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21

# POTENTIAL EXPANSION OF SOVIET FAR EAST LOG EXPORTS TO THE PACIFIC RIM

July 1989

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## PREFACE

This manuscript resulted from a recent visit by Dr. Peter A. Cardellichio (University of Washington) and Dr. Clark S. Binkley (Yale University) to the Soviet Far East. Dr. Vadim K. Zausaev (Institute for Economic Research, Far Eastern Branch of the Soviet Academy of Sciences) was one of the principal hosts and played a critical role in facilitating this scientific exchange and providing information about the forest sector.

Several people deserve special thanks for the success of this trip. Dr. Judith A. Thornton (Director of the Institute for Economic Research, University of Washington) and Dr. P. Ya. Baklanov (Director of the Institute for Economic Research, Far Eastern Branch of the Soviet Academy of Sciences) were largely responsible for developing this exchange program between their respective institutions. Dr. Pavel Minakir (Institute for Economic Research, Far Eastern Branch of the Soviet Academy of Sciences) provided a great deal of assistance, encouragement, and enthusiasm during the project. Mr. Alexander I. Karp served brilliantly as an interpreter and translator.

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# 1. INTRODUCTION

International trade in sawlogs and veneer logs is concentrated in the Pacific Rim. According to world forestry statistics (Food and Agricultural Organization of the United Nations, 1989), Japan, the People's Republic of China, Taiwan, and South Korea accounted for 72% of the world imports of sawlogs and veneer logs in 1987.[1] The volume of world trade in coniferous logs and nonconiferous logs is roughly equivalent, as is the coniferous-nonconiferous import mix for these countries as a whole.[2]

The Soviet Union plays a critical role in the Pacific Rim market for coniferous logs. As shown in *Table 1*, the Soviet Union accounted for 25% of Japanese coniferous log imports in 1987 and 41% of Chinese imports. Japan is the principal market: just over 5 mm $m^3$ were exported to Japan in 1986 and 1987. The peak year for Soviet coniferous sawlog exports to Japan occurred in 1978 when shipments totaled 7.9 mm $m^3$. The recent decline in the volume of Soviet sawlog exports to Japan may be explained by a reduction in total Japanese coniferous sawlog imports, and, more importantly, by the growth of the Chinese market for softwood sawlogs. *Table 1* indicates that the Soviet Union exported 2.5 mm $m^3$ to China in 1987.

*Table 1.* Coniferous Log Trade among Major Regions of the Pacific Rim in 1987 (mm $m^3$, except where % is indicated)

| | Destination | | | |
|---|---|---|---|---|
| Source | Japan | China | South Korea | Sum |
| U.S. | 11.88 | 2.89 | 2.10 | 16.87 |
| Market Share (%) | 57.9 | 48.5 | 71.4 | 57.7 |
| Soviet Union | 5.16 | 2.47 | 0.13 | 7.76 |
| Market Share (%) | 25.2 | 41.4 | 4.4 | 26.5 |
| Canada | 2.73 | 0.42 | 0.29 | 3.44 |
| Market Share (%) | 13.3 | 7.1 | 9.7 | 11.8 |
| Chile-New Zealand | 0.59 | 0.17 | 0.43 | 1.19 |
| Market Share (%) | 2.9 | 2.9 | 14.5 | 4.1 |

Source: Data are from the Pacific Rim Assessment data base, and are reported in Cardellichio, Youn, and Adams (1989). The original data were compiled from individual country statistics, and subsequently adjusted to reconcile differences. In some cases, differences between these data and the original data may be large because of varying assumptions concerning the appropriate factors for converting North American volumes to a metric basis.

1. Statistics for the People's Republic of China and Taiwan are aggregated in the FAO data. The large majority of imports by China are coniferous logs, while nonconiferous species dominate the Taiwan market.

2. In this manuscript, we use the term "logs" to refer specifically to sawlogs and veneer logs. Pulpwood logs are not discussed.

The Soviet Union exported 9.0 mm $m^3$ of sawlogs in 1987, slightly below the 9.2 mm $m^3$ exported in the 1986 peak, and on a par with the previous peak of 9.4 mm $m^3$ in both 1977 and 1978 (Foreign Trade Statistics of the USSR, various years). Because Japan and China are the primary destinations, the vast majority of sawlog exports originate from the Eastern Soviet Union.[3] Although Eastern Siberia makes a significant contribution to these export totals, the Far East is the dominant supplier and will continue to be in the future. Data on log exports for the early 1970s suggest that the Far East originated over 80% of the volume destined for the Pacific Rim (based on data from Barr, 1989, Table 23). More recent data on exports by origin are not available. However, it is likely that the Far East has experienced a small decrease in its share in recent years due to the increasing importance of the Chinese market, and the resulting improvement in Eastern Siberia's competitive position.

Potential timber production in the Soviet Far East is enormous. The Far East accounts for 33.5% of the Soviet forest land, and 31.4% of the stock of mature coniferous trees (refer to *Table 2*). The 1983 Far Eastern growing stock volume of 20.7 billion $m^3$ ($bm^3$) is similar to the timber volume in the entire U.S. (21.4 $bm^3$ in 1987 (Haynes, 1988)), or in Canada (23.2 $bm^3$ in 1986 (Canadian Forestry Service, 1988)).

*Table 2.* Forest Land Areas and Growing Stock Volumes under Central State Management for the Four Major Administrative Regions of the USSR

| Region | Area mm ha | Growing Stock Volume ($bm^3$) Total | Mature | Mature Coniferous |
|---|---|---|---|---|
| European Region | 157.5 | 17.3 | 9.0 | 6.9 |
| Western Siberia | 75.7 | 9.7 | 7.0 | 4.8 |
| Eastern Siberia | 216.0 | 27.2 | 20.4 | 18.5 |
| Far East | 226.0 | 20.7 | 14.9 | 13.8 |
| South | 70.2 | 8.9 | na | na |
| North | 155.8 | 11.8 | na | na |
| Total | 675.2 | 74.9 | 51.3 | 44.0 |

Note: Source of data is Barr and Braden (1988), Tables 3.3 and 3.7. It should be emphasized that the data are for lands under central state management. In 1983, the total growing stock in the Soviet Union was 86 $bm^3$, of which approximately 67 $bm^3$ (or 78%) were softwood (Forest Encyclopedia of the USSR, 1986).

3. The remaining sawlog exports are destined for a large number of European countries.

How much timber will the Far East supply to the Pacific Rim in the future? This paper addresses this complex question by examining a wide array of relevant issues such as timber inventory, timber availability, institutional factors, environmental constraints, infrastructure, labor and capital availability, and domestic consumption needs. We conclude that increases in future log exports are likely to be quite limited. While lack of infrastructure and labor and capital shortages pose important problems, these are secondary to constraints on timber availability. Although the Far East has vast timber reserves, economic conditions, environmental restrictions, and institutional factors limit the possibilities for additional harvesting.

## 2. FOREST LAND, TIMBER INVENTORY, AND SPECIES MIX

The administrative subregions of the Soviet Far East are shown in *Figure 1*. The Far East may be subdivided into two zones: the South, which includes Maritime kray, Kharbarovsk kray, Amur oblast, and Sakhalin oblast; and, the North, which includes Kamchatka oblast, Magadan oblast, and Yakutia. Although the forest land area in the North substantially exceeds that of the South, it is far less productive and plays a much smaller role in forest products markets for a variety of economic and environmental reasons. Yakutia alone has over half the forest land area and timber volume in the Far East, but accounts for only 10-15% of the regional harvest. Because of jurisdictional differences between Yakutia and other subregions, Soviet Far East forest statistics generally exclude Yakutia; thus, it is also excluded from our data tables.

Soviet sources categorize forest land area by stocking density and accessibility class. The total area of fully-stocked stands is 115.5 mm ha (see *Table 3*). More than half of forest lands in this region (129.0 mm ha) have very low stocking densities or virtually no tree cover. The percentage of fully-stocked stands declines as one moves from south to north. Maritime kray has the highest percentage of fully-stocked stands (94%), while Magadan oblast has only 25%. Just over half of the stands in Kharbarovsk kray, which stretches far into the northern zone, are fully-stocked.

Figure 1. Administrative Subregions of the Soviet Far East

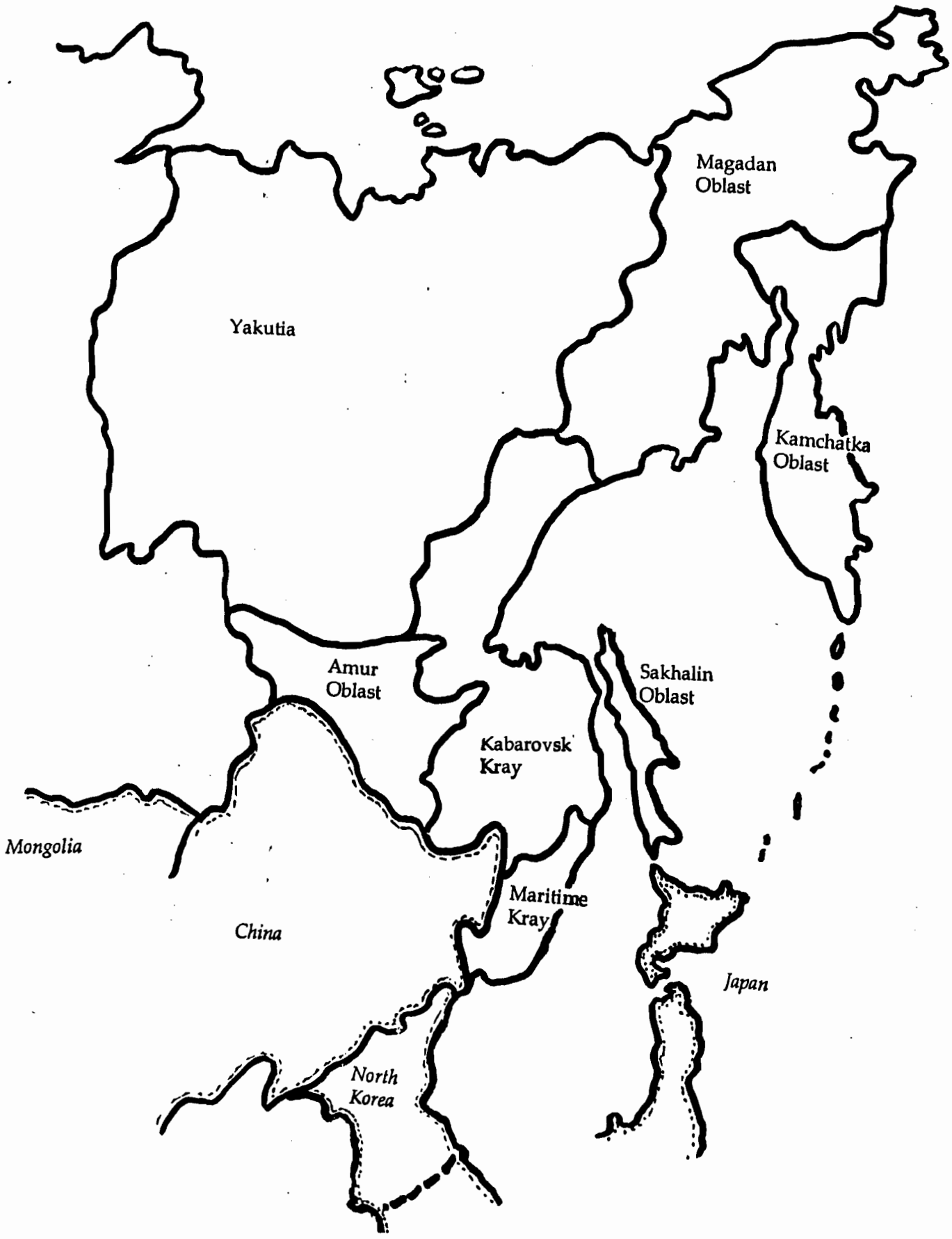


*Table 3.* 1978 Forest Land Area in the Soviet Far East Classified by Stocking Density

| | Fully-stocked Stands | | Low Stocking or No Tree Cover | |
|---|---|---|---|---|
| | mm ha | % | mm ha | % |
| Maritime | 11.21 | 93.9 | 0.73 | 6.1 |
| Kharbarovsk | 42.12 | 54.3 | 35.46 | 45.7 |
| Amur | 20.85 | 67.0 | 10.28 | 33.0 |
| Kamchatka | 18.81 | 42.8 | 25.13 | 57.2 |
| Magadan | 17.84 | 24.6 | 54.82 | 75.4 |
| Sakhalin | 4.70 | 64.7 | 2.56 | 35.3 |
| Total | 115.53 | 47.2 | 128.98 | 52.8 |

Note: Data are compiled from Zausaev, Sheyngauz, and Runik (1984), Table 2.3.

Disaggregating this same total area according to accessibility criteria is especially useful for timber supply analysis. One Soviet classification scheme divides forest land into three groups: protection forests (Group I), restricted forests (Group II) where some logging is permitted, and commercially-exploitable forests (Group III) which are designated for development.[4] *Table 4* indicates that 204.66 mm ha of the total 244.41 mm ha of forest area in the Far East (excluding Yakutia) belong to the commercially-exploitable class. Of the remaining 39.85 mm ha (Groups I and II combined), 90% is protection forest.

The exploitable forests may be further disaggregated into areas which are currently or potentially exploitable (judged on infrastructure, terrain, physiographic conditions, and technology), areas which have been removed from harvesting operations (so-called reserve forests), and areas which are inaccessible/nonoperational and will not be logged. We designate these subcategories as Groups IIIA, IIIB, and IIIC and show the area and percentage of Group III forest land that belongs to each subgroup in *Table 4*.

Although 84% of the forest land is classified as commercially exploitable (a very high percentage compared to the European USSR), the majority of this land must be eliminated from consideration for near- or medium-term supply analysis. Only 36% (73.38 mm ha) of the commercially-exploitable area is classified as currently or potentially accessible (*Table 4*). Part of the reason for this low share is that large areas in the northern zone are simply too remote or too poorly

4. For more detailed explanation of these classifications, see Barr and Braden (1988), Chapter 3, or Fenton and Maplesden (1986), Section 2.1.1.

stocked to be economically viable for timber production. However, the large area of reserves in the southern zone (particularly in Kharbarovsk kray) also significantly reduce the potential timber supply.

*Table 4.* 1978 Forest Land Area in the Soviet Far East Classified by Accessibility

| | | Group III | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Currently or Potentially | | | | Inaccessible/ | | |
| | Groups I & II | Exploitable,IIIA | | Reserves,IIIB | | Nonoperational,IIIC | | Total,III |
| | mm ha | mm ha | % | mm ha | % | mm ha | % | mm ha |
| Maritime | 3.48 | 7.89 | 93.3 | -- | -- | 0.56 | 6.7 | 8.46 |
| Kharbarovsk | 8.15 | 25.57 | 36.8 | 37.59 | 54.1 | 6.28 | 9.0 | 69.44 |
| Amur | 3.07 | 22.05 | 78.6 | 3.22 | 11.5 | 2.79 | 10.0 | 28.06 |
| Kamchatka | 8.83 | 5.64 | 16.1 | 11.40 | 32.5 | 18.08 | 51.5 | 35.12 |
| Magadan | 14.20 | 8.10 | 13.9 | -- | -- | 50.36 | 86.2 | 58.46 |
| Sakhalin | 2.13 | 4.14 | 80.7 | -- | -- | 0.99 | 19.3 | 5.13 |
| Total | 39.85 | 73.38 | 35.9 | 52.21 | 25.5 | 79.07 | 38.6 | 204.66 |

Notes: 1) % refers to percent of Group III area.
2) It is not clear whether the areas made accessible by BAM were already included in Group IIIA or if they will require a shift in the land base from Group IIIC to IIIA.
3) Data are compiled from Zausaev, Sheyngauz, and Runik (1984), Table 2.3.

Inventory data for major species groups are shown by subregion in *Table 5*. The volumes shown are for fully-stocked stands only, and exclude brushwood, which covered 26.7 of the 115.5 mm ha of fully-stocked lands. The forests of the southeastern Soviet Far East include spruce, fir, pine, larch, ash, oak, birch, and poplar: the mixed conifer-hardwood forest type resembles the forests of the northeastern U.S. and adjacent areas of Canada (Osawa, 1989).

Several important characteristics of the Far Eastern timber inventory (excluding Yakutia) are revealed in *Table 5*. First, 90% (9.44 of 10.53 mm $m^3$) of the timber in fully-stocked stands is located in the southern regions. Second, conifers predominate, comprising 82% (8.59 of 10.53 mm $m^3$) of the inventory. Third, larch is the most plentiful species, accounting for 45% of the total growing stock, and 55% of the coniferous group. Fourth, in the deciduous forest, the mix of shade-tolerant and shade-intolerant species is roughly equivalent. However, stone birch comprises 69% of the shade-tolerant category, and white birch accounts for 63% of the shade-intolerant group.

*Table 5.* 1978 Inventory Data for the Soviet Far East for Fully-stocked Stands (mm $m^3$)

| | Coniferous Species | | | | Deciduous Species | |
|---|---|---|---|---|---|---|
| | Spruce-Fir | Pine | Larch | Total | Shade Tolerant | Shade Intolerant |
| Maritime | 562 | 569 | 168 | 1299 | 352 | 200 |
| Kharbarovsk | 1894 | 254 | 2436 | 4584 | 159 | 322 |
| Amur | 83 | 58 | 1468 | 1609 | 15 | 262 |
| Kamchatka | 44 | -- | 115 | 159 | 452 | 83 |
| Magadan | -- | -- | 368 | 368 | -- | 26 |
| Sakhalin | 399 | -- | 171 | 570 | 53 | 13 |
| Total | 2982 | 881 | 4726 | 8589 | 1031 | 906 |

Notes: 1) Shade-tolerant species include primarily ash, oak, and stone birch. Shade-intolerant species include primarily white birch, aspen, basswood, and poplar.
2) Data are compiled from Zausaev, Sheyngauz, and Runik (1984), Table 2.6.

Larch merits special comment because of historical concern that the abundance of this species represents a major hurdle to expanded utilization of the Far Eastern forests. Problems with larch are caused by its high density, hence hardness and weight, and its high resin content. Larch also has some advantages in the marketplace however. Its strength characteristics make it well suited for structural applications and it is known for its resistance to rot and decay (Fenton and Maplesden, 1986).

Data from the Japan Lumber Journal (various issues) suggest that larch successfully penetrated the Japanese market many years ago. In the mid-1960s, 20-25% of Japanese sawlog imports from the Soviet Union were larch. The share of larch climbed to 30% by 1970 and hovered between 35-40% in the late 1970s. In 1985-1987 the share had fallen to 33% which may be partially explained by the large reduction in total Soviet exports to Japan. Larch is widely accepted in Japan and it seems clear that price discounts have been adequate to adjust for species preferences (delivered prices of larch logs in the Japanese market were 60% of fir and red pine log prices in 1988).

Not only is larch lumber used in packaging uses in Japan, but it is commonly used in construction applications, such as sills, rafters, and rafter supports. Apparently, some companies have also experimented with using it in decorative applications (Fenton and Maplesden, 1986). The major technological breakthroughs in larch consumption have been in veneer/plywood manufacture and pulping. Larch plywood is produced in Siberia and at least three veneer/plywood mills in Japan utilize larch. Fenton and Maplesden (1986) report that except for stiffness, most physical properties of

larch plywood are superior to those of lauan. Larch chips constitute a significant share of the softwood chips exported by Soviet enterprises, and one pulp mill on Sakhalin Island uses larch exclusively.

From the perspective of wood utilization, it does not appear that the large volumes of larch in the Soviet Far East comprise a serious impediment to expanded development. In fact, the larch share of the Far Eastern timber harvest has increased over time and now represents 40-45% of total harvest; thus, it is nearly proportional to its share of standing timber volume. However, the location, size, and

The annual allowable cut (AAC) serves as a useful guide to potential harvest levels, though it may be questioned on theoretical grounds, and more practically, is subject to large measurement errors. The current AAC for the Soviet Far East (excluding Yakutia) is estimated to be 72.7 mm $m^3$ (see *Table 6*). This seems reasonably consistent with estimates of biological productivity. To determine the mean annual increment (MAI) for the Far East, we sum the MAI for all subregions. The MAI for each subregion is computed by multiplying estimates of MAI per hectare times the Group IIIA forest land area.[5] We use the following estimates of MAI (in $m^3$/ha/yr): Maritime, 1.6; Kharbarovsk, 1.2; Amur, 1.2; Kamchatka, 0.8; Magadan, 0.5; and Sakhalin, 1.5 (Zausaev, Sheyngauz, and Runik, 1984). This method yields an estimated MAI of 84.5 mm $m^3$ for the Far East, and an average MAI of 1.15 $m^3$/ha/yr for the region.[6,7]

Given even-flow regulations in the USSR, timber stock calculations also suggest that the AAC levels in the Far East are in the appropriate range. The Soviets demonstrate a serious concern for the long-run sustainability of the forest, which is suggested by references to the eternal nature of production units. An even-flow constraint is implicit in their AAC calculations. With this perspective,

5. Group IIIA forests form the basis for well over 90% of the allowable cut calculation.
6. One published estimate suggests that the MAI for the Far East (excluding Yakutia) is 108.6 mm $m^3$ (Zausaev, et al., 1984). However, we use our method because we are not certain if the published estimate is restricted to growth on lands that are exploitable in the near term.
7. Given what we learned about yield functions in the Maritime kray, these estimates of MAI/ha/yr seem to be on the low side. International comparisons also suggest these estimates may be low. For example, the MAI for British Columbia is 2.3 $m^3$/ha/yr which ranges from a low of 1.3 to over 5 in the coastal zone (Bickerstaff, Wallace, and Evert, 1981). Questions also arise concerning the distinction between actual MAI and potential MAI under different forest management regimes. Although we pursued this matter in some detail, a fuller investigation was not possible. The task is especially difficult due to both the inherent complexity of forest mensuration and differences in regional practices.

the relevant question of forest potential becomes: what level of cut can the standing inventory of mature trees sustain until regenerated stands have time to mature? Since average stocking levels for Group IIIA forests are not available, the forest potential may be estimated as follows. For each subregion, multiply average stocking levels for fully-stocked stands times the Group IIIA area. This calculation yields 7.63 $bm^3$. Assuming a 100-year conversion period, the production potential of the forest is 76.3 mm $m^3$/yr. However, the potential declines to 63.6 mm $m^3$ for a 120-year conversion.

The huge land base in the Soviet Far East makes the AAC seem comparatively low by international standards. Interestingly, the AAC for British Columbia in 1987 was 72.2 mm $m^3$ (Cuthbert, 1989), which is almost identical to our estimate for the Soviet Far East. Yet the net productive land base in B.C., which constitutes the basis for this estimate, is only 35.4 mm ha (B.C. Ministry of Forests, 1980). Significant differences in timber growth rates, stocking levels, and forest management practices are largely responsible. For example, the MAI in B.C. is estimated to be 2.3 $m^3$/ha/yr (Bickerstaff, Wallace, and Evert, 1981) and managed stands on medium-to-good sites may yield 10 $m^3$/ha/yr on the coast and 4 $m^3$/ha/yr in the interior regions (Merkel, 1989).

How do historical harvest levels compare with this production potential? Harvest levels have not been published in official statistical yearbooks since 1976 when this information was deemed classified; however, it is now possible to obtain updated data from local authorities. *Figure* 2 depicts the harvest levels for the Far East (including Yakutia). The rapid expansion between 1970 and the late 1970s was a continuation of the harvesting expansion observed in the 1960s in this region. As can be seen in *Figure* 3, most of this expansion was fueled by increases in the Kharbarovsk kray. The more modest expansion between the late 1970s and late 1980s was due to harvest increases in Amur oblast (*Figure* 4). Extrapolation of these harvest levels suggests that harvest increases may be quite limited over next decade. Linear regression over the full 1970-1988 period indicates the harvest will increase 2.9 mm $m^3$ from 1986-1988 to reach 38.7 mm $m^3$ in 2000. Eliminating the rapid expansion of the 1970s, a regression over the 1975-1988 period leads to a prediction of only 37.1 mm $m^3$ by 2000 (1.3 mm $m^3$ greater than 1986-1988). It is also interesting to note that there has been virtually no expansion since 1978. While much of the pattern between 1978 and 1988 can be explained by the world recession in the early 1980s, this stagnation also may be due to a lack of attractive new production opportunities.

One method to quantify supply tightness is by comparing timber removals with the AAC in each subregion. In *Table 6*, we present the effective utilization rate for timber production -- the actual level of removals divided by the AAC. Since the reported harvest levels represent log deliveries to mills, we have adjusted these data to improve the estimates of removal levels. First, we adjust all data for losses in tree-to-log conversion (for example, branches and tops) and assume this loss to be 10% throughout the Far East. We then adjust tree harvests to account for felling losses. Felling losses vary considerably across regions and range from as low as 5% in Sakhalin oblast to 30-35% in the Maritime

Figure 2. Soviet Far East Timber Harvest

(million cubic meters)

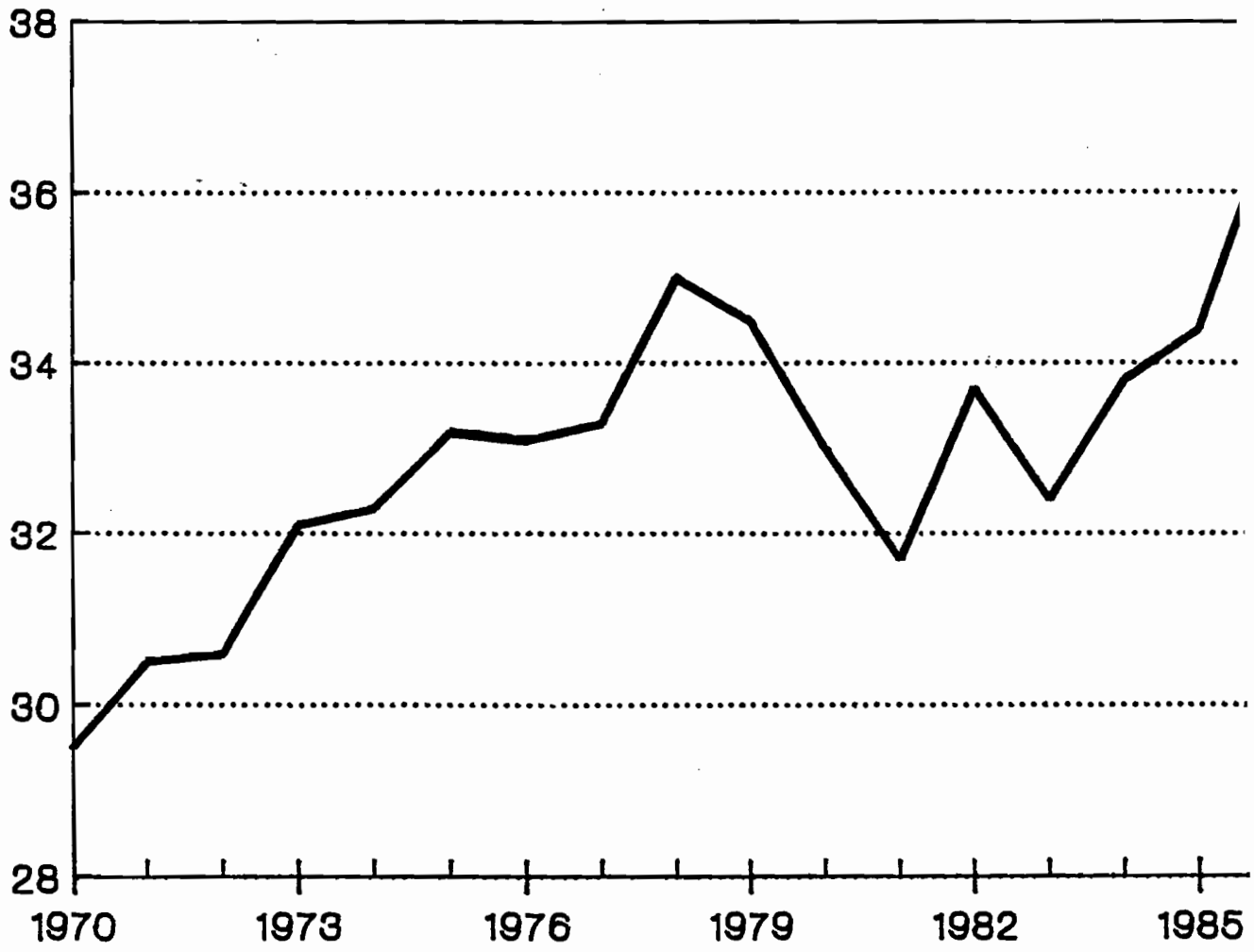


Figure 3. Kharbarovsk Timber Harvest

(million cubic meters)

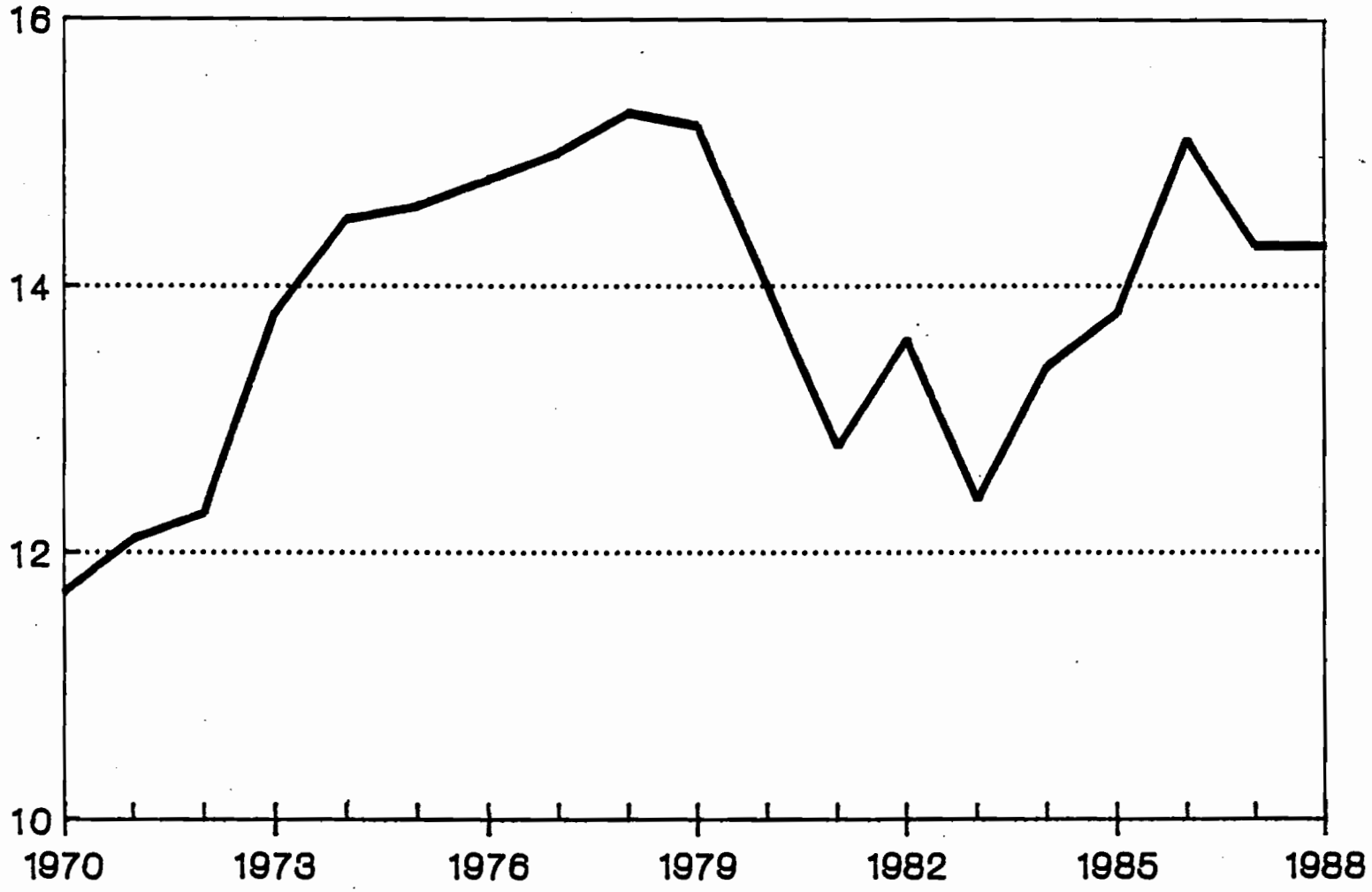
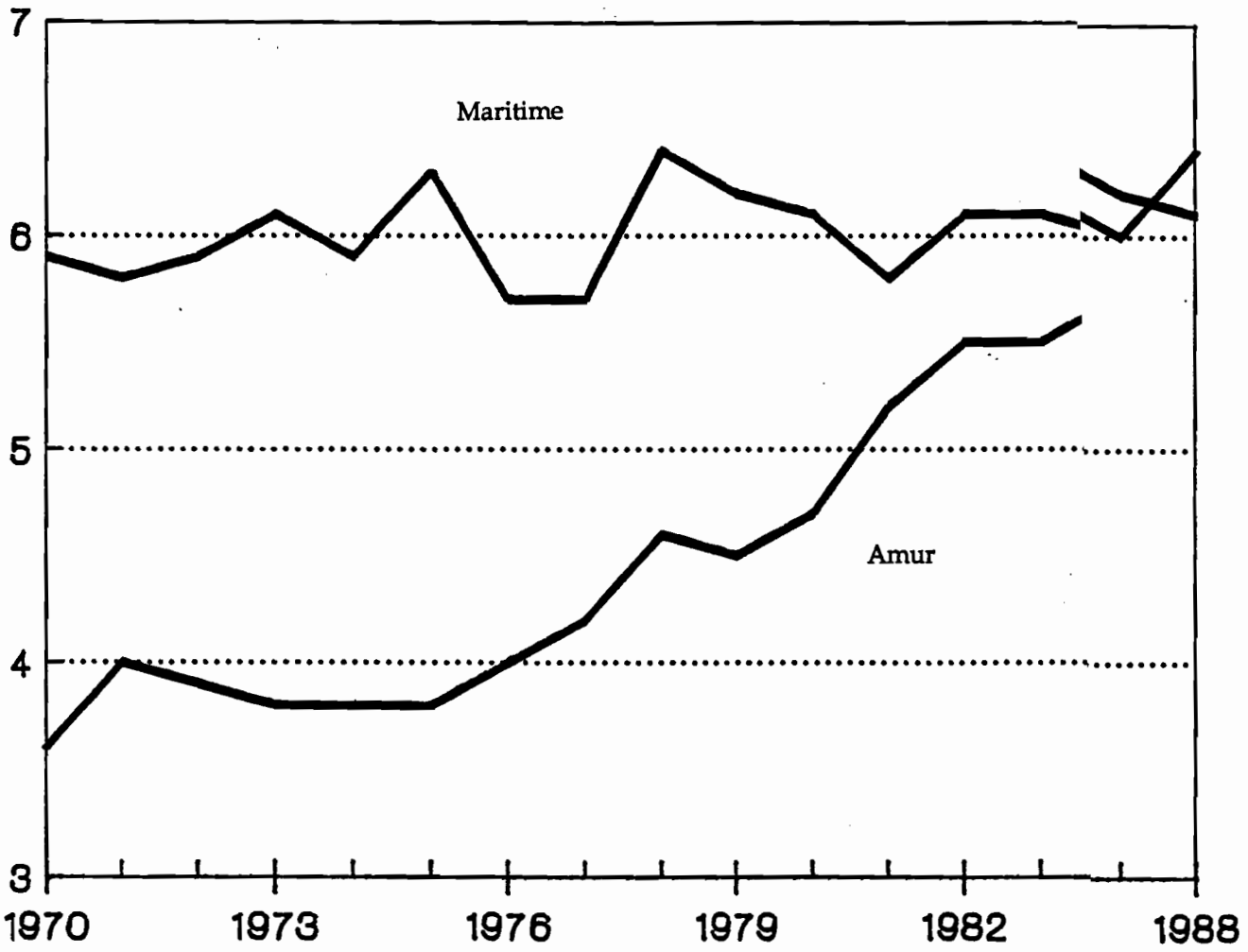


Figure 4. Maritime and Amur Timber Harvest

(million cubic meters)



kray. The term "felling losses" is used loosely here -- while it is intended to include only true felling losses or logging residues, it also includes some material left behind due to so-called selection felling. Much of this material consists of suppressed and undesirable trees, hence unmerchantable material. While forest plans call for the harvest of these residual stands at some future date, there are apparently few instances of loggers returning to cut such sites. Although our calculation overstates removals, we believe it is a more realistic way to view the harvest situation. The high effective utilization rates in *Table 6* present a less sanguine picture of the expansion potential than that suggested by previous analyses which simply compare reported harvested levels to the AAC. Furthermore, these data suggest that supply is particularly tight in some regions; one of these is the Amur oblast which has been the primary source of expansion in recent years.

*Table 6.* Timber Removals and AAC in Soviet Far East Regions (mm $m^3$, except where % is indicated)

| | Reported Harvest Level 1986-1988 Average | Felling Losses | Removals | AAC | Effective Utilization Rate |
|---|---|---|---|---|---|
| Maritime | 6.2 | 35% | 10.6 | 14.1 | 75% |
| Kharbarovsk | 14.6 | 30% | 23.2 | 37.7 | 61% |
| Amur | 6.2 | 25% | 9.2 | 10.8 | 85% |
| Kamchatka | 1.0 | 20% | 1.4 | 1.7 | 82% |
| Magadan | 0.4 | 25% | 0.6 | 1.0 | 56% |
| Sakhalin | 3.5 | 5% | 4.1 | 7.2 | 57% |
| Total | 31.9 | 27% | 49.1 | 72.7 | 68% |

Notes: 1) Removals are calculated by first assuming that there is a 10% loss in converting from felled trees to delivered logs (harvest quantities). Removals are then computed by adjusting the volume of felled trees upward to account for region-specific felling losses.
2) The AAC figures for Maritime, Kharbarovsk, and Kamchatka are from 1965 (Agyeyenko, 1969) since they have undergone only minor changes in the past 20 years. There have been significant downward revisions in the AAC in Amur, Magadan, and Sakhalin and the 1965 figures have been adjusted to reflect current estimates.

It is well recognized in the Soviet Far East that timber stands are being high-graded for sawlog material, and that this practice has constrained total harvest levels. Poor resource use is indicated by the distribution of roundwood consumption by the lumber, plywood, and pulp and paper industries: in 1985 100% of roundwood used by these industries in the northern zones (Kamchatka oblast, Magadan oblast, and Yakutia) was consumed in lumber manufacture, 99% in Amur oblast, 98% in

material on harvested sites, but also the utilization of material growing on poor sites.

Many Soviets appear to believe that prevention of further degradation of the forest is an essential goal: harvesting practices have caused a backlash of criticism concerning forest management in the region and public opposition to harvest expansion has been reflected in recent political campaigns. Hence, future timber production will likely emphasize better management of the resource around existing facilities, rather than continued high-grading in new regions.

A discussion of timber removals would not be complete without some mention of the important role of fire in this ecosystem. About a million hectares burn each year in the Far East, half of which are forested. Losses amount to 25 mm $m^3$ annually, or about 70% of the harvest. In 1978, 8.7% (13.6 mm ha) of the commercial forest land was classified as "burned and destroyed." One particularly large fire in 1976 burned several million hectares in the prime-producing areas of Kharbarovsk and Maritime krays. The fire was hot enough to consume all of the topsoil in some places, and vast areas are covered only with small birch trees. Because of the serious threat which fire poses to the forests of the Far East, fire control receives a large share of the funds allocated for forest management activities.

## 4. ENVIRONMENTAL AND ECOLOGICAL CONSTRAINTS ON TIMBER SUPPLY

Environmental and ecological constraints limit the utilization of Soviet forests for industrial wood production. Silvicultural practices, prescribed in Soviet forest law, generally require that timber be harvested with a form of selective cutting. For example, in Kharbarovsk kray (the largest producing region), this involves a 16-cm diameter cutting limit for softwoods and a 20-cm diameter limit for hardwoods. Because the forests are stratified by species, this practice is a form of high-grading and tends to reduce the fir and spruce components of the stands while increasing the share of birch and larch. Clearcutting accounts for only about 25% of the volume of timber produced.

The forests of the Eastern Soviet Union provide medicinal plants, edible foods, and animals and furs of commercial value. Timber harvesting diminishes some of this wealth and as a consequence, environmental concerns are likely to constrain the future expansion of harvests. These constraints will take the form of reductions in land area available for harvesting, restrictions of felling methods, and limitations on the use of some species. The Group IIIA forests -- exploitable and accessible -- contain many areas that would be classified as protection forests were it not for their

small size. Examples include buffers along small streams and small areas with steep slopes or unsuitable terrain. As management practices become more sophisticated, it will be possible to recognize such areas and exclude them from harvest activity. For example, in Maritime kray, the area of Group IIIA forests could decline 10-15% by the end of the century due to this effect.

Harvesting of Korean pine, locally known as cedar, has been effectively banned throughout the Soviet Far East due to the scarcity caused by earlier episodes of intensive felling and fire damage. These forests are home to the Ussuri tiger, which is endangered in the Soviet Union and hence protected by legislation. In the Far East, over 4 mm $m^3$ of Korean pine were harvested in 1980, but legal restrictions reduced the cut to 2 mm $m^3$ in 1985 and banned cutting altogether by 1989.

Until recently, Korean pine accounted for over 1/3 of the total harvest in the Maritime kray. To maintain aggregate production in the face of this ban required intensifying the harvest of other commercially-valuable species, especially spruce and fir. Harvests are progressing from the lower elevations into the mountains where the spruce-fir forests provide an important protective function for upland watersheds. Hence future harvests of these forests may be reduced as well.

Because of environmental concerns, all river driving of free-floating logs will probably be forbidden by the early 1990s. This is particularly important because over half the commercially-exploitable forest is accessible to water transport, compared to only 22% accessible to existing roads (Barr, 1989). Logs may still be floated on rafts on some of the larger rivers. One example is the Amur river and another is the Lena river in Yakutia where log rafts are moved to the port of Tiksi on the Arctic ocean.

## 5. INFRASTRUCTURE

Infrastructure, especially the limited extent of railroad and highway networks, remains an important impediment to expanded timber supply from the Soviet Far East. As discussed earlier (and shown in *Table 4*), 39% of the fully-stocked forest land is classified as unavailable, and in many areas, limited access is the primary obstacle to harvesting. The problem is particularly severe in Magadan and Kamchatka, and the figures would be more dramatic if Yakutia were included.

In the difficult climate and terrain of the Far East, railroads form the principal transportation network. Although the Baikal-Amur Mainline (BAM) was recently completed, it carries only 1 million tons of freight per year compared to its design capacity of over 30. Recent logging expansion has been in areas adjacent to this railroad, and forest planners have fully incorporated the output from these areas in their estimates of AAC.

Because of difficulties in access and the declining quality of stands as one moves northward, much of this wood is economically marginal at best. The only areas that can be seriously considered

for their potential supply in the near term are those along BAM, where investment in infrastructure has already been made. However, as discussed by Fenton and Maplesden (1986) and Barr (1989), these stands frequently are not high-quality virgin timber. Some areas apparently had been harvested larch forests in that region are largely untapped, there are some questions concerning the quality of the resource. In the areas now being penetrated by the railroad, stocking densities are low (about 50 $m^3$/ha) and trees are small (averaging 18-24 cm DBH). Harvesting costs in this region are high and it seems likely that most of the timber produced will be consumed locally.

Locomotive and railcar shortages occasionally limit the transport of logs and lumber. However, railcar shortages are more frequently encountered in China and this appears to be a key bottleneck in international trade. About half of the shipments between the Soviet Far East and China are made by sea transport, and three rail links carry the bulk of the remainder (some pulp logs are also shipped to the pulp mill at Jiamusi via the Songhuajiang river). Logs are reloaded from Soviet railcars to Chinese cars at the border, and delays have occurred at transshipment points.

The Soviet Far East possesses ample port facilities for exporting forest products. Aside from several small ports along the coast, there are major commercial ports at Nahodka, Vostochny, and Vanino.[8] Although Vladivostok and Pos'yet accounted for over 20% of log exports in 1972 (Barr, 1989), log exports from these cities stopped in the mid-1980s since they were no longer needed. The excess capacity of these ports may be explained by improvements in efficiency at other ports, and the shift in exports to China, half of which move by rail.

River transportation of logs in the Soviet Far East is relatively unimportant, and now accounts for less than 10% of all log transport. As mentioned earlier, river driving of logs has been effectively banned, primarily for environmental reasons. Rafts are still used on large rivers like the Amur and Lena. Some special-purpose log carriers are used on the Amur and Songhuajiang rivers.

8. Fenton and Maplesden (1986) reported that Japan imported sawlogs from 18 Soviet ports between 1979 and 1984.

## 6. LABOR AND CAPITAL

The forest sector has not escaped the chronic labor shortages of the Soviet Far East. Two means have been used to alleviate this problem: the substitution of capital for labor, and the use of "guest workers" from other communist countries. Because capital is also scarce, the former is difficult to achieve but we observed several examples. One is the increased use of mechanized harvesting which has risen from about 5% in the mid-1970s to perhaps 20% currently. A principle piece of equipment used is the Soviet-built LP-49 feller-forwarder, which replaces a crew of four fallers with a single equipment operator while achieving the same level of output. This machine, which costs about 30,000 rubles, utilizes a chainsaw felling head and a clam bunk for accumulating the felled trees. Like the skidders we observed, the vehicle is tracked with live ground wheels to reduce soil compaction.

Currently, "guest workers" from North Korea, Cuba, China, and Vietnam comprise about 10% of the logging labor. These laborers are paid through a barter arrangement. Labor costs are based on Soviet wage rates. Other log production costs -- supervisor, camp operation, capital depreciation, and stumpage fees -- are also allocated to log production. Logs and chips are then apportioned between the Soviet Union and the participating country in relation to these cost shares.

Although a sizable quantity of labor is available from these labor surplus areas (especially northern China), there are constraints on expansion. These workers create a need for social infrastructure -- shops, housing, medical care, etc. -- which are already in chronically short supply for the Soviets. Although loggers operate on an incentive system much like the piece rate system used in many places in the U.S., logging productivity is low and the cost of labor has increased over time. Not only does importation of labor do nothing to breach these problems, it may exacerbate them by dampening incentives for new investment in labor-saving capital. Finally, there is some concern that foreign labor will not maintain the care in resource stewardship that might be expected from the "owners" of the land.

One new approach suggested for the problem of labor and capital scarcity is a three-way joint venture. Labor would be supplied by existing partners. Higher technology labor-saving capital would be supplied by a Western country. The Soviets would, of course, provide the timber and infrastructure, and the output would be divided much as with the traditional joint venture. This would solve the short-run labor scarcity problem, while forming the foundation for long-run increases in labor productivity.

## 7. PROFITS, PROCESS DEEPENING, AND FOREIGN EXCHANGE

Profits are calculated at each level of processing -- logging, lumber production, etc. Profit equals the difference between state-administered prices and costs. For products which are exported to countries with convertible currencies, prices are multiplied by "long-run hard currency coefficients." These coefficients are designed to correct for disparities between the internal prices for inputs and world market prices.

The cost calculation conforms very much to U.S. definitions and includes direct variable costs such as labor and fuel as well as charges for capital depreciation (15%/yr of capital deployed) and an interest charge for funds used. Logging enterprises must purchase timber and the stumpage fee is determined on a derived basis, much as in U.S. Forest Service appraisal process or Canadian stumpage pricing practices. Factors such as species, stand density, and distance to mill should affect the stumpage charge. In practice however, stumpage prices are only token charges ranging from 0.5 to 1.5 rubles/$m^3$, or 0.85 to 2.55 USD/$m^3$ at the official exchange rate, and substantially less at the unofficial rate. The price of logs delivered to the mill has not been updated since 1982 -- in many areas log prices paid by mills actually fall significantly below the cost of harvest and delivery. Stand access is clearly subsidized and restructuring to emphasize improved efficiency could lead to significant reductions in harvest levels.

Most of the profits generated by an enterprise do not accrue to that unit of production. Profit distribution depends on the product but always heavily favors the central authorities. For present forest enterprises, more than 70% of the profit flows to the central budget, 2-3% to the local government, and about 2% to the territorial ministry; the remaining 20% of the profit accrues to the enterprise. Part of the enterprise's share is used for reinvestment, and part for output-based incentives for workers. Clearly, the current distribution of profits blunts the effect of the profit motive at both the enterprise and territorial level, and thus is one of the main targets for reform under *perestroika*.

Current psychology strongly favors seeking additional value added -- or process deepening -- as the appropriate direction for wood products exports. Although this attitude is prevalent in many parts of the world, it is typically used to encourage employment or improve the utilization of installed capacity. Because the Soviet Far East is a region experiencing both labor and capital shortages, the rationale for deepening is somewhat more tenuous. Generally, those who seek to maximize hard currency earnings argue that more value must be added in the Soviet Union.[9] Processing logs into

9. However, it is interesting to note that "long-run hard currency coefficients" range from 1.1 to 1.3 for logs and are close to 1.0 for lumber; hence these levels favor the export of logs to the production of lumber, either for domestic consumption or for export.

lumber in the Soviet Union converts ruble-denominated labor into hard currency.[10] An alternative objective is maximizing "export effectiveness," measured as export dollars earned per ruble input. The outcome of the efficiency debate is uncertain and depends on the choice of accounting methods.

The importance of hard currency earnings in Soviet decisions is closely linked to the critical issue of exchange rates. Currently there are large discrepancies between official and black market exchange rates (the black market may offer 10 times the rate as the official market). The black market exchange rate is the appropriate measure of the shadow price of foreign exchange. Hence, calculating ruble-denominated export prices using black market rates would have a dramatic effect on the economics of timber harvesting in the Soviet Far East. At these exchange rates, much of the discussion concerning the high cost and low profitability of Far East timber production would be misleading. For example, from the Soviet perspective, measurement of export prices in this manner would be equivalent to a tenfold increase in Pacific Rim log and lumber prices.

The impact of policy changes which narrow the gap between official and unofficial exchange rates must be interpreted cautiously. If, due to a large-scale restructuring of the economy, such a change were to occur, significant changes in Soviet production costs would also likely occur. Since the shadow value of prices and costs are unknown, the net effect on the profitability of the Soviet forest sector remains uncertain.

## 8. CONSUMPTION TRENDS: SOVIET WOOD FOR SOVIET CONSUMERS?

It is not possible to estimate accurately the level of log and lumber consumption in the Far East due to the significant share of exports from the region, including both exports to other countries as well as shipments to other regions of the USSR. Although the level of sawlog exports to Japan and China is known, it is not possible to obtain time-series data on regions of origin. As for domestic shipments, Barr (1989) reports that in 1985, 1.5 mm $m^3$ of sawlogs were shipped long distances to domestic markets in Kazakhstan and Soviet Central Asia, and 0.9 mm $m^3$ of lumber were shipped to domestic points outside of the Far East. Time-series data on domestic shipments are not available.

While the lack of data prohibits estimation of consumption behavior in the Soviet Far East, it is possible to make a rough approximation of per capita consumption levels. The total harvest in 1985 was 34.4 mm $m^3$. We estimate that 1985 shipments out of the region were: 6.1 mm $m^3$ of sawlogs (1.5 to domestic locations and 4.6 -- or 70% of the 6.5 shipped to Japan and China -- to export); 1.3 mm $m^3$

10. Depending on the price structure of the market, it is possible that further processing can result in value reduction. Because the Japanese have a strong preference for logs, they may pay a high price for logs and a comparatively low price for lumber. Apparently there is evidence of such price discrimination: Fenton and Maplesden (1986) report that the Soviets receive less money for lumber than for the equivalent volume of logs needed to produce that lumber.

of pulpwood (total exports to Japan and China); and, 2.6 mm $m^3$ of lumber in roundwood equivalent form (assuming 50% recovery, and 0.9 shipped domestically and 0.4 exported). Thus, roughly 24.4 mm $m^3$ of roundwood were consumed by the 7.2 million people in the Far East, indicating a consumption rate of 3.4 $m^3$/capita. Population projections suggest future growth will be substantial, rising from 7.8 million now to 9.5 million by 2000. If wood per capita consumption rates remain at recent levels, an additional 5.8 mm $m^3$ of wood would be needed in the Far East by 2000. We should also note that domestic wood shortages are quite apparent at the current time, but it is difficult to assess the extent of these shortages since scarcity is not reflected through price adjustments. Given stated goals to improve domestic welfare, this scarcity should generate even greater pressure for higher consumption in the future.

## 9. DISCUSSION

The potential for expanded sawlog exports from the Soviet Far East is quite limited. The most critical dimension of the problem is timber availability. In spite of the vast reserves of timber in this region, economic conditions, environmental restrictions, and institutional factors limit the possibilities for additional harvesting. The most favorable locations have been heavily cut and the share of deciduous and low-quality trees has risen sharply. The northern areas, such as Yakutia, remain too remote and contain too much low-quality wood to contribute significantly to export markets. Only the areas adjacent to BAM in Kharbarovsk kray and Amur oblast hold much potential for increased harvesting over the next 10 years. An additional harvest of 3 to 5 mm $m^3$ of wood by 2000 seems most likely. This view is shared by many Soviet experts and is consistent (though a bit optimistic) with historical rates of harvest expansion. The increase will occur primarily in two regions: Amur oblast will increase 2-3 mm $m^3$ by 2000, while the increase in Kharbarovsk kray will be 1-2 mm $m^3$. Yakutia appears to be the only other region where harvest increases are anticipated (perhaps 1 mm $m^3$). Because of heavy cutting in Maritime kray and Sakhalin oblast, harvests may even decline in these regions.

The limited extent of railways and roads and shortages of labor and capital certainly have an important effect on timber production in the Soviet Far East. However, creative avenues for solving these difficulties are becoming more readily available in the Soviet economy so we do not view these as binding constraints. Because timber supplies are limited by economic, environmental, and institutional constraints, it is difficult to justify aggressive investment in these other factors of production.

Higher harvests do not translate directly into higher sawlog exports for three reasons. First, the composition of the harvest is gradually changing so that more deciduous species and low-quality

coniferous trees will be harvested. An increasing proportion of this wood will not be sawlog quality; hence, it will be more suitable for reconstituted panels and pulp than for lumber production. Second, the projected harvest increases will occur in areas that are relatively far from export ports. Third, anticipated increases in lumber consumption in the Far East will reduce the availability of sawlog material for export markets. The success on increasing regional consumption will depend on the general success of *perestroika*, as well as the need to raise hard currency through the export of wood products.

It is quite likely that there will be some substitution of lumber exports for log exports over the next 10 years, but it is difficult to assess the magnitude of this shift. Given the intensity of the current debate concerning process deepening, the need for capital and labor to accomplish these objectives, and the established markets for Soviet sawlogs, it is safe to assume that any changes will proceed slowly.

Finally, the development of the Soviet Far East must be considered in a world context. As production costs increase, and log quality declines, log exports from the Far East will face stiffer competition from New Zealand and Chilean exporters. In the absence of significant future price increases in Pacific Rim markets, further development of high-cost Soviet resources will be increasingly difficult to justify.

*Perestroika* could significantly alter the present course of development of the Far Eastern timber sector, but even the direction of change is uncertain. Reform that leads to a substantial revision of the division of profits might induce local governments to exploit virgin timber more rapidly: this could be accomplished by eliminating even-flow constraints, reducing stringent environmental constraints, and revamping harvesting practices. It is also possible that economic reform would result in lower harvest levels. Clearer measurement of profits would lead to more efficient resource utilization, and hence harvesting might cease in many subsidized areas where stumpage values are now negative. Low stumpage returns could lead to even more stringent harvest regulations as environmental and nontimber benefits take precedence over timber production. Foreign currency exchange rates are critical in these calculations. Until the nature and extent of institutional reforms become apparent, their impact on the forest sector cannot be predicted more precisely.

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