COMMONWEALTH OF AUSTRALIA.

A DESIRABLE BALANCE BETWEEN HARDWOOD AND SOFTWOOD PRODUCTION IN AUSTRALIA

BY

H. R. GRAY,

Officer-in-Charge, Division of Timber Supply Economics, Forestry and Timber Bureau.

(PAPER FOR SEVENTH BRITISH COMMONWEALTH FORESTRY CONFERENCE—AUSTRALIA AND NEW ZEALAND, 1957.)

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1. INTRODUCTION AND DEFINITIONS.

In mid-western Europe, the cradle of systematic forestry, the traditional grouping of commercial timbers as hardwoods and softwoods was natural and realistic. Typical commercial hardwoods were broad leaved deciduous trees, such as oak, beech, elm, ash, &c., and typical softwoods were pines, spruces, firs, larch, &c., all possesing needle-like leaves and, with the exception of larch, all evergreen.

In addition to the broad silvicultural distinction between the two groups, each group was fairly distinct from the other in the physical properties of the respective timbers, hardwoods generally being physically hard, strong, often heavy and durable, and softwoods generally being physically soft and light and seldom durable.

The above distinctions are of far less general application when applied to the commercial hardwoods and softwoods of the world, and foresters present will understand that in this paper the scientific distinction will be used throughout, viz.—

Hardwoods = pored timbers = (for all practical purposes) non-conifers;

Softwoods = non pored timbers = (for all practical purposes) conifers.

One can understand why saw-millers, timber merchants and timber users in Australia have become accustomed to class as softwoods many of the rain forest hardwoods of Queensland and New South Wales, and some imported hardwoods also, because they are considerably softer and more easily worked than the majority of Australian hardwoods. Quite recently a well-known timber man complained of the unreality, in his opinion, of the accepted distinction between hardwoods and softwoods. He had offered, for an overseas order for sleepers, eucalypts and other timbers much harder and stronger than hardwoods offered by other countries. The Australian timber man considered that these latter timbers should have been classed as softwoods, when he would have enjoyed a legitimate sales promotion advantage in this particular avenue of use. Conversely, it may be a sales promotion disadvantage having to offer timbers correctly classified as hardwoods which are, in fact, relatively soft and easily worked, and eminently suitable for a purpose where hardness and strength are not prime requisites.

There is, however, no acceptable remedy for complaints such as the above. Even if relative hardness were the most important variable characteristic of timber, which is questionable, there is no scientific method, suitable for day to day commercial practice, of classifying timbers on the basis of physical hardness. Nor do there seem to be any simple alternative names which are likely to command more popular acceptance than the traditional names, hardwoods and softwoods, for classifying timber groups.

2. FACTORS INFLUENCING THE PREFERENCE FOR HARDWOODS OR SOFTWOODS.

Among the many factors involved, influencing the preference for hardwoods or softwoods, reference may be made to some of the important ones, but it should be realized that some of the separate factors are inter-related to some extent.

(a) **Availability.**—Its general availability is undoubtedly a prime reason why through the ages timber has, perhaps more than any other material, supplied man with a diversity of requirements. Naturally, therefore, the progressive use of timber developed in those types most readily available. So it is that in the large timber-consuming countries of the northern hemisphere, where softwoods dominate the forest flora, timber consumption has always been predominantly in softwoods.

(b) **Tradition and custom.**—Arising from the above, the use of softwoods has become traditional for a large number of uses including many for which hardwoods are intrinsically more suitable. Europeans settling in new lands have tended to carry these traditions of use with them, and to compare unfavorably local timbers not having the properties to which they have been accustomed for such uses.

(c) **Intrinsic properties.**—For purposes where special strength and durability are not required, and these purposes form a large proportion of total usage, the comparative lightness, uniform structure, ease of seasoning, relative softness and ease of working of coniferous timbers render them intrinsically superior to hardwoods. On the other hand, for purposes where hardness and strength are prime requisites, hardwoods are in general superior to softwoods. If, in addition, durability is required, this property is often found in hardwoods and seldom in softwoods.

It must not be overlooked that there are a few softwoods—redwood (*Sequoia sempervirens*) and huon pine (*Dacrydium franklinii*) are outstanding examples—which have great natural durability but are relatively soft.

Again where colour, figure, and beauty of texture are desirable characteristics in use, hardwoods are generally superior to softwoods.

Paper-making from wood pulp was developed from softwoods and Australian hardwoods were once considered quite unsuitable. Techniques have now been developed to make a wide range of papers from hardwood pulps, but generally a proportion of the longer fibred softwood pulp is a necessary ingredient.

Hardwoods are eminently suitable for the manufacture of hard fibreboard.

(d) **Price.**—Other things being equal, the relative price to the user of softwoods and hardwoods is a powerful factor influencing the preference for either. In turn, price is affected in the first place by costs of production and delivery to markets of rough-sawn material. Forests carrying high volume per acre of species of more or less uniform properties and relatively free from faults, allow for a high degree of mechanization in initial harvesting operations in the forest, and for large concentrations of logs which can be milled by mass production methods with concomitant economies. Mills located close to centres of consumption of converted timber or within easy access to ocean transport of converted timber to overseas markets, enjoy cost advantages.

By contrast, in forests composed of a mixture of species of variable commercial value, having a high percentage of fault, or otherwise carrying low usable volume per acre, high initial harvesting costs are involved, and further, mill mass production methods are only possible by transporting logs long distances. If logging areas are small and scattered in distribution and cheap transport facilities are not available for concentration of log supplies at big mills, mass production milling operations are not possible. Finally, mills distant from local consumption centres are at a cost disadvantage.

Relative ease of working, seasoning, processing and fixing of timber in its final use affects labour costs and so ultimately the cost to the user.

On most of the above counts, the softwoods of the western coast of North America and of the Baltic countries possess cost advantages in overseas markets over Australian hardwoods and, indeed, over Australian hardwoods in the large consumption centres of Australia which are sea ports.

3. THE AUSTRALIAN BACKGROUND.

The true pines (*Pinus spp.*) and spruces, firs, hemlocks, &c., so common in the temperate zone of the northern hemisphere, are absent from the indigenous flora of Australia. Our never large resource of conifers was composed mainly of hoop and bunya pines (*Araucaria cunninghamii* and *A. bidwilli* respectively) and kauri (*Agathis spp.*) naturally occurring in the rain forests of the central and north-eastern coastal belts of the mainland, restricted supplies of huon pine (*Dacrydium franklinii*), celery-top pine (*Phyllocladus rhomboidalis*), King Billy pine (*Athrotaxis selaginoides*) of Tasmania, and cypress pine (*Callitris glauca* and *C. calcarata*) of the dry western districts of the eastern mainland States. The few other conifers occurring are of little commercial importance. The naturally occurring resource of hoop and bunya is a fast diminishing asset and the smaller resource of kauri hardly less so. These superlative softwoods, which occur naturally in rain forests of mixed species, are being artificially re-established in pure plantations. Production of Tasmanian indigenous conifers has for years been very small. The useful termite-resisting but slow-growing cypress may be expected to give a permanent yield under natural regeneration, though not of a large quantity.

The bulk of Australian forests consists of hardwoods dominated by a very large number of species of the genus *Eucalyptus*. These are generally hard and strong, and many are durable. Generally the commercial eucalyptus occur in mixed forest. Notable exceptions are jarrah (*E. marginata*) and karri (*E. diversicolor*) of Western Australia, mountain ash (*E. regnans*) and alpine ash (*E. gigantea*) of Victoria and Tasmania, large tracts of which species are often found in more or less pure forest. In the rain forests, particularly of the north-eastern coastal areas of the mainland, a large number of species of other hardwood genera occur in mixture. Many of these produce high quality cabinet and furniture timbers and generally are relatively soft and easy to work. As indicated in the introduction, these rain forest species are often erroneously described as softwoods.

4. TREND OF CONSUMPTION OF HARDWOODS AND SOFTWOODS IN AUSTRALIA.

Uses requiring durability, strength and hardness have been met by local hardwoods in all States: e.g. for posts, poles, piles, sleepers, girders, bridge and harbour timbers, decking, house blocks, boat building and, of course, fuel. For many of these purposes softwoods are used in other countries and special treatment is required there: e.g. softwood sleepers have to be impregnated with preservatives, and " chairs " and " plates " used to minimize rail cutting, such as is not required with the durable hard Australian eucalypts. Similarly, the needs in flooring are largely met by Australian hardwoods, while the more decorative species have satisfied the requirements for cabinet making, panelling, furniture, &c.

For the multitude of other uses where lightness, ease of seasoning and working are the important requisites, availability and price are powerful influencing factors. In Sydney, Melbourne and Adelaide it was found cheaper to import softwoods from overseas for a great variety of purposes for which it was claimed that local hardwoods were no more suitable and often less. Queensland, with the largest natural softwood resources, had no need to import, and Western Australian and Tasmanian imports were negligible because local timbers were cheap and traditionally used for practically all purposes.

Nevertheless, 45 years ago nearly half of the sawn timber, excluding sleepers, consumed in Australia, consisted of imported softwoods.

The cumulative effect of tariffs, war-time necessity to use hardwoods, post-war import licensing restrictions to conserve overseas credits, and changing price levels, has brought about many changes and in recent years imports have fallen to about 20 per cent. of sawn consumption while, although not large, an increasing proportion of imports have been hardwoods. On the other hand, the decrease in production of natural forest softwoods has been more than offset by the increased production of plantation softwoods in Australia. The net result is that at the present time, the sawn timber consumption of the various States is as follows:—

——	Hardwood.	Softwood.
	Percentage.	Percentage.
New South Wales	54	46
Victoria	80	20
Queensland	69	31
South Australia	17	83
Western Australia	98	2
Tasmania	95	5
Commonwealth	68	32

N.B.—The above figures include those of interstate trade.

These figures indicate that there is no general pattern of relative use of hardwoods and softwoods for Australia as a whole and give point to the various factors involved influencing the relative use.

5. MANAGEMENT AND ECONOMIC ASPECTS OF HARDWOOD AND SOFTWOOD PRODUCTION.

(a) **Production.**—A large proportion of the virgin forests of Australia carry comparatively few marketable logs per acre. Generally the bulk of the actual and potentially useful volume is in very large-sized trees. A good deal of the growing space is occupied by fire-damaged or otherwise useless material. Notwithstanding, some forest types—mountain ash and karri are outstanding examples—carry very large volumes of marketable timber per acre. This is mainly because of the exceptionally large size of the individual trees and of the comparative uniformity of the species composing these types. More generally, and especially in mixed rain forest types, the volume of marketable timber per acre is not of a high order.

Now it is neither technically desirable nor economically possible to grow again trees of the size attained in the virgin forest. Future managed crops are not likely therefore to contain trees of such large volumes as are found in the virgin forest. The large spreading crowns which most of the hardwoods must develop to produce a reasonably good bole diameter increment means that the number of final crop trees per acre will be much smaller than with coniferous crops. The marketable stem volume of such trees and any intermediate yields there may be forms a much smaller proportion of total volume than in the case of coniferous crops. (Under present conditions, intermediate yields of hardwood forests are largely confined to durable poles, posts, &c., but the use of preservatives is likely to be greatly extended, and this will permit utilization of timber of non-durable species for these purposes). The net result is that the usable volume production of hardwoods on a technical rotation is smaller than that of conifers. Furthermore, the technical rotation of hardwoods is generally longer than that of softwoods. Hence, in a given time, usable volume production per acre of hardwoods is very much smaller than that of softwoods.

The above applies assuming that the hardwood forests are fully stocked with sound marketable trees. Actually the bulk of the forests have been incompletely cut over and contain varying quantities of over-mature unmarketable trees, fire damaged and faulty younger trees and, under present conditions, unmarketable species also. Since it will be many years before a near approach to full stocking of sound and useful timber will be attained in the hardwood forests of Australia, the production advantages of softwoods over hardwoods will for a long time remain greater than indicated in the paragraph above.

(b) **Costs of production.**—Natural regeneration is generally fairly readily obtained in most native hardwood forests while, for the first rotation at any rate, coniferous plantations have to be established by planting which as a first cost appears to be considerably dearer. However, to obtain full stocking in hardwood forests considerable expenditure is involved in removing useless growth and in adequately tending the scattered and uneven natural regeneration. Over an average technical rotation the aggregate costs of production, per unit of usable volume, of naturally regenerated hardwoods may therefore be as great or greater than that of softwoods grown on shorter rotations and yielding larger per acre volumes of usable timber. Consequently, the apparent advantage of cheap establishment of naturally regenerated hardwoods is more illusory than real.

(c) **Extraction.**—Cost of felling and extraction per unit of quantity of the relatively high per acre yields of even aged plantation conifers is considerably less than that of the lower per acre yields of uneven aged mixed hardwood forests.

Combining (a), (b) and (c), the net monetary return per unit of production should be higher with coniferous plantations than with hardwoods, so that, in general, it is more profitable to grow plantation conifers than native hardwoods.

6. AVAILABILITY OF LAND FOR FOREST PRODUCTION.

Reliable information is not available of the total area of natural forest suitable for permanent commercial timber production in Australia. It is known that approximately 40 per cent. of total timber production, excluding firewood, is obtained from private property which, to a large extent, it would be unwise to regard as a permanent timber production resource. It is generally considered also that although in the distant future, if there is material improvement in the stocking of useful timber in the native forests, sustained production from these may be substantially increased, this is most unlikely for a considerable period ahead. By that time the timber requirements of Australia could easily be double what they are now. The alternative to having to rely on progressively larger quantities of imports is to increase the area of plantation conifers to a sufficient extent.

The fact that, other things being equal, a larger quantity of usable timber can be produced from a given area in a given time from plantation conifers than from natural forest, may make it desirable to convert portion of the natural forest to plantation conifers, and in the long term it may be essential to do this, if, through pressure of population, it becomes possible to obtain adequate areas for plantation purposes only by using some of the land reserved for natural forest production.

7. BASIC ASSUMPTIONS.

Because of the time lag between establishment, by any means, of forest crops and their harvesting, present day plans have to be in terms of future requirements, and as the key to the future supply problem is largely dependent on expansion of coniferous plantations, it is both realistic and convenient to set the time period on which to base forward estimates in terms of rotations likely to hold for coniferous plantations in Australia.

This raises the first of the many assumptions involved in any attempt to estimate desirable production. It may first be assumed that the ultimate object is to grow plantation timber to meet the main range of uses for which softwoods are suitable, from big structural members and large peeler logs on the one hand, to case timber and pulpwood on the other. Technical rotations might, therefore, vary from 50 to 25 years,* depending on the class of timber aimed at in the final crop, and on species and site. Thinnings will, of course, provide large quantities of small dimensioned timber regardless of the final crop dimensions aimed at. Financial considerations,

* Where pulpwood production is the primary crop, even shorter rotations may obtain.

combined with the need for large volumes of timber within the next three or four decades, will probably result for some time to come in a low percentage of plantations being grown on rotations longer than 40 years.

With the above in mind, it may be assumed that the weighted average rotation of plantation grown timber will be about 35 years.

The main factors now to be considered are—

(a) Future requirements;
(b) The extent to which natural forest production can be increased;
(c) Yield from coniferous plantations.

Common to all estimates are the following basic facts:—

	Millions of cubic feet, log volume, true measurement.
Present production of all classes of timber (ex firewood) ..	about 337.4
Of this, coniferous plantation production is	„ 23.7
Imports of logs, timber, veneers, &c. (in terms of log equivalent)	„ 61.2
The log equivalent of imported pulp and paper products is ..	„ 56.2
Exports of all classes of timber, including the log equivalent of pulp and paper products	„ 5.6

(N.B.—The above figures are for 1954-55, when availability and requirements were about in balance.)

(a) **Future requirements.**—These depend on population increase and on per capita requirements.

Per capita.—For sawn timber the per capita figure for 1954-55 was about the average of a five-year period and the above figures give a fair indication of consumption of all classes of timber for that period, namely, $337.4 + 61.2 + 56.2 - 5.6 = 449.5$ or, say, 450 million cubic feet log volume. This for a mean population of 9.09 millions in 1954-55 represents a per capita consumption of 49.5 cubic feet. An estimate of the trend of per capita consumption is beset by many uncertainties. First it may be accepted that politically and socially continued expansion of the Australian economy at the highest possible rate is extremely desirable. Under such conditions, per capita requirements for materials should be maintained at a high rate. It is more likely than otherwise that timber will maintain its proportionate share in these materials if there is no difficulty in obtaining supplies of the kind required, or fear that there will be difficulty in the future, at prices competitive with substitute materials. There may be changes in the forms of use, e.g. relatively greater use of plywood, hard fibreboard and pulp products, &c., without necessarily decreasing the overall per capita use of timber.

For the purposes of this forecast, it will be assumed that over the periods considered the average annual per capita consumption (A) will be maintained or, alternatively, (B), that it will be 80 per cent. of the present figure.

Population.—An estimate of future population increase is likewise beset by uncertainties, but again from the political and social stand-point as high a rate of increase as possible is desirable. Within recent years it has been at the rate of over 2½ per cent. which, if continued, would result in doubling the population in about 28 years and quadrupling it in 56 years.

For the purpose of this forecast it will be assumed that the population will double in about 35 years (2 per cent. increase) and increase by a further 60 per cent. in 70 years.

Total requirements.—On the above assumptions, requirements may be set at—

	Millions of Cubic Feet, Log Volume True Measurement.	
	(A).	(B).
In 35 years	900	720
In 70 years	1,440	1,152
Allowing that it is desirable and practicable to increase exports pro rata, the figures will be—		
In 35 years	911	729
In 70 years	1,457	1,166

(b) **Natural forest production.**—Production from coniferous plantations is excluded from the estimates in this sub-section.

There is considerable diversity of opinion on the extent, if any, that the present level of natural forest production can be increased on a sustained yield basis. On the one hand there is virtual certainty of a very large decrease in private property production, but on the other hand improved stocking and better protection and treatment may ultimately lead to increased production from permanent natural forests, State and private. Fuller utilization in a variety of ways, e.g. of species not at present generally used, waste for chipboard production and greater use of poor quality forest and timber for expanded hardboard production and other pulp products will help to bring about an increase.

It must not be overlooked, however, that desirable though it may be for foresters and saw-millers to utilise the growing stock to the maximum, consumer resistance may be expected against attempts to force sales of inferior material in order to increase recovery per log and per acre. Such attempts could well result in consumers seeking alternative materials, and thus to a loss of markets for timber.

Owing to depleted supplies of merchantable sized timber, about which there can be little doubt, any substantial overall increase which may prove possible is likely to be over a long-term rather than a short-term period. It would be unwise to assume that such increased production will be greater than about 15 per cent. in 35 years, i.e. from about 314 to about 361 million cubic feet, and greater than 30 per cent. in 70 years, i.e. to about 408 million cubic feet.

No reliable data are available to confirm or confute the above general assessment of the situation. In the writer's opinion it is optimistic, and is put forward as a measure of conservatism in the softwood plantation proposals to follow.

On the above assumptions of production, the natural forests will be unable to supply the requirements (including exports) estimated in the previous section to the extent set out below—

	Millions of Cubic Feet, Log Volume True Measurement.	
	(A).	(B).
In 35 years	550	368
In 70 years	1,049	758

Even if production in 35 years increased by 50 per cent. above the present level, and this is extremely unlikely, the natural forests would not, by a very wide margin, meet requirements then. Accordingly, there is everything to be gained by restricting expenditure on forestry operations in the natural forests to the production of those species which have intrinsic or economic advantages over softwoods, both for domestic and overseas markets, and in the case of natural forests of marginal quality* and marginal economic accessibility, confining operations mainly to fire control measures necessary for soil conservation and to lessen the hazard to more valuable forests and property.

This practice will tend to raise the average quality of timber produced and to lessen the costs of production.

(c) **Yield from coniferous plantations.**—There are numerous factors to be considered in making an overall estimate of usable timber yield. Not only are there variables due to species, site, and rotations, as affecting the mean annual increment, but also to the degree of utilization possible. Thus relatively low yields may be expected, for example from *P. pinaster* on poor sandy soils, although when plantations are close to centres of consumption such plantations may be economically well worth while to grow. Again, very high per acre yields can be obtained from *P. radiata* on good sites and quite high ones on average sites, but this species is not suitable for all conditions of growth in Australia and, in general, yields from other species are not so high. Furthermore, such a high degree of utilization per acre cannot be expected from areas distant from markets as from those more accessible, nor from the very large areas to be utilized in the future as from the comparatively small areas now being utilized. Finally, it may not be possible to obtain the large areas required for planting equal in average yield capacity to that of the comparatively small area already planted.

Having regard to all the above factors, it would seem reasonable to set the weighted average m.a.i. of usable timber from plantations no higher than 165 cubic feet log volume, true measure, per acre.

8. TENTATIVE PATTERN OF PRODUCTION.

No discussion on this subject would be complete without reference to the part imports may play in meeting long-term requirements. (It may be accepted that they will inevitably be an important factor in the short term.)

Among the reasons for considering imports in the long term are: to meet the demand for special classes of timber which cannot be grown economically in Australia; to assist neighbouring countries with an adverse balance of trade with Australia, and for the general advantages likely to accrue from reciprocity in international trade, particularly in timber products. To meet these various aims it might be considered reasonable to set a long term annual import of timber and timber products at the equivalent of 84 million cubic feet log volume, which is less than the present figure and roughly equal to 10 per cent. of total requirements 35 years ahead.

* Some of these areas may be capable of economic production of coniferous crops, and it may be necessary to convert them to conifers for the reasons given under section 6.

The supply and production pattern might therefore be set out as follows:—

	Millions of Cubic Feet, Log Volume.			
	(A).	Approximate %.	(B).	Approximate %.
IN 35 YEARS.				
Native forest	361	40	361	50
Coniferous plantation	466	51	284	39
Imports	84	9	84	11
Total	911	..	729	..
IN 70 YEARS.				
Native forest	408	28	408	35
Coniferous plantation	965	66	674	57
Imports	84	6	84	7
Total	1,457	..	1,166	..

It should be noted that the natural forest production will include 12.5 to 16.5 million cubic feet of cypress pine, a quantity likely to be more than the total of hardwoods included in the imports, so that for all practical purposes hardwood use may be taken to equal native forest production and softwood use to equal the sum of plantation production plus imports in the above statement.

Turning now to plantation production, it will be apparent that the approximate total acreage required, depending on which of the alternative estimates is taken, is—

	(A).	(B).
	Acres.	Acres.
In 35 years	2,800,000	1,700,000
In 70 years	5,800,000	4,000,000

(N.B.—No allowance has been made for plantation failures, or their destruction by fire or other agencies.)

It is fully realized that any of the many assumptions entering into the above estimates might be varied—the sustained production from Australian natural forests may be higher or lower, the rate of population increase might be faster or slower, the per capita consumption higher or lower and the average m.a.i. of usable growth may be higher or lower. In the overall picture the plus and minus errors of estimate may tend to cancel each other.

It is interesting to recall that in 1934 an estimate was put forward[1] that to meet Australia's softwood needs 60 years from that date, i.e. in 1994, a plantation area of 1½ million acres would be required. In 1946 another estimate was put forward[2] that to meet Australia's softwood needs 45 years after that date, i.e. in 1991, a minimum plantation area of

(1) H. R. GRAY.—"Coniferous Planting in Australia," Commonwealth Forestry Bureau Bulletin No. 15, 1934.
(2) G. J. RODGER.—"Softwoods in Australian Forestry." Presidential Address—Section K—Agricultural and Forestry, of Association for the Advancement of Science, Adelaide, 1946.

1 million acres would be required with continuing increase afterwards. The main reason why the first estimate was higher than the second (of plantation area requirements for approximately the same future date), is that the average m.a.i. used in the first estimate was more conservative than later information indicates it is reasonable to expect. In other words, the two estimates would have been about the same had a similar m.a.i. been used in both cases.

Both of the above estimates were made at a time when the rate of population increase and the per capita consumption were lower than has obtained for some years past. These considerations, combined with the fact that the present estimate of requirements includes those for the log equivalent of pulp and paper products while former estimates embraced requirements for sawn and peeled logs only, are the main reasons why the present estimate of plantation area requirements (for approximately the same future date, i.e. about 35 years hence) is 1.7 to 2.8 million acres rather than 1 million acres. The attempt in the present estimate to assess the probable limits to sustained production from Australian hardwood forests is to emphasize that, whatever opinions may be held on the relative merits of and preferences for the two types of timber, the key to adequacy of future supplies lies in expansion of softwood plantations. Account has also been taken in the present estimate of the part which imports and exports may play on a long-term basis.

The total net area of softwood plantations in Australia is only about 400,000 acres at present. It is submitted, therefore, that even according to minimum estimates of future requirements, the planting programme ahead of Australia is one of very great magnitude if the country is not to become dependent on imports to a hazardous degree.

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