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Paper 3

EXTENT, CONDITION, MANAGEMENT, AND RESEARCH NEEDS OF BOTTOMLAND HARDWOOD-CYPRESS FORESTS IN THE SOUTHEASTERN UNITED STATES

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3.1 INTRODUCTION

The bottomland hardwood-cypress (BHC) forests of the Southeastern United States are found in the broad bottoms and swamps of major rivers; in the bottoms of coastal, black water rivers; in and around ponds, bays, and pocosins; in the non-alluvial swamps at headwaters of many Coastal Plain streams; on the fringes and margins of smaller streams and intermittent drainages that lace the pine forests; and in many other damp sites too numerous to single out.

3.2 EXTENT AND OWNERSHIP

There are about 12.9 million acres (5.22 million hectares) of BHC forest in the five Southeastern** States of Virginia, North and South Carolina, Georgia, and Florida***. These States contain about 42 percent of the 30.8 million acres of BHC forests found in the entire South. The BHC forests of the Southeast are found largely on the Coastal Plain, but the type also occurs on river and stream margins in the Piedmont Plateau. About 71 percent of the BHC forests found within this region is owned by farmers and other private owners. Nearly 24 percent is owned or leased by forest industry, largely the pulp and paper industry. Very little forest land is

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**The terms "Southeastern" or "Southeast" as used in this paper refers to the States of Florida, Georgia, South Carolina, North Carolina and Virginia.

***The statistics presented in this paper are based on continuing forest surveys carried out by the Forest Service's Research Work Unit, Renewable Resources Evaluation in the Southeast, Southeast. For. Expt. Stn., Asheville, NC, Joe P. McClure, Project Leader, under the Forest and Rangeland Renewable Resources Research Act of 1978.

owned by the furniture and veneer industry, which is therefore dependent on other landowners for raw materials. Public ownership is relatively small--only about 5 percent of the forest type (Table 3.1).

TABLE 3.1
Area of commercial BHC forest land in Southeastern States of Florida. Georgia, South Carolina, North Carolina and Virginia by ownership class[a]

Ownership class	Area	Percent
	(M-acres)	
National forest	241.7	1.9
Other public	398.4	3.1
Forest industry	3,084.5	23.9
Farmer	4,650.1	36.0
Other private	4,540.2	35.1
Total	12,914.9	100.0

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA. Asheville, NC. under the Forest and Rangeland Renewable Resources Research Act of 1978.

The acreage occupied by BHC forests in the Southeast over the past 4 decades has remained fairly stable (Table 3.2). Although there have been losses to highways, reservoirs, and urban areas, there have also been gains from other land uses. No large land-clearing efforts in BHC forests have occurred in the Southeast, such as that cleared for farmland in the Mississippi Delta (Sternitzke 1976).

3.3 SPECIES COMPOSITION

The species composition of BHC forests is extremely variable and complex (Table 3.3). More than 70 different commercial tree species grow in a multitude of mixtures on sites varying from moist to hydric. Hence, relatively high abundance of water is about the only common thread tying the BHC forest complex together (Johnson 1973, Stubbs 1973). In reality, the complex contains a dozen or more relatively distinct forest types or site types. Water tupelo and swamp tupelo* have the highest rate of

*Scientific names of species are shown in Table 3.3.

occurrence of any species in BHC forests of the Southeast. Pondcypress, sweetgum, red and other soft maples, the red oaks, ash, baldcypress, bay and magnolia, yellow-poplar, and loblolly pine are other common species in this BHC forest.

TABLE 3.2
Area of commercial BHC forests of Southeast by State, as determined by forest surveys during the 1935-1940 period and the 1970-1978 period[a]

State	Forest survey period	
	1935-1940	1970-1978
	--------- *Thousand acres* ---------	
Florida	4,728.1	4,055.1
Georgia	2,287.4	3,200.2
South Carolina	2,279.1	2,268.2
North Carolina	2,240.1	2,677.9
Virginia	967.6	713.3
Total	12,502.3	12,914.7

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA. Asheville, NC, under the Forest and Rangeland Renewable Resources Act of 1973.

3.4 CLASSIFICATION OF BHC SITES

Topographic position, stand composition, and abundance of water are key factors used in classifying forest sites as BHC types. However, such BHC sites are far from being homogeneous. Species occurrence and productivity vary considerably in relation to subtle changes in topography, water regime, and soil characteristics.

Forest surveys place BHC forests of the Southeast into several physiographic classes. About half of BHC forests occur on mesic sites in which the soil moisture is near field capacity for a large part of the growing season, but soil seldom inundated for more than a few weeks at a time. The other half are on hydric sites, which are saturated or flooded most of the growing season. Sites may be further classified according to the following forest survey definitions (see footnote *** on page 71).

TABLE 3.3

Ranking of species by their frequency of occurrence in BHC forests of the Southeastern States (Florida, Georgia, South Carolina, North Carolina, Virginia)[a]

Species	Number of trees[b]	Volume of trees[b]
	(Million)	*(Million cu. ft.)*
Water and swamp tupelo (*Nyssa aquatica* L., *N. sylvatica* var. *biflora* (Walt.) Sarg.)	395.3	4,985.8
Pondcypress (*Taxodium distichum* var. *nutans* (Ait.) Sweet)	197.4	1,588.4
Sweetgum (*Liquidambar styraciflua* L.)	190.2	2,405.7
Soft maples (*Acer rubrum* L., *A. negundo* L., *A. saccharinum* L.)	140.2	1,498.4
Red oaks (*Quercus laurifolia* Michx., *Q. nigra* L., *Q. phellos* L., *Q. falcata* var. *pagodifolia* Ell.)	129.7	1,985.3
Ash (*Fraxinus pennsylvanica* Marsh., *F. caroliniana* Mill.)	85.4	957.7
Baldcypress (*Taxodium distichum* (L.) Rich.)	77.8	1,266.2
Bays and Magnolia (*Gordonia lasianthus*(L.) Ellis, *Magnolia virginiana* L., *M. grandiflora* L.)	70.0	629.1
Yellow-poplar (*Liriodendron tulipifera* L.)	47.6	773.6
Loblolly pine (*Pinus taeda* L.)	32.9	656.6
Elm (*Ulmus americana* L., *U. alata* Michx., *U. rubra* Muhl.)	32.2	398.1
Slash pine (*Pinus elliottii* Engelm.)	29.0	342.9
White oaks (*Quercus lyrata* Walt., *Q. michauxii* Nutt., *Q. alba* L., *Q. stellata* Wangenh., *Q. virginiana* Mill.)	28.9	571.7
Atlantic white-cedar (*Chamaecyparis thyoides* (L.) B.S.P.)	12.3	122.0
Hickory (*Carya aquatica*(Michx. f.) Nutt., *C. glabra* (Mill.) Sweet, *C. tomentosa* (Poir.) Nutt.)	11.7	215.7
Sycamore (*Platanus occidentalis* L.)	8.1	183.3
Pond pine (*Pinus serotina* Michx.)	8.1	104.2

TABLE 3.3 (Continued)

Ranking of species by their frequency of occurrence in BHC forests of the Southeastern States (Florida, Georgia, South Carolina, North Carolina, Virginia)[a]

Species	Number of[b] trees	Volume of[b] trees
	(Million)	*(Million cu. ft.)*
Cottonwood (*Populus deltoides* Bartr. ex Marsh., *P. heterophylla* L.)	4.0	92.8
Spruce pine (*Pinus glabra* Walt.)	2.3	48.6
Shortleaf pine (*Pinus echinata* Mill.)	2.2	24.2
Beech (*Fagus grandifolia* Ehrh.)	1.8	50.9
Longleaf pine (*Pinus palustris* Mill.)	1.7	18.2
Black cherry (*Prunus serotina* Ehrh.)	1.7	14.9
Eastern redcedar (*Juniperus virginiana* L.)	1.5	10.0
Basswood (*Tilia caroliniana* Mill.)	1.4	15.3
Hard maples (*Acer saccharum* Marsh., *A. barbatum* Michx.)	1.2	16.4
Black walnut (*Juglans nigra* L.)	1.2	14.1
Virginia pine (*Pinus virginiana* Mill.)	.5	2.9
Black locust (*Robinia pseudoacacia* L.)	.3	3.5
Other eastern hardwoods[c]	41.8	523.6
Total	1,558.4	19,520.1

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA, Asheville, NC, under the Forest and Rangeland Renewable Resources Research Act of 1978.

[b] Trees 5.0 inches d.b.h. and larger occurring on the 12,914,700 acres of BHC forest of the Southeast.

[c] Includes *Aesculus* spp., *Betula* spp., *Celtis* spp., *Cornus* spp., *Diospyros virginiana* L., *Gleditsia* spp., *Ilex* spp., *Morus* spp., *Salix* spp., *Carpinus caroliniana* Walt., *Planera aquatica* J.F. Gmel., *Persea borbonia* (L.) Spreng., *Sassafras albidum* (Nutt.) Nees and *Cercis canadenis* L.

Mesic physiographic classes:

Flatwoods.--Flat or nearly level areas, mostly imperfectly drained, sandy soils. Water table levels at soil surface during periods of high rainfall. BHC types occur on the wetter portions of this class.

Narrow stream margins.--Low, moist, fertile areas along small streams. These sites may flood during short periods of high rainfall.

Broad stream margins.--Broad, moist bottoms of alluvial land forming the margins of large streams. These bottoms may be flooded during short periods of high rainfall.

Hydric physiographic classes:

Deep swamps.--Large, low, wet, flat forested areas which are flooded for long periods in the growing season. Portions of large, poorly drained stream bottoms fall into this class. Soil and flooding on these sites favor baldcypress, pondcypress, swamp tupelo, and water tupelo.

Cypress strands.--Strands of forest land along the deep drainage features of the Lower Coastal Plain. There is a severe species limitation in these areas because of the almost constant presence of water.

Small drains.--Narrow, wet strands without a well defined stream. Although these areas serve as drains for the surrounding sites, they are usually poorly drained themselves.

Cypress ponds.--Small depressions scattered throughout the flatwoods of the Lower Coastal Plain. These areas are filled with water during all but the driest season.

Willow heads and strands.--Small areas in the early stages of succession to forest found around deep ponds and strands of permanent water.

Bays and wet pocosins.--Large, low, wet forested land depressions along the Lower Coastal Plain. Peaty soils and boggy conditions characterize these sites.

Table 3.4 shows acreages of bottomland forests in the Southeast in each of these classes.

3.5 CONDITION OF BHC FORESTS

More than two-thirds of the BHC forests in the Southeast are medium to fully stocked with commercially valuable tree species (Table 3.5). Nearly one-third is classed as poorly stocked; 15 percent of the poorly stocked

TABLE 3.4
Area of commercial forest land in bottomland forest types in the Southeastern States of Florida, Georgia, South Carolina, North Carolina, and Virginia by physiographic class[a]

Physiographic class	Area
	(acres)
Mesic	
Flatwoods	1,777,792
Narrow stream margins	2,514,471
Broad stream margins	1,675,447
Other mesic variants	509,636
Total mesic	6,477,346
Hydric	
Deep swamps and cypress strands	1,752,794
Small drains	2,364,599
Cypress ponds and willow heads and strands	884,473
Bays and wet pocosins	1,242,524
Other hydric variants	193,176
Total hydric	6,437,566
All classes	12,914,912

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA, Asheville, NC, under the Forest and Rangeland Renewable Resources Research Act of 1978.

is non-stocked. The poorly stocked stands have more rough and rotten trees and inhibiting vegetation than do the better stocked ones. These stand components greatly reduce productivity by taking up space that could be occupied by desirable trees. What can be done to raise productivity and at what cost?

Gross growth of BHC forests averages about 59 cubic feet/acre/year, which is 82 percent of the estimated growth potential for this forest type (Table 3.6) and 94 percent of the gross growth of all forest types in the Southeastern States. Mortality averages 11 cubic feet/acre/year, which is 56 percent higher than the average of 6.7 cubic feet/acre/year for all

TABLE 3.5
Area of commercial forest land in bottomland forest types in the Southeastern States of Florida, Georgia, South Carolina, North Carolina and Virginia by stocking class and percent occupancy by selected stand components[a]

		Selected stand components			
Stocking class	Area	Desirable growing stock trees	Rough & rotten trees	Inhibiting[b] vegetation	Non-stocked
	(M-acres)	------- *(Percent of stocking class)* ------			
Fully stocked (More than 99% stocked)	3,167.5	88.0	11.7	0.1	0.2
Medium stocked (60-99% stocked)	5,711.7	70.9	25.1	1.7	2.3
Poorly stocked (Less than 60% stocked)	4,035.7	35.2	35.7	13.6	15.5
All stands	12,914.9	65.9	24.2	4.6	5.4

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA, Asheville, NC under the Forest and Rangeland Renewable Resources Research Act of 1978.

[b] Inhibiting vegetation--such as vines, shrubs, or grass--sufficiently dense to prevent establishment of tree seedlings.

forest types in the Southeast. Because of this high mortality, net growth (gross growth minus mortality) is reduced to 48 cubic feet/acre/year. Hence, only 67 percent of the estimated average growth potential is realized by landowners. These statistics raise several questions: How can mortality be decreased and growth increased? What effect does mortality have on wildlife habitat?

The bright side of the regional growth picture is that removals are only 31 cubic feet/acre/year--65 percent of growth. As a result, BHC forest inventories are increasing at a rate of 17 cubic feet/acre/year or more than 318 million cubic feet per year for all BHC forests in the Southeast.

Traditionally, the incentive for growing hardwoods has been and will probably continue to be the high stumpage prices of high-quality timber (McLintock 1979). Hardwood sawtimber stands, on an average, contain less

TABLE 3.6
Annual change (1980) in volume of timber on bottomland forest types in the Southeastern States of Florida, Georgia, South Carolina, North Carolina and Virginia[a]

Item	Growing stock		Sawtimber	
	Total	Per acre	Total	Per acre
	(M cu.ft.)	*(cu.ft.)*	*(M bd.ft.)*	*(bd.ft.)*
Gross growth	756,758	59	2,823,845	219
Mortality	135,112	11	428,565	33
Net growth	621,646	48	2,395,280	186
Removals	403,191	31	1,704,573	132
Net change	+218,455	+17	+ 690,707	+ 54

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA, Asheville, NC under the Forest and Rangeland Renewable Resources Research Act of 1978.

than 15 percent grade 1 logs and less than 25 percent grade 2 logs (Knight and Hilmon 1978). If markets are not strong for the lower quality logs, then many if not most of these lower quality trees will continue to be left in the woods. The rough and rotten trees that exist in many stands are the result of past cutting of only the high quality trees. Leaving the lower quality, less desirable species is called high-grading. The current condition, composition, and quality of much of the BHC resource reflect this high-grading. The problems are: What can be done to rehabilitate and increase the quality of desired species on these sites? When harvest cuttings are made, what practices are necessary to regenerate the desired species?

About 3.2 percent of BHC forests are disturbed or given some type of treatment each year (Table 3.7). Only about 198,000 acres (1.53 percent) are harvested by clearcutting each year. At this rate of cutting, the average rotation age of these forests is about 65 years. A relatively small proportion of these BHC forests is disturbed or treated each year, and when placed in the perspective of the total land area in the five States, this annual disturbance rate amounts to less than 0.3 percent of the total land area.

TABLE 3.7
Annual rates of treatment and disturbance in BHC forests in the Southeastern States of Florida, Georgia, South Carolina, North Carolina and Virginia over the past decade[a]

Treatment or disturbance[b]	Annual rate
	(M-acres)
Final harvest	198
Intermediate cutting	113
Natural disturbance[c]	58
Other treatments or disturbance	45
No significant treatment or disturbance	12,501
Total area	12,915

[a] Based on data from continuing forest surveys carried out by the Southeastern Forest Experiment Station, Forest Service, USDA, Asheville, NC under the Forest and Rangeland Renewable Resources Research Act of 1978.

[b] Excludes withdrawals, diversions, and rotations to another type.

[c] Includes wildfire, disease, insects, weather, and beaver damage.

3.6 CURRENT UTILIZATION AND POTENTIAL MARKETS

Currently, about 65 percent of the net BHC growing stock growth and about 71 percent of sawtimber growth are harvested annually. As a result hardwood inventories are increasing. In fact, in the last 25 years the total hardwood inventories in the Southeast have increased about 39 percent (USDA, Forest Service 1978a). In the last decade markets for hardwood flooring and railroad ties have declined, but the furniture market continues to be fairly strong (Knight and Hilmon 1978). Although the hardwood tie market is at a low ebb, it is predicted to increase about 50 percent in 20 years. The hardwood pallet market is expected to double and the hardwood pulpwood market to quadruple in 20 years (USDA, Forest Service 1978b). Potentially, the fuelwood market (although unpredictable) could dramatically increase, favorably affecting management of stands with a high proportion of low-quality trees. New uses of hardwood, such as for structural lumber, could provide more markets for intermediate quality timber.

These growing markets bode well for the landowner because they will tend to increase stumpage values (value of standing timber at the stump) and provide dollar incentives for landowners to manage their hardwood lands. New markets and a growing awareness of the ecological values of BHC forests will increase the demand for knowledge gained through research on how to couple these values for the best use of this resource.

3.7 VALUE OF THE BHC RESOURCE

The timber inventory value of the BHC resource is conservatively estimated to be about $3 billion or $253 per acre. The value of the net annual growth is about $104.4 million, and the value of the annual mortality is about $22.9 million. Thus, the direct dollar value of this renewable resource to the landowner is considerable. When the wood is used in homes, furniture, paper products, pallets, railroad ties, and other products, the value of the annual growth is increased considerably, often 6 to 19 times (Forest Industries Council 1979a, b) or from $626 to $1,983 million.

Much less is known about the indirect values of BHC forests, but they certainly are considerable (Horowitz 1978). Portions of this forest ecosystem serve as an interface or buffer between terrestrial and aquatic ecosystems, and so the resource probably has high indirect values related to erosion, water pollution control, and eutrophication prevention. In addition it serves as a floodstorm buffer by reducing peak flows. During droughts, BHC forests are important sources of water (Carter, et al. 1979). The BHC ecosystem also provides important wildlife habitat for fish, fur animals, and waterfowl (Horowitz 1978). In short, BHC forests have high on-site and off-site values.

3.8 RESEARCH NEEDS IN BHC FORESTS

3.8.1 Silvics of bottomland species

A better understanding is needed of the effects of edaphic, climatic, and allelopathic factors on growth and reproduction of commercially important species and species valuable for wildlife. Studies are needed on soil-plant-water-light relations and their interactions, especially studies related to flood tolerances of species. These studies should also include the ecology of various sites and the physiological processes that affect growth of individual species. A better understanding of the basic ecology will provide enhanced methods for regenerating natural stands to the most productive or desirable species complex, and for manipulating natural plant succession and managing stands to obtain a desired species composition. Better knowledge of the silvics of individual species will enable a better choice of species to fully utilize the productive resources of the site.

3.8.2 Classification of BHC forest types and sites

The major forest types that are now classed as "bottomland hardwood-cypress" and the sites on which they grow need to be more clearly defined and described. As Boyce and Cost (1974) have commented,

> "Without an adequate method of classification of these wetland forest communities, it is very difficult to study, much less predict, responses to management practices."

The "physiographic classes" now used by the forest survey and described in section 3.4 of this paper should provide a starting point for this effort.

3.8.3 Responses to cultural treatments

Measures used to control competition, composition, and stocking in young BHC stands should dramatically increase growth, yield, and timber quality. However, little is known about the magnitude of the responses or the economic attractiveness of the measures applied. Commercial thinning and timber stand improvement practices should also be investigated because quantitative responses to these practices are largely unknown. In many high graded stands rough, rotten, and otherwise defective trees of less desirable species predominate. Satisfactory methods for rehabilitating these stands have not been devised. Basic information is needed on growth responses of various species to promising rehabilitation measures. Most hardwood species are very site specific. How much of this effect can be attributed to water relations and how much to soil fertility is unknown. Some of these questions could be researched under (3.8.1) above, but fertilization field trials are needed. Fertilization may also influence stocking and competition by increasing growth of dominants and decreasing survival tree in suppressed and intermediate crown classes. In brief, innovative and low-cost stand treatments need to be researched.

3.8.4 Natural regeneration of desired species

Techniques that will consistently reproduce and favor desired species should be developed for BHC sites. Such research would be related to (3.8.1) above but would deal with the more practical aspects of regeneration. For some species little is known about sprouting (root and stump) or about the effect site, season of cutting, or age and size of tree have on this sprouting. Effects of seed supply and such environmental factors as sunlight and soil moisture need additional research to determine the part these factors play in consistently obtaining satisfactory regeneration.

3.8.5 Growth and yield

Although some growth and yield information for bottomland hardwoods is now available, most is for unmanaged stands. So little is known about managed stands that landowners and their foresters cannot evaluate effects of cultural measures in dollars. Growth and yield information as related to site, density, species composition, and various cultural practices is needed for evaluating management opportunities and for developing rotational guidelines and thinning schedules.

Quality of product is important for many of the species in these stands. A number of factors affect log quality, but one related to stand management and especially to density, age, and history of the stand is epicormic branching. Young saw-log trees of some species develop epicormic branches when a stand is opened by thinning. This response immediately lowers the quality of the tree. At the same time, hardwood pulp is becoming easier to market each year, and total fiber production will be the major goal of many growers of hardwoods. Obviously, economic decisions will have to be made concerning the trade-offs of volume and quality.

3.8.6 Wildlife habitat

Knowledge of general habits and environmental relationships is documented for many species of wildlife that use BHC forests. However, knowledge is limited on effects and impacts of specific silvicultural practices on wildlife habitat and populations. Information on the role and impact of wildlife on trees, especially regeneration, is also scanty.

3.8.7 Hydrologic functions

Hydrologic functions and values of BHC forests--such as detention storage of flood waters, moderation of stream flow, filtering and uptake of pollutants (e.g., their value as sinks in moderating water pollution and eutrophication), and stream bank protection--need to be quantified. In turn, the effects or impacts of silvicultural treatments on these functions and values must be studied in depth so that appropriate and compatible silvicultural treatments may be used in managing these forests.

3.8.8 Ecosystem

In addition to or more appropriately in conjunction with the above research, ecosystem models of BHC forests are needed to provide better insight and understanding of the interrelationships of processes and uses that take place within BHC forests. These models should also provide a means of testing alternative solutions to practical problems facing decision-makers. Because of their diverse nature, BHC forests present special problems in applying the typical ecosystem analysis. Logically, an entire floodplain needs to be analyzed, but this is not feasible, economical, or practical. New approaches or methods need to be devised for measuring the input-output processes.

3.9 RESEARCH APPROACH

Much of the needed research will be field-oriented; many people will be needed for field studies and data collection over a wide range of site types involving many variables. The problems also require long-term studies. The magnitude of the problems and the geographic scope involved require a very close cooperative effort between all agencies and entities (public and private) which have the funds, facilities, study sites, and personnel to participate in this effort.

The research effort must be a combination of field, hydroedaphytron, greenhouse, and laboratory work. Research with practical objectives needs to be combined with more basic research so that the why's and wherefore's from the problem-oriented research can be interpreted and applied as widely as possible. BHC forests contain relatively small stands growing on a mosaic of microsites with different species or groups of species filling their respective ecological niches. Knowledge of soil-water-plant-light relationships and all the many interactions is requisite to answering basic and practical problems and developing sound management practices for a given area. Thus, a balanced program of basic and applied research is especially important.

3.10 CONCLUDING REMARKS

BHC forests have been used since the days of early settlement. The resource is too vast and its economic value too high to be ignored. The products harvested and manufactured from this resource contribute significantly to the economy of the region and the user needs of this Nation.

The hydrologic, wildlife, and other on-site and off-site values are important and need careful consideration as these BHC forests are managed.

A good deal is already known about BHC forests, but not nearly enough for optimum use of the resource. Gaps in our knowledge exist that need to be filled by research. With this new knowledge, a more scientifically sound job can be done in managing these lands for the many uses and benefits that stem from these forests.

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