River site. During late August (Metric # 15), none of the alternatives would produce temperature variations different from the Base Case at the Hiwassee River site. At the Elk River site, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative would produce less temperature variation (substantially beneficial conditions) during this period. At the Holston River site, five of the alternatives would produce less temperature variation during late August (slightly beneficial habitat conditions under Reservoir Recreation Alternative A and the Equalized Summer/Winter Flood Risk Alternative; substantially beneficial conditions under Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Preferred Alternative).

The Summer Hydropower Alternative is not included in the metric evaluation of the flowing-water habitats because the Water Quality model could not provide output data for low-flow years (such as 1987 to 1989) when that alternative would result in discharging virtually all of the water in several tributary reservoirs. The general impressions about the effects of the Summer Hydropower Alternative on protected aquatic species that can be derived from its description (see Section 3.3.4) suggest that summer flow and, probably, water temperatures in the tributary tailwaters would be more variable than under the Base Case (less natural conditions for protected aquatic species). In mainstem reservoirs and tailwaters during the summer months, the Summer Hydropower Alternative probably would provide higher flows and, possibly, higher DO concentrations (more natural conditions for protected aquatic species) than would occur under the Base Case.

Shoreline and Lowland Habitats

The shoreline and lowland habitats that exist along the margins of the reservoirs and regulated stream reaches included in the ROS study area are inhabited by many types of animals and plants, some of that are protected at the federal or state level. The cluster of species covered by this part of the protected species evaluation includes a total of 39 species: 30 plants, five

birds, two fish, an amphibian, and a reptile. Each of these species is identified in the "Direct Effects Analysis" column in Appendix D6a. Some of these species spend their entire lives submersed in springs, ponds, or other bodies of water (such as largeleaf pondweed and spring pygmy sunfish) but most of the others live in and around wetland habitats at the edges of the waterbodies. Changes in summer and winter pool levels, and when the reservoirs would be filled and drawn down under the various policy alternatives, could substantially affect the protected species living in these shoreline and lowland habitats. The general aspects of those effects are discussed in Section 5.8 (Wetlands) and Section 5.10 (Terrestrial Ecology). The following paragraphs focus on the ways various policy alternatives could affect the protected species living in these habitats.

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would involve holding reservoir pool levels higher until, or later than, Labor Day. Under these alternatives, large areas on the mainstem reservoirs now occupied by scrub/shrub or bottomland hardwood communities would become aquatic beds; however, the Preferred Alternative would not involve any pool level changes or impacts on shoreline habitats on Kentucky Reservoir. Protected plants and animals now living in scrub/shrub or bottomland hardwood communities (such as lamance iris and green treefrog) would be adversely affected by the loss of suitable habitat. Other protected species (such as the great egret and wood stork) might benefit from the additional foraging habitat; however, they also might lose present roosting and potential nesting sites. Spring and seep habitats harboring protected aquatic species adjacent to the full-pool reservoirs would not be adversely affected and might increase in size as the scrub/shrub habitats declined. Overall, these alternatives would adversely affect protected species living in shoreline and lowland habitats, primarily because of the unreplaced loss of the scrub/shrub habitats.

Under the Summer Hydropower Alternative, reservoir pool levels would be held at high levels for much shorter time periods during the year than would occur under the Base Case. Under the Summer Hydropower Alternative, large areas of mainstem and tributary reservoirs now occupied by various types of wetland habitats would lose water more quickly during the growing season, and upland species would encroach on those habitats. Protected species that require wetland habitat conditions (such as sweetflag) would be adversely affected. This alternative also would result in adverse impacts on protected species living in shoreline and lowland habitats, again because of habitat loss.

The changes in reservoir pool levels that would occur under the Equalized Summer/Winter Flood Risk Alternative would result in continual changes in reservoir pool elevations. These pool level changes would occur throughout the growing season and would essentially prevent the establishment of stable wetland communities (see Section 5.8, Wetlands). As with the previous two sets of alternatives, protected species that require relatively stable wetland habitat conditions would be adversely affected by the Equalized Summer/Winter Flood Risk Alternative, although, once again, different operations policy would be responsible.

The Commercial Navigation Alternative would involve only minor modifications in pool levels during summer. During winter, the higher mainstem pool levels would serve to stabilize some wetland habitats, perhaps as slightly different communities than presently exist. Higher winter mainstem pool levels also could result in less foraging habitat for protected shorebirds such as the piping plover. Overall, this alternative probably would result in slightly beneficial impacts on protected shoreline and lowland species when compared to the Base Case.

Upland Habitats

The upland habitats cluster of protected species includes 30 plants (identified in the "Direct Effects Analysis" column in Appendix D6a) and one bird (Swainson's warbler). All of these species have been encountered within the 200-foot buffers around one or more ROS waterbodies; however, they typically occur in drier upland habitats that are not influenced by manipulation of the reservoirs or tailwaters. As indicated for all upland plant and animal communities (see Section 5.10, Terrestrial Ecology), these protected species would not be affected (directly or indirectly) by any of the policy alternatives. None of the alternatives would include raising summer pool levels any higher than under the Base Case; none of the alternatives would involve changes in the loss of land by wave action, erosion, or mass wasting (see Section 5.16, Shoreline Erosion); and none of the alternatives would result in changes in the locations or rates of conversion of open land to residential or commercial developments (see Section 5.15, Land Use).

Apalachia Bypass Reach

The eight protected species included in the Apalachia Bypass Reach cluster consist of four plants, two freshwater mussels, an aquatic snail, and a fish. These species are being evaluated together mostly because one of the habitats in which they all occur would be affected by a flow modification that is proposed as part of each of the policy alternatives.

During all times of the year, except when spilling is required from Apalachia Dam, nearly all of the flow at this dam is diverted through a tunnel to the powerhouse. The river channel in this bypassed stream reach receives leakage flow from the dam and unregulated inflow from several small tributary streams. Terrestrial vegetation along the bypass reach includes some species adapted to life in and along the river channel, along with trees and other woody vegetation that can survive infrequent but substantial flooding and scouring. These eight protected species include two plants (Ruth's golden aster and gibbous panic-grass) that are only found in rock crevices along scoured streambeds; two aquatic or semi-aquatic plants (creekgrass and a pondweed) that occur in the water; and three mollusks and a fish (knotty elimia snail, Cumberland bean, tan riffleshell mussels, and tangerine darter) that occur on, in, or not far from the stream bottom.

TVA may augment minimum flow in the 13-mile reach of the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse to enhance the diversity of aquatic species in that waterbody. The present concept is to release a continuous flow of approximately 25 cfs from Apalachia Dam into the bypass reach between June 1 and November 1. The additional flow

would be intended to increase the wetted area down the length of the bypass channel and provide additional flow and habitat stability for native aquatic species. This modification in the flow pattern downstream from Apalachia Dam is included in each of the policy alternatives (see Section 3.4.1).

The additional minimum flow would increase the amount of, and improve the quality of, the habitats for the protected mollusks and fish, and, potentially, for other protected aquatic species that exist or could be introduced into this part of the Hiwassee River. With regard to the plants, however, the infrequent but substantial spilling events control whether these protected species can continue to survive along this river channel. Previous observations have suggested that submersal for more than 10 consecutive days during the growing season (March through September) probably would have adverse effects on at least some of these plant species. Analysis of the actual flow data; however, indicates that spills exceeding 10 days duration have occurred routinely during the 60-year period since Apalachia Dam was built. Adoption of the proposed additional flow down this bypass channel would not result in more days of spilling or longer duration spills than would occur under the Base Case. These results indicate that the proposed change would not likely result in adverse effects on the protected plants or animals in this area.

Wide-Ranging Species

This cluster of six species includes two birds (peregrine falcon and bald eagle) and four mammals (eastern big-eared bat, gray bat, eastern small-footed bat, and Indiana bat). All six of these species have specific breeding, feeding, and roosting requirements; however, they all also range over wide areas on a daily or a seasonal basis, typically including some time over or along reservoirs and larger streams. Peregrine falcons and eastern small-footed bats would continue to forage, roost, and reproduce unaffected by the types or extent of changes involved in the policy alternatives.

Bald eagles and gray bats could be benefited by Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative to the extent that each alternative would increase the size of reservoir pools and increase the numbers of food items (mostly fish and waterfowl for the eagles and adult aquatic insects for gray bats). The Summer Hydropower Alternative could have the opposite effect on these species because it would decrease the size of mainstem reservoir pools and might decrease the number of food items for these species. Results of the Aquatic Resources evaluation indicate that Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would likely result in degraded biodiversity but increases in the number of warm-water fishes (see Section 5.7, Aquatic Resources). That evaluation also indicated that the Commercial Navigation Alternative would result in similar effects on aquatic life to what would occur under the Base Case.

In contrast, eastern big-eared bats and Indiana bats could be adversely affected by Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation

Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative to the extent that each alternative would increase the size of reservoir pools and decrease the number of suitable roosting trees in forested wetlands (see Section 5.8 [Wetlands] and Section 5.10 [Terrestrial Ecology]). Under any of these alternatives, both of these species would be able to find other suitable roosting trees in adjacent areas and would be able to adapt to the habitat changes without any long-term adverse effects.

Reservoir Inflow-Related Areas

This evaluation cluster includes only four species; however, these species represent a variety of relationships that may be pertinent across many parts of the river systems. One of these species, Cumberland rosemary, lives on seasonally inundated banks and bars along swift Cumberland Plateau streams—including a site on the Emory River just upstream from the full pool level on Watts Bar Reservoir. The second species, the Appalachian elktoe, is known from unimpounded stream reaches just upstream from Fontana and Calderwood Reservoirs. The third, bluemask darter, occurs in unimpounded stream reaches just upstream from Great Falls Reservoir. And the fourth, sicklefin redhorse (a fish), is known from impounded and unimpounded reaches upstream from Mission and Fontana Reservoirs. In all four of these cases (and, potentially at least, in several others), the flowing-water habitats in which these species occur extend downstream to the limits of or, occasionally, into the impoundments. The present status of these species (and, in effect, the Base Case) includes the fact that the impoundments were built and the habitats within those reservoirs may not be suitable for the protected species. Each of the policy alternatives calls for the reservoirs to be filled to present summer pool levels at some point during the year, and none of the policy alternatives includes raising summer pool levels any higher than they would be under the Base Case. Those facts support the conclusion that none of the policy alternatives would result in additional impacts on protected aquatic species living upstream from the affected reservoirs. The same facts also support the conclusion that none of the policy alternatives would likely provide any long-term benefits to upstream populations of protected aquatic species because any flowing-water habitat restored by lowering a reservoir pool during part of the year would be re-impounded at other times during the year.

Cave Aquifers

Three protected species are known from pools or flowing water in caves within the 200-foot buffer areas around the ROS waterbodies. These three protected aquatic cave species are an un-described cave shrimp, the Alabama cavefish, and the southern cavefish. In each of the locations where these species occur adjacent to ROS waterbodies, the underground aquifer systems exist at a higher elevation than the full pool level of the adjacent reservoir or regulated stream reach and do not appear to fluctuate when the reservoir pool levels are changed. Given that none of the policy alternatives would include raising pool levels higher than the elevations already reached under the Base Case, none of the policy alternatives would directly affect these protected cave aquatic species.

Indirect Effects

As indicated in Section 4.13, Table 4.13-02, and the introduction to this section, at least a few of the 526 protected species know from within the 1-mile buffers around the ROS waterbodies could occur in virtually any habitat present in those corridors. On that basis, the possibility exists that one or more of the policy alternatives could result in secondary or indirect effects on some protected species even though the operational changes at the dams associated with the alternatives would not directly affects those species.

While secondary and indirect effects on protected species might occur under some of the policy alternatives, information presented in other sections of this EIS indicates that no indirect effects on these species would occur. As indicated for all the terrestrial plant and animal communities (see Section 5.10, Terrestrial Ecology), none of the alternatives would include raising summer pool levels any higher than would occur under the Base Case; none of the alternatives would involve more than minor changes in the loss of land by wave action, erosion, or mass wasting (see Section 5.16, Shoreline Erosion); and none of the alternatives would result in changes in the locations or rates of conversion of open land to residential developments (see Section 5.15, Land Use). If none of the alternatives would affect the locations or rates of residential shoreline development, they also would not lead to any indirect effects on waterbodies included in this evaluation or any stream segments further upstream from the tributary reservoirs.

5.13.3 Base Case

Under the Base Case, existing trends would continue with regard to the status of endangered, threatened, and other protected species in the ROS study area. As indicated in Section 4.13, 526 of the species that occur in the TVA region have been provided additional protection by the federal and state governments because their original habitats had been severely degraded by human development of the land and the water. The variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years are likely to continue and perhaps would be expanded. Laws and regulations would continue to provide some level of protection for these species. Future trends for the protected species in the ROS study area are likely to include a few successes, more failures, and many unknowns. The following summaries indicate the likely trends for the seven clusters of protected species discussed in Section 5.13.2 under the Base Case.

Flowing-Water Habitats. As indicated in Section 4.7, Aquatic Resources, the flowing-water habitats in the tributary tailwaters are beginning to show signs of improvement following the addition of minimum flows and DO augmentations identified in the Lake Improvement Plan. Except for the expanding snail darter populations in the tailwaters downstream from Cherokee and Douglas Dams, monitoring data do not yet indicate that protected aquatic species are responding to these improvements. Some protected species are being reintroduced into the tributary and mainstem tailwaters on the assumption that they should survive and reproduce there. Populations of most protected freshwater mussel species living in mainstem waterbodies do not include many young individuals and appear to be declining toward extirpation in those habitats.

Shoreline and Lowland Habitats. Information presented in Section 4.8 (Wetlands) and Section 4.10 (Terrestrial Ecology) indicates that most shoreline and lowland plant and animal communities appear to have adapted to the present operations policy; however, the spread of invasive wetland species and continuing pressure to develop shoreline property are reducing the size and number of these habitats. Unrelated to the TVA reservoir operations policy, the continuation of existing trends along shorelines and other lowland habitats would include the gradual loss of suitable habitat and populations of protected species that occur in those areas.

Upland Habitats. Protected species living in upland areas around the reservoirs and regulated streams are not directly affected by the present operations policy. Given the presence of the reservoirs, the continuation of existing trends would include the gradual loss of natural upland habitats to invasive species and development. More than likely, some protected upland species would benefit from ongoing and future enhancement activities; however, many others would continue to remain unknown to the general public and could be adversely affected by increasing development pressures.

Other Protected Species. Under the Base Case, the other clusters of protected species discussed in Section 5.13.2 also would continue to follow existing trends. Most of the wide-ranging birds and bats would continue to expand in numbers and distribution as ongoing management activities fulfill their goals, while the Indiana bat would continue to decline. Protected species living in caves or free-flowing stream reaches upstream from impoundments would not be affected by the reservoir operations policy but could be affected by localized pollution events or development pressures.

5.13.4 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and Tailwater Recreation Alternative

Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative, summer pool levels would be extended on most tributary reservoirs to Labor Day but would vary from each other in the amounts and the timing of releases from the dams. Concerning protected species, the variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years are likely to continue and perhaps would be expanded. Laws and regulations would continue to provide some level of protection for these species, and future trends for the protected species in the ROS study area would likely be similar to the patterns described for the Base Case. The following summaries indicate how impacts on habitat clusters of protected species under these alternatives would differ from those described in the Base Case.

Flowing-Water Habitats. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative would result in relatively few changes in the habitats of protected aquatic species in the regulated river system. In tributary tailwaters, Reservoir Recreation Alternative A and the Tailwater Recreation Alternative would result in more natural summer water temperatures in some cool-to-warm waterbodies than the Base Case, while all three of these alternatives would result in less natural water temperatures in others. In the Tennessee River mainstem, all three alternatives would result in higher minimum water levels in

tailwaters, which could provide some additional habitat for protected aquatic species. Reservoir Recreation Alternative A also might result in less DO than the Base Case in the releases from some mainstem dams.

Shoreline and Lowland Habitats. The longer duration of summer pool levels on tributary reservoirs that would occur under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative would result in losses of scrub/shrub habitats along the margins of those waterbodies. Protected species that depend on scrub/shrub habitats would be adversely affected by these changes.

Upland Habitats. Like the Base Case, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative would not affect protected species living in upland habitats.

Other Protected Species. Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative, the longer duration of summer pool levels could benefit populations of bald eagles and gray bats foraging over the affected reservoirs. Under these alternatives, impacts on other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse would not differ from what would occur under the Base Case.

5.13.5 Equalized Summer/Winter Flood Risk Alternative and Tailwater Habitat Alternative

Although the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative have different purposes, both would involve operating the dams based on the amount of runoff coming into the river system. Under these alternatives, reservoir pool levels and flows in the tailwaters would vary in response to how much water was flowing down the rivers. Laws and regulations would continue to provide some level of protection for protected species in the ROS study area, and future trends for those species would likely be somewhat similar to the patterns described for the Base Case. The variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years also would be likely to continue and perhaps would be expanded within the context of either of these alternatives.

Flowing-Water Habitats. Both the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would tend to provide more natural flow and temperature regimes in mainstem tailwaters than the Base Case; however, the Tailwater Habitat Alternative also could provide more stressful DO conditions in mainstem waterbodies. In the tributary tailwaters, these alternatives would lead to more natural summer flow and water temperature conditions.

Shoreline and Lowland Habitats. The Equalized Summer/Winter Flood Risk Alternative would lead to adverse changes in the habitats of shoreline and wetland protected species because reservoir pool levels would be continually changing throughout the year. The Tailwater Habitat Alternative would lead to adverse changes in the habitats of some shoreline and wetland

protected species because tributary reservoir pool levels would remain higher during parts of the year than they would under the Base Case.

Upland Habitats. The Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would not affect protected species living in upland habitats.

Other Protected Species. Under the Tailwater Habitat Alternative, the longer duration of summer pool levels on tributary reservoirs could benefit populations of bald eagles and gray bats foraging over those areas. Impacts under the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would not differ from those described under the Base Case for other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse.

5.13.6 Commercial Navigation Alternative

The operational changes included in the Commercial Navigation Alternative would focus on improving the reliability of the mainstem Tennessee River for commercial navigation. Impacts on protected species related to the changes in winter pool levels and minimum flows downstream from the mainstem dams associated with this alternative would be similar to those described for the Base Case. The variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years would likely continue and perhaps would be expanded under this alternative. Laws and regulations would continue to provide some level of protection for these species, and the future trends for the protected species in the ROS study area would remain unchanged from what would occur under the Base Case.

Flowing-Water Habitats. Impacts on the habitats of protected aquatic species under the Commercial Navigation Alternative would be similar to those described for the Base Case. In tributary tailwaters, the only differences in impacts from those described for the Base Case would be a few more examples of more natural average summer water temperatures. In mainstem habitats, the only differences would be increases in minimum water elevations. None of the flowing-water metrics indicated more adverse impacts than would occur under the Base Case.

Shoreline and Lowland Habitats. The higher winter pool levels and only minor modifications in summer pool levels on mainstem reservoirs that would occur under the Commercial Navigation Alternative would slightly benefit protected species living in shoreline and wetland habitats.

Upland Habitats. The Commercial Navigation Alternative would not affect protected species living in upland habitats.

Other Protected Species. The relative stability in mainstem pool levels provided by the Commercial Navigation Alternative would result in potential benefits to bald eagles and gray bats. This alternative would not have effects any different from the Base Case on other wide-ranging protected species, protected species occurring upstream from impoundments or living

in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse.

5.13.7 Summer Hydropower Alternative

Operation of the reservoir system under the Summer Hydropower Alternative would focus on maximizing power production at the dams. Daily and seasonal changes in dam operations would result in a variety of differences from the Base Case. Although monitoring activities on the river system would likely continue, some habitat improvement and enhancement activities that have been started in recent years might not be continued because of the decrease in tailwater habitat stability. Laws and regulations would continue to provide some level of protection for endangered and threatened species; future trends for the protected species in the ROS study area would be the same as described for the Base Case.

Flowing-Water Habitats. As indicated in Section 5.13.2, the Summer Hydropower Alternative could not be included in the metric evaluation because no water quality modeling data were available. General impressions about the effects of the Summer Hydropower Alternative on protected aquatic species that can be derived from its description suggest that summer flow and probably water temperatures in the tributary tailwaters would be more variable than would occur under the Base Case (less natural conditions for protected aquatic species). In mainstem reservoirs and tailwaters during summer, the Summer Hydropower Alternative probably would provide higher flows and possibly higher DO concentrations (more natural conditions for protected aquatic species) than the Base Case.

Shoreline and Lowland Habitats. The early lowering of summer reservoir pool levels under the Summer Hydropower Alternative would reduce the amount of wetland habitats and would result in adverse changes for protected species that occur in those areas.

Upland Habitats. The Summer Hydropower Alternative would not affect protected species living in upland habitats.

Other Protected Species. The early lowering of summer reservoir pool levels under the Summer Hydropower Alternative would reduce the size of mainstem reservoir pools, which could lead to decreases in the numbers of prey species for bald eagles and gray bats. Impacts under the Summer Hydropower Alternative would not differ from those described under the Base Case for wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse.

5.13.8 Preferred Alternative

Under the Preferred Alternative, tributary reservoir drawdown would be restricted from June 1 through Labor Day, summer operating zones would be maintained through Labor Day at four additional mainstem projects, and higher winter pool operating ranges would be established at 10 tributary reservoirs. Base Case minimum flows and the DO targets adopted following

completion of the Lake Improvement Plan would continue to be met and, subject to flood control operations or extreme drought conditions, scheduled releases would be provided at five additional tributary projects to increase tailwater recreational opportunities. No changes in operations policy would occur on Kentucky Reservoir under the Preferred Alternative.

Concerning protected species, the variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years are likely to continue and perhaps would be expanded. Laws and regulations would continue to provide some level of protection for these species, and future trends for the protected species in the ROS study area would likely be similar to the patterns described for the Base Case.

Flowing-Water Habitats. The Preferred Alternative would result in relatively few changes in the habitats of protected aquatic species in the regulated river system. In tributary tailwaters, this alternative would result in more natural summer water temperatures in some cool-to-warm waterbodies and less natural water temperatures in others than would occur under the Base Case. In the Tennessee River mainstem, adoption of the Preferred Alternative would not degrade present habitat quality downstream from the dams; however, additional effort would be required to continue to provide a minimum of 4 mg/L DO downstream from Watts Bar Dam.

Shoreline and Lowland Habitats. The longer duration of summer pool levels on tributary and some mainstem reservoirs that would occur under the Preferred Alternative would result in losses of scrub/shrub habitats along the margins of those waterbodies. Protected species that depend on scrub/shrub habitats would be adversely affected by these changes. These effects would not occur on Kentucky Reservoir because no changes in operations policy would occur in that reservoir under the Preferred Alternative.

Upland Habitats. Like the Base Case, the Preferred Alternative would not affect protected species living in upland habitats.

Other Protected Species. Under the Preferred Alternative, the longer duration of summer pool levels could benefit populations of bald eagles and gray bats foraging over the affected reservoirs. Under this alternative, impacts on other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse would not differ from what would occur under the Base Case.

5.13.9 Summary of Impacts

Table 5.13-05 provides a summary of the results of the analysis of impacts on threatened, endangered, and other protected species.

In general, these results indicate that the Commercial Navigation Alternative would not result in any adverse effects on protected species and would provide beneficial effects on summer water temperatures for protected species in comparison to the Base Case. The Preferred Alternative would also provide beneficial effects on summer water temperatures for protected aquatic

species in some tailwaters but would result in adverse summer temperature effects in other tailwaters. Both the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would lead to some adverse effects on scrub/shrub habitats along reservoir shorelines but would also provide beneficial temperature effects for protected species in tributary tailwaters. The Tailwater Recreation Alternative, Reservoir Recreation Alternative A, and Reservoir Recreation Alternative B would result in some adverse effects on scrub/shrub habitats along reservoir shorelines and some adverse summer temperature effects on protected aquatic species in tributary tailwaters. The Summer Hydropower Alternative probably would result in adverse effects on summer water temperature ranges in tailwaters and on scrub/shrub habitats along reservoir shorelines.

Table 5.13-05 Summary of Impacts on Endangered, Threatened, and Other Protected Species by Policy Alternative

Alternative	Evaluation Cluster							
	Flowing-Water Mainstem Reservoirs and Tailwaters	Flowing-Water Tributary Reservoirs and Tailwaters	Shorelines and Lowland Habitats	Uplands Habitats	Apalachia Bypass Reach	Wide-Ranging Species	Reservoir Inflow Areas	Cave Aquifers
Base Case	No change – Continuation of existing trends could lead to eventual loss of some mussel species from these habitats.	No change – Continuation of existing trends would include increasing diversity and reintroductions of protected species in these tailwaters.	No change – Continuation of existing trends would include the gradual loss of habitats and species populations.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.
Reservoir Recreation A	Slightly beneficial – Higher minimum water levels on tailwaters; less DO in releases from some dams.	Variable – Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Reservoir Recreation B	Slightly beneficial – Higher minimum water levels on tailwaters; less DO in releases from some dams.	Variable – Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.

Table 5.13-05 Summary of Impacts on Endangered, Threatened, and Other Protected Species by Policy Alternative (continued)

Alternative	Evaluation Cluster							
	Flowing-Water Mainstem Reservoirs and Tailwaters	Flowing-Water Tributary Reservoirs and Tailwaters	Shorelines and Lowland Habitats	Uplands Habitats	Apalachia Bypass Reach	Wide-Ranging Species	Reservoir Inflow Areas	Cave Aquifers
Summer Hydropower	Beneficial – Probably higher flows and DO concentrations.	Adverse – Probably more variable summer flows and water temperatures.	Adverse – Unreplaced loss of wetland habitats due to shorter duration of summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Adverse – Potential adverse effects to gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Equalized Summer/ Winter Flood Risk	No change – Lower tailwater level at one site.	Beneficial – Less variation in June flow rates and less summer temperature variation in some tailwaters; more natural summer water temperatures in most tailwaters.	Adverse – Unreplaced loss of wetland habitats due to frequent changes in pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.
Commercial Navigation	Beneficial – Higher minimum water levels on most tailwaters.	Slightly beneficial – Very similar to Base Case; more natural summer water temperature in some tailwaters.	Slightly beneficial – Increased stability of slightly modified wetlands.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.

Table 5.13-05 Summary of Impacts on Endangered, Threatened, and Other Protected Species by Policy Alternative (continued)

Alternative	Evaluation Cluster							
	Flowing-Water Mainstem Reservoirs and Tailwaters	Flowing-Water Tributary Reservoirs and Tailwaters	Shorelines and Lowland Habitats	Uplands Habitats	Apalachia Bypass Reach	Wide-Ranging Species	Reservoir Inflow Areas	Cave Aquifers
Tailwater Recreation	Beneficial – Higher minimum water levels on tailwaters.	Variable – Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Tailwater Habitat	Variable – Higher minimum water levels on tailwaters; larger volume of low DO water; longer time of low DO discharges at one dam.	Beneficial – More natural summer water temperatures and late summer temperature ranges in some tailwaters.	Adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Preferred	No change – Longer time of low DO discharges at one dam (would be corrected).	Few changes from Base Case – Less natural water temperatures in some tailwaters; more natural in others.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels; no change from Base Case on Kentucky Reservoir.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.

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