5.9 Aquatic Plants

5.9.1 Introduction

Changes in water elevation or duration have the potential to affect the following factors related to aquatic plants: area of total plant coverage, area of invasive species coverage, and composition of plant communities. However, the effects of environmental factors beyond human control and prediction, such as weather and the hydrologic cycle, are overriding factors in determining increases or decreases in coverage of aquatic plants and invasive aquatic plants. These factors cannot be managed and would transcend most changes in water management or drawdown regime. Thus, while the following discussion of reservoir operations policy alternatives is based on qualitative metrics, these estimates must be viewed in the context of natural event cycles.

The primary qualitative metric used for impact comparison was a change in coverage (in acres), although community composition changes are also discussed. A change in coverage includes either an increase or a decrease in the vegetated acres. Change can be seen as adverse or beneficial, depending on the reader's perspective. For example, increases in plant coverage are generally considered beneficial by bass anglers and fisheries and wildlife managers. These same increases may be viewed as undesirable by shoreline property owners and recreational boaters. Consequently, the impacts discussed below are not described as adverse or beneficial. Due to their dominance, any increase or decrease in aquatic plant coverage discussed below was assumed to be mostly a change in invasive species coverage.

5.9.2 Impact Assessment Methods

The policy alternatives were divided into groups based on similar changes in water elevations and durations. Table 5.9-01 (see Section 5.9.10) lists generalized operational changes in the reservoirs (for example, higher winter pool elevations and more rapid water drawdown), and their potential effects on the aquatic plants in the mainstem and tributary reservoirs. However, a majority of these impacts, particularly those on the mainstem reservoirs, would be overridden by the natural hydrologic and climatic variability in the system. Some of the impacts anticipated on the tributary reservoirs may fall outside the range of natural variability; nevertheless, they still would be relatively small scale.

Both storage and run-of-river reservoirs have been included in the analyses below. Because of operational differences, the potential for impacts on aquatic plants on storage reservoirs would be greater than on run-of-river reservoirs. Impacts occurring on storage reservoirs could result from changes in water elevations and durations. Run-of-river reservoirs would not undergo substantial changes in water elevations or durations. On these reservoirs, therefore, aquatic plant and aquatic invasive plant coverage would continue to increase or decrease based primarily on the natural fluctuation associated with hydrologic and climatic events and hydrogeneration schedules.

All impacts caused by the proposed alternatives and discussed below are ranked "low" in terms of substantially affecting the Tennessee River watershed because all impacts would be overridden by the natural variability in the system or the small scale of any measurable impact.

Substantial increases in algal biomass have the potential to decrease the amount of light available for aquatic plant growth. As discussed in detail in Section 5.4, Water Quality, regression analysis for chlorophyll-a concentrations indicated that the proposed alternatives are not anticipated to substantially alter the algal biomass of either the mainstem or tributary reservoirs. Changes in algal biomass that can be attributed to the proposed alternatives are anticipated to be less than 10 percent, which is within the range of the present natural variation of the system. Chlorophyll-a concentration in samples collected in 2002, a year when flows approximated those of several of the alternatives, indicated higher levels of chlorophyll-a than predicted by the regression analysis for several mainstem reservoirs. Coverage of aquatic macrophytes slightly increased or remained stable in all mainstem reservoirs in 2002 (Table 4.9-02); indicating no clear short-term inverse relationship between chlorophyll-a concentrations and aquatic macrophyte coverage. As discussed in Section 4.9.3, data were not available for trends in coverage of riverine plants of the Tennessee Valley. Although some of the alternatives may substantially change the velocity and duration of water flow, which could lead to scouring of habitat areas, community species shift, or reductions of light due to increased sediment load, these changes could not be measured with available information and were not included in the alternatives analyses below.

Impacts for each of the policy alternatives on overall populations of most emergent, invasive, or nuisance species listed in Table 4.9-01 are expected to be similar to changes in emergent wetlands discussed in Section 5.8, Wetlands. An exception is American lotus, where changes are likely to be more similar to those of submersed and floating-leaved aquatic plants. Historically, many of the emergent, invasive plants (e.g., purple loosestrife, common reed, and reed canary grass) in Table 4.9-01 have not been a widespread nuisance on TVA reservoirs. However, emergent invasive plants could become more abundant in situations where propagule sources (e.g., seeds, rhizomes, and fragments) are readily available and in additional areas of suitable habitat that become available for colonization. Invasive emergent species with existing large, established populations—such as alligatorweed, Uruguayan waterprimrose, water smartweed, and giant cutgrass—would likely have the highest potential for expansion, especially on mainstem reservoirs.

Few changes in invasive and nuisance emergent plant populations are expected for the Commercial Navigation Alternative compared to the Base Case. Several of the alternatives (e.g., Reservoir Recreation Alternative A, the Tailwater Habitat Alternative, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Preferred Alternative; and the Equalized Summer/Winter Flood Risk Alternative on mainstem reservoirs) may allow expansion of emergent wetlands (see Section 5.8) and would maintain and possibly enhance habitat for the expansion of invasives. These same policy alternatives that positively affect emergent communities would adversely affect shrub/scrub and forested wetlands by increasing the duration of surface water and soil saturation. This could provide additional opportunities for expansion of invasive emergents into "open" habitats caused by the decline of these wetland

types. The remaining alternatives (the Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative on tributary reservoirs) that negatively affect emergent wetlands by decreasing the duration of surface water and soil saturation could reduce populations of emergent and nuisance invasive plants. However, some emergent invasive species (e.g., purple loosestrife, common reed, reed canary grass, and alligatorweed) that sometimes colonize drier sites might expand into the upper drawdown zone under the Summer Hydropower Alternative on both mainstem and tributary reservoirs as the water recedes. In the short term, these same species might also colonize the habitat opened by the lower summer pool elevations on tributary reservoirs und the Equalized Summer/Winter Flood Risk Alternative. In the long term, these species would likely be replaced by terrestrial plants that would colonize this zone.

5.9.3 Base Case

The Base Case would continue existing water drawdown regimes. As shown in Figure 4.9-01, plant coverage has widely fluctuated naturally under existing operations. Under the Base Case, therefore, aquatic plant and aquatic invasive plant coverage on all mainstem and tributary reservoirs would continue to increase or decrease based primarily on the natural fluctuation associated with hydrologic and climatic events.

5.9.4 Commercial Navigation Alternative

The Commercial Navigation Alternative is similar to the Base Case but differs by raising winter pool levels where possible on the mainstem storage reservoirs. Aquatic plant and aquatic invasive plant coverage on mainstem and tributary storage reservoirs would continue to increase or decrease based primarily on the natural fluctuation associated with hydrologic and climatic events. Higher winter levels on mainstem storage reservoirs could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into areas of the drawdown zone that are presently colonized primarily by spinyleaf naiad and other annuals.

5.9.5 Reservoir Recreation Alternative A and Tailwater Habitat Alternative

Under Reservoir Recreation Alternative A and the Tailwater Habitat Alternative, summer or near-summer pool elevations would be held for a longer duration and winter pool elevations would be raised where possible. On the tributary storage reservoirs, summer pool levels under the Tailwater Habitat Alternative would be held longer than those under Reservoir Recreation Alternative A. Little change in plant coverage is expected on mainstem storage reservoirs for either alternative. Coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deep-water side of the colonies due to a reduction in light penetration. Aquatic plants in the drawdown zone could slightly increase due to longer summer pools. Higher winter water levels on the mainstem storage reservoirs could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into some areas of the drawdown zone that are presently colonized primarily by spinyleaf naiad and other annuals. Because of longer summer pool levels, aquatic plant coverage could slightly increase in tributary storage reservoirs in flatter areas with suitable substrate, especially if the increase in winter water elevation is

sufficient to dampen the drawdown amplitude to less than 10 feet. Under the Tailwater Habitat Alternative, the potential for slightly larger increases in plant coverage on tributary storage reservoirs could occur because of summer pool levels extending longer into fall. Invasive aquatic plants such as spinyleaf naiad and other annuals could colonize these areas.

5.9.6 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would fill storage reservoirs to summer pool elevations and hold the water at these elevations until Labor Day—later in the year than existing operating guidelines but not as late as under the Tailwater Habitat Alternative. Winter water elevations would be increased, where possible. Little change in plant coverage on mainstem storage reservoirs is anticipated. Coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deep-water side of the colonies due to a reduction in light penetration. Aquatic plants in the draw down zone could slightly increase due to longer summer pools. Higher winter water levels on mainstem storage reservoirs could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into some areas of the drawdown zone that are presently colonized primarily by spinyleaf naiad and other annuals. A slight increase in coverage could occur on tributary storage reservoirs with a large drawdown (over 10 feet). On a few tributary storage reservoirs (for example, the Chatuge and South Holston), where the amplitude of drawdown is reduced to less than 10 feet, slightly larger increases in coverage could occur where suitable substrate exists. Invasive aquatic annuals such as spinyleaf naiad could have the highest potential for establishment.

5.9.7 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, drawdown would begin in June to increase power production. On mainstem storage reservoirs, the potential exists for substantial decreases (estimated at 10 to 40 percent reduction) in total plant coverage (primarily spinyleaf naiad and other annuals) growing in the upper portion of the drawdown zone. Decreases in total coverage would be greater in reservoirs such as Chickamauga with a large drawdown (about 7 feet) and less in reservoirs like Guntersville with a small drawdown (2 feet). A slight expansion of Eurasian watermilfoil and hydrilla into deeper areas could occur because of increased light penetration (due to less water to filter light through). In most tributary storage reservoirs where higher winter water levels would occur, a slight decrease in overall coverage is anticipated because water levels would not be elevated long enough during summer for annual plants to complete their seed cycle.

5.9.8 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative would result in lower summer pool water elevations and higher winter pool elevations on the tributary storage reservoirs, and later-filling, longer summer pool water elevations that are reduced quickly on the mainstem storage reservoirs (similar to Reservoir Recreation Alternative B but with a faster drawdown). This modification may result in a wide variety of effects, depending on how much the water levels vary from the existing regime. A slight decrease in plant coverage on mainstem reservoirs is

anticipated. Coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deepwater side of the colonies due to a reduction in light penetration. Aquatic plants in the drawdown could decrease slightly due to the delayed fill, although extended pool to later in the growing season could offset some of the decrease. Decreases under the Equalized Summer/Winter Flood Risk Alternative likely would be greater than under the remaining alternatives, except for the Summer Hydropower Alternative. Lower summer water elevations on tributary storage reservoirs could slightly decrease existing small populations of plants by dewatering the upper contours. The longer summer pool levels and decreased drawdown could slightly increase submersed and floating-leaved plants in flatter areas with suitable substrate, particularly in some reservoirs (for example, Chatuge) where the drawdown is less than 10 feet.

5.9.9 Preferred Alternative

The Preferred Alternative would result in a delayed fill in Chickamauga and upstream mainstem reservoirs, and extended summer pool elevations on several mainstem reservoirs. Summer pool levels would extend to Labor Day on tributary reservoirs, and winter water levels would be raised where possible. Little change in plant coverage on mainstem reservoirs is anticipated. In reservoirs with extended summer pool elevation, coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deep-water side of the colonies due to a reduction in light penetration. Aquatic plants in the upper portion of drawdown zone could decrease slightly in reservoirs with delayed fill. This decrease could be offset by the extended summer pool levels.

The extended summer pool elevations and decreased drawdown in tributary reservoirs could slightly increase submersed and floating-leaved plants in flatter areas with suitable substrate, particularly in some reservoirs (for example, Chatuge) where the drawdown is reduced to less than 10 feet. Invasive aquatic annuals such as spinyleaf naiad could have the highest potential for establishment.

5.9.10 Summary of Impacts

Table 5.9-01 describes impact analysis considerations related to aquatic and invasive aquatic plants by operating option. Table 5.9-02 provides a summary of impacts on aquatic plants in mainstem and tributary reservoirs by policy alternative. Except for the Summer Hydropower Alternative, the policy alternatives would not cause aquatic plant and aquatic invasive plant coverage to change substantially from the Base Case on all the mainstem reservoirs and a majority of the tributary reservoirs. Potential coverage changes on mainstem reservoirs for alternatives other than the Summer Hydropower Alternative would be slight, and during most years natural environmental factors, such as weather and the hydrologic cycle, would override the effects of these alternatives in determining aquatic plant and invasive aquatic plant growth or decline. An exception is the Equalized Summer/Winter Flood Risk Alternative, where a slight decrease in coverage might occur during some years. Some of the impacts anticipated on the tributary reservoirs may fall outside the range of natural variability during some years; nevertheless, they still would be relatively small scale.

Table 5.9-01 Impact Analysis Considerations Related to Aquatic Plants by Operating Characteristic

Operating Characteristic	Impacts on Aquatic Plants in Mainstem Reservoirs	Impacts on Aquatic Plants in Tributary Reservoirs
Summer pool elevations held past present drawdown date	Because these plants have already completed their life cycle, little increase or decrease in coverage is expected; slight decrease or no expansion of Eurasian watermilfoil and hydrilla into deeper contours because of light limitations; slight increase in drawdown zone coverage due to longer growing season, and possibly more Eurasian watermilfoil/hydrilla in drawdown zone during summer.	Not many exist here; potential slight increase in coverage in flatter areas where habitat and substrate exist—primarily the annual/naiad mix, which can complete seed production before dewatering.
Higher winter pool elevations	In some mainstem reservoirs, potential to increase coverage of Eurasian watermilfoil and hydrilla because not dewatered; reducing area of drawdown zone would result in decreased coverage of annual/naiad mix.	Decreased amplitude of fluctuation to 10 feet or less in higher winter pool levels would increase potential for plants to colonize suitable habitat areas, which could increase coverage.
Lower summer pool elevations	Potential to decrease coverage in upper contours by reducing inundated habitat; increased light levels would allow expansion of Eurasian watermilfoil and hydrilla into deeper contours.	Not many exist here; reducing inundated habitat in upper portion of drawdown zone may result in slight decreases in the few existing populations.
Faster drawdowns, dewatering earlier in year	Shorter growing season could decrease coverage, especially in drawdown zone; annual species such as naiads and pondweeds may not be able to complete their seed cycles; may see species shift to perennial species with growth from underground propagules or to species that can complete their life cycles; possible expansion of hydrilla and Eurasian watermilfoil due to increased light penetration.	Not many exist here; decrease in the few existing populations and decrease in potential for establishment of additional populations.

Note: This table is applicable to storage reservoirs; run-of-river reservoirs would not experience large water elevation fluctuations under the policy alternatives.

Table 5.9-02 Summary of Impacts on Aquatic and Invasive Aquatic Plants by Policy Alternative

Alternative	Description of Impacts
Base Case	Aquatic and invasive aquatic plant coverage on mainstem and tributary reservoirs would continue to increase or decrease based primarily on natural fluctuation associated with hydrologic and climatic events.
Reservoir Recreation A	Little change in plant coverage is expected on mainstem reservoirs; a species shift could occur between increasing and decreasing communities of invasive plant species. Due to longer summer pool levels, aquatic plant coverage could increase slightly in some tributary reservoirs, especially if increase in winter water elevation is sufficient to reduce the drawdown to less than 10 feet.
Reservoir Recreation B	Little change in plant coverage on mainstem reservoirs is anticipated; however, a species shift could occur between increasing and decreasing communities of invasive species. A slight increase in coverage could occur on tributary reservoirs with a large drawdown (over 10 feet). On tributary reservoirs (for example, Chatuge and South Holston), where the drawdown is reduced to less than 10 feet, larger increases in coverage could occur.
Summer Hydropower	On mainstem reservoirs, there is potential for large reductions in plants growing in upper portion of drawdown zone. A slight expansion of Eurasian watermilfoil and hydrilla into deeper areas could occur because of increased light penetration. In most tributary reservoirs where higher winter water levels would occur, a slight decrease in overall coverage is anticipated because water levels would not be elevated long enough during summer for annual plants to complete their seed cycle.
Equalized Summer/Winter Flood Risk	This alternative may result in a wide variety of effects, depending on how much water levels vary from current regime. A slight decrease in plant coverage on mainstem reservoirs is anticipated during some years. Lower summer water elevations on tributary reservoirs could decrease existing populations of plants; however, longer summer pool levels and decreased amplitude of drawdown could increase submersed and floating-leaved plants—particularly in some reservoirs (for example, Chatuge) where the drawdown is less than 10 feet.
Commercial Navigation	Coverage on the mainstem and tributary reservoirs would continue to increase or decrease based primarily on natural fluctuation associated with hydrologic and climatic events. Higher winter water levels on mainstem reservoirs could favor establishment and expansion of perennial invasive species into some areas of drawdown zone currently colonized by annuals.
Tailwater Recreation	Little change in plant coverage on mainstem reservoirs is anticipated; however a species shift could occur between increasing and decreasing communities of invasive species. A slight increase in coverage could occur on tributary reservoirs with a large drawdown (over 10 feet). On tributary reservoirs (for example, Chatuge and South Holston), where drawdown is reduced to less than 10 feet, larger increases in coverage could occur.

Table 5.9-02 Summary of Impacts on Aquatic and Invasive Aquatic Plants by Policy Alternative (continued)

Alternative	Description of Impacts
Tailwater Habitat	Little change in plant coverage is expected on mainstem reservoirs; however, a species shift could occur between increasing and decreasing communities of invasive species. Due to summer pool levels extending later into fall, potential for increases in plant coverage on tributary reservoirs could be greater than under Reservoir Recreation Alternative A, especially if increase in winter water elevation is sufficient to reduce the drawdown to less than 10 feet.
Preferred	Little change in plant coverage is expected on mainstem reservoirs; however, a species shift could occur between increasing and decreasing communities of invasive species. A slight increase in coverage could occur in some tributary reservoirs, with the highest potential in reservoirs (for example, Chatuge) where the increase in winter elevation is sufficient to reduce the drawdown to less than 10 feet.

Note: Most anglers and waterfowl hunters would consider increases in aquatic plants to be beneficial, while most recreational boaters and shoreline property owners would consider such increases adverse.