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Commuting and service travelling of forest workers in Sweden

Skogsarbetskraftens arbets- och servicefärder

by

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FOREWORD

This paper is an abbreviated version of a report by BIRGER YTTERMYR B. A. and the author, entitled "Skogsarbetskraftens arbets- och servicefärder", published as No. 30 in the series "Research Notes", Department of Operational Efficiency, Royal College of Forestry, Stockholm, Sweden. That report also includes a list of publications on the subject.

Professor ULF SUNDBERG, Royal College of Forestry, Sweden was the supervisor of the investigation, read the manuscript and gave many valuable comments on it. I owe many thanks both to him and to Mr. LESLIE TROUP, Forestry Commission, U. K., who also read the manuscript and whose comments and suggestions were of great help to me. Mr. J. Flower-Ellis, Royal College of Forestry, Sweden, has also been of great help in the same respects. The author alone is to blame if, in spite of their work, errors or doubtful statements occur in the text.

Mrs. VERA ÅBERG and Mrs. LUCIA DRUKER typed the text and corrected the proofs. I am very grateful for their help.

Rome, February 1967
MÅRTEN BENDZ

Introduction

Changes in the area-bound branches of the Swedish economy—agriculture and forestry—have been rapid during the last few decades. Development, mainly involving mechanization, has decreased the demand for labour in rural areas and as a consequence, the population in these areas is gradually decreasing. Thus the maintenance of services is becoming difficult.

National and provincial authorities, most forest enterprises, companies, forest owner associations, and others, are working on the problem of the deployment of forest workers. The factors to be considered are principally the following:

1. Possibilities for maintaining existing and setting up new service establishments increase with a more concentrated type of settlement.
   The cost of building homes for workers decreases in more densely populated areas (within limits).
2. The distance to the work site increases when the forest workers' homes are centrally situated. The commuting cost is related to the distance.

In order to evaluate various methods of siting the homes of the forest labour force, information about the factors which affect the problem is needed. Since the problem is complex, touching not only forestry but also geography, sociology and psychology, it was not feasible to investigate all its components in the same study.

This paper, the first step in a research programme, constitutes a detailed study of the work and service travel undertaken by the forest worker.

Note:

Some terms used in this paper are defined on page 39.

1. Plan of the survey

1.1 Objective

The survey had the following purposes:

1. To obtain data on travel distances and time expenditure, types of vehicles used, frequency of car sharing, etc.
2. To examine the correlation between these factors and the site of the home, family circumstances, etc.
3. To study the buying habits, demand for different kinds of services and service travel of the forest workers and their families.
4. To compare different categories of workers in the above aspects and to explain differences.
5. To obtain data for use in planning with respect to the deployment of forest workers, such as cost and time required for commuting and service travel.

The task is thus primarily a data-gathering problem. A detailed report on the study, designed for the purposes mentioned above, is the immediate object of this paper.

1.2 Method of study

Various ways of conducting the study were considered. The most reliable method of personal interviews was too costly and a method using questionnaires distributed on certain days to a randomly selected sample of workers was chosen.

1.3 Population

Only workers with more permanent employment, selected in the way described below (points a—d), were included. The reasons for this limitation are the following:

1. In today's forestry, the worker employed throughout the year is of more interest than the temporary worker.
2. From the point of view of commuting, forest owners working on their own holdings are of less interest. Generally they live on their farm and have their working sites within an acceptable walking distance.
3. Practical reasons limit the range of the survey. In order to draw the sample it is necessary to have a fairly well defined population of workers, preferably available on some sort of list or register.

For these reasons it was decided that the survey should encompass two categories, viz. employees in large-scale forestry (S-workers) and employees in forest owners' associations (B-workers). Large-scale forestry is defined here as forestry organised into ranger districts.

The individual worker to be sampled should meet the following requirements:

(a) He should at the time of sampling (Sep. 1964) be active and on the payroll of the employer.
(b) He should be assumed to continue in his job at least until the turn of the year.
(c) He should work mainly on tasks generally encountered in ranger districts.
(d) He should not be a foreman.

Through the sampling, the individuals making up the population represent a number of statistical observations (see section 1.7).

1.4 Regions

The country was divided into regions, as shown in fig. 1, on the following grounds:

1. To create regions which are homogeneous from the commuting point of view. In this respect there was no supporting information available and subjective estimates had to be made.
2. To enable comparisons to be made with other forest, administrative or geographical conditions, it should link up with other (previous) divisions into regions.
3. To keep the study within a workable size and to retain the desired significance of the sub-groups, between five and ten regions would be required.

The regions are as follows.

Region nNi = inland parts of northern Norrland
nNk = coastal parts of northern Norrland
sNi = inland parts of southern Norrland
sNk = coastal parts of southern Norrland
S = Svealand
G = Götaland

1.5 Questionnaires

Before the questionnaires were finally printed they were tested in five stages and successively modified. The demand for small and easily handled forms was met through the method of data-collecting, which permits a

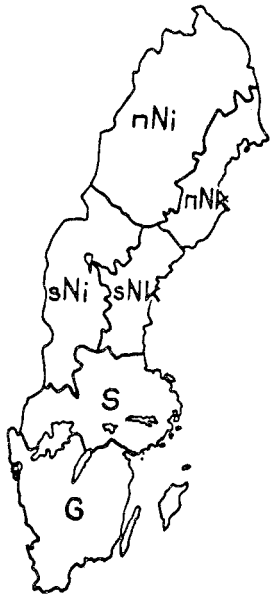


Fig. 1.

breakdown of the questions into three different groups, each printed on a separate form.

Form 1. Questions concerning general matters (family, type of settlement etc.)

Form 2. Questions concerning commuting and daily work.

Form 3. Questions concerning service travelling.

Forms 1 and 3 were distributed once and Form 2 five times during the observation period (see section 2.1).

1.6 Pilot study

To obtain an estimate of the deviation to be expected in the main study, a pilot study was carried out in the summer of 1964. Randomly selected workers all over the country were interviewed. The pilot study gave information about the expected average value and standard deviation for the main factor, viz. daily travelling time (one direction).

1.7 Sample size

The size of the sample was calculated in the following way:

significance level = 95 %

average value (A) to fall within $A \pm \frac{A}{15}$

From the pilot study the following measures were calculated:

average value (A) = 26.4 minutes

standard deviation (S) = 14.8 minutes

(these values were based on 24 observations in the region S).

Required number of observations = n.

$$t_{0.05}\sqrt{\frac{S^2}{n}} = \frac{A}{15}$$

$$2.06\sqrt{\frac{219.5}{n}} = \frac{26.4}{15}$$

$$n \approx 300$$

Three hundred observations are needed for every category and region with these assumptions. It is presumed that observations concerning travelling time are independent provided that they are not located too close in time.

It was decided that every worker should be questioned on five different occasions during a half-year investigation period, which should give information about the average location of the work place during a year.

With these assumptions, the sample size will be $\frac{300}{5} = 60$ forest workers for each category and region. Thus the total requirement is $60 \times 2 \times 6 = 720$ workers or $720 \times 5 = 3{,}600$ observation days.

1.8 Sampling scheme

1.8.1 S-workers

Forest rangers distributed and collected the questionnaires. This category of workers was represented by a two-stage sample in the following way: In the forest employers' associations the ranger districts are listed and a similar list is available for the State Forest. The ranger districts were numbered and for every region, seven districts were chosen at random. In each district eight or nine workers were randomly selected until 60 per region had been listed.

1.8.2 B-workers

Questionnaires were posted direct to the worker and returned by post. This category of workers was represented by a stratified sample in the following way: Every forest owners' association gave an estimate of its

number of employees. From these estimates the number of workers required from each association was calculated. The associations were visited and the required number of workers randomly chosen. Simultaneously their postal addresses were registered.

2. Execution of the survey

2.1 Observation days

Of the above mentioned five observation days, two were during the snow-free period, two in the snow period and one in the forest planting and silvicultural period. In order not to complicate the estimates of distances for campers, the observation days were fixed for days when weekly commuting does not normally take place. Since some workers travel between home and camp not only at the weekend but also in the middle of the week, the observation day was made to fall on Tuesday.

The observation days were the following:

No. 1	10/11-64
2	1/12-64
3	19/1-65
4	16/2-65
5	11/5-65

2.2 Reliability of replies

In order to control the reliability and accuracy of replies, an independent estimate of certain observation factors was undertaken. This estimate was made by the forest ranger together with the officers in charge of the investigation. A sample of ranger districts was visited on every observation day and the distances etc., for the daily commuting of the workers were measured on available maps. These figures were compared with the workers' figures on the questionnaire. Significant differences did not appear.

2.3 Non-response analysis

For workers who did not return the questionnaires concerning the first three observation days, a simple non-response analysis was undertaken. Only the category B-workers was included, mainly because of the very high percentage of response from S-workers (see section 3.3). The analysis was arranged as a postal contact with the forest inspector in charge of the district in which the worker was active. The inspector was asked to fill in a questionnaire instead of the worker on observation day No. 4. The information was tested against the data submitted. Neither for travelling time nor for travelling distance were significant differences calculated.

3. Results

3.1 General

Computations were made with the aid of an electronic computer, making it possible to analyse a great number of combinations of the factors investigated. The results were programmed in frequency tables covering three variables; it was also possible to calculate the standard deviation for one of these variables.

The results are reported with the reservation that they are valid for the selected population of workers only. The investigation did not include the whole forest labour force—only the more permanently employed part of it.

The complete tables are included in the main report. Extracts and abbreviated tables are enclosed in this text.

3.2 Methodological reservation

3.2.1 Randomness

Random sampling was intended. Certain practical restrictions caused deviations from this intention.

1. S-workers. Ranger districts were disregarded in the calculations, as a practical means of simplifying processing. It was shown that there was no significant difference between dispersions within and between districts.
2. B-workers. The sample was not fully random because of the method of drawing. The number of workers to be drawn from every forest owners' association was calculated beforehand on the basis of estimated number of employees. Practical reasons dictated this method; the associations were to be visited one by one. Thus differences between the estimated and the actual number of employees caused this method not to be fully random.
3. All workers. In principle, every worker represents five different values for the factors covered in questionnaire No. 2. Despite the rather long time between the observation days, some co-variation between the observations was still possible. The procedure was dictated by practical reasons. To obtain independent observations, it was necessary to take new samples for every observation day. Because of the great difficulties in gathering the necessary lists for the sampling, this was difficult to accomplish.

3.2.2 "Wild" observations

Before coding the questionnaires, a check for "wild" observations was carried out. Obviously inconsistant figures, for instance, on commuting time and travelling distance were carefully examined. Corrections in the questionnaires were made only if the question had obviously been misunderstood, or the answer given in the wrong unit. In special cases the observation was excluded.

3.2.3 Validity

Since temporarily employed workers and forest owners working on their own holdings were not included in the survey, it is not valid for the whole labour force. Especially concerning the sociological factors, differences between permanent and temporary labour are likely to appear.

3.3 Percentage replies

The questionnaires were returned to the following extent:

Form 1	Percentage replies
S-workers	96.4
B-workers	87.8
All	92.1
Form 2	
S-workers	96.1
B-workers	75.7
All	85.9
Form 3	
S-workers	90.8
B-workers	61.9
All	76.4

The number of values for the factors was less than the figures given above because all questionnaires returned did not represent active workers. In accordance with the instructions given in questionnaire No. 2, the worker

Table 1. Activity on the day of observation.

Category	S-workers		B-workers		All	
	number	%	number	%	number	%
Active.....	1,473	85.2	1,174	86.2	2,647	85.6
Not active....	256	14.8	188	13.8	444	14.4
Sum.....	1,729	100.0	1,362	100.0	3,091	100.0

returned it, even if he had nothing to report concerning the day's work and commuting (table 1).

The 444 "non-active" observations derives from the observation days in the following way:

Observation day No.				
	1	10 Oct.	1964	11.3 per cent
	2	1 Dec.	1964	17.0 ,,
	3	19 Jan.	1965	12.8 ,,
	4	16 Feb.	1965	18.5 ,,
	5	11 May	1965	40.4 ,,
				100.0 per cent

The high figure for observation day No. 5 indicates that in spite of the method of sampling, the workers were, to a considerable degree, working seasonally.

3.4 General data about the workers

3.4.1 Age distribution

The age distribution for the workers selected (table 2) corresponds closely with the distribution reported from the population census for forest workers.

Table 2. Age distribution.

Age	Per cent
—30	21.7
31—45	38.8
46—	39.5
	100.0

Median age	S-workers	44.7 years
	B-workers	38.9 years
	All	42.4 years

3.4.2 Civil status

The number of workers who were married differed between the categories, 62.1 per cent of S-workers and 49.8 per cent of B-workers being married. The difference is partly explained by the differences in age between the categories.

3.4.3 Number of children

By combining the information for number of children and civil status, it is possible to compute the average family size (table 3).

Table 3. Average family size (including the worker).

Average family size	Category		
	S-workers	B-workers	All
all workers	2.69	2.40	2.56
married workers	3.72	3.82	3.76

Differences between the categories primarily depend on differences concerning age and civil status. Between regions there were small differences in civil status.

3.4.4 Ownership of motor vehicles

Table 4 shows ownership of motor vehicles in different regions. The borrowing of vehicles from, for instance, relatives or friends is not included.

Table 4. Ownership of motor vehicles (per cent).

Region / Owns	nNi	nNk	sNi	sNk	S	G	All
car	64	73	49	49	54	60	58
motor-cycle, moped	25	13	36	31	26	31	27
no motor vehicle	11	14	15	20	20	9	15

It may be seen that 85 per cent of the workers own some kind of vehicle. Between S- and B-workers there is no difference, but ownership of a car is more common for younger workers than for older ones.

3.4.5 Duration of forest employment

Table 5 shows the workers' active years in forestry. The question was put: "What year did you start regular work in forestry?" Since continuity was not asked for, it is possible that breaks of different length might have occured.

Table 5. Duration of forest employment (accumulated per cent).

Category / Least No. of years in occupation	S-workers	B-workers	All
0	100	100	100
10	80	59	70
20	54	37	46
30	29	21	25
40	12	8	10

3.4.6 Employment on own holding

One-third of the workers were farming their holding (agriculture or forestry or both) beside their occupation as forest workers. There was no difference in this respect between the S- and the B-worker, but the latter farmed larger holdings on the average.

3.4.7 Place of home

Different methods are available for describing the workers' place of home. In the main report these methods are briefly discussed. The distance to establishments with local utilities (food shops) was used.

The following medians (km) were calculated:

Region	
nNi	3.8
nNk	1.4
sNi	2.2
sNk	2.0
S	2.4
G	3.3

There were considerable deviations from these values. The upper quartile was in nNi = 16 km and in G = 5 km. S-workers had on the average a longer distance to local utilities than B-workers, the upper quartile being 7.3 and 5.4 km respectively.

4. Results—Commuting

4.1 General

Work travelling refers to daily as well as to weekly commuting. Because of the great difference between these concepts, they are separated in the following text. To indicate the extent of weekly commuting, camping (which must be provided when weekly commuting occurs) will be described first together with some other general facts.

4.1.1 Camping

Table 6 shows the number of nights spent in camp as a percentage of total number of nights investigated.

Table 6. Frequency of nights in camp.

Region	nNi	nNk	sNi	sNk	S	G
Frequency	25	10	31	11	6	1

In total 13.5 per cent of investigated nights were spent in camp. No differences between S- and B-workers appeared. Since the question ("Did you spend last night in camp?") was put on Tuesdays, the 13.5 per cent does not mean that $13.5\,\% \times 365$ nights per annum are spent in camp on the average. If the number of working days is 220 per annum, and if four nights are spent in camp every week, the average number of nights in camp per annum for all workers is calculated to be approximately 25.

4.1.2 Car sharing

The frequency of car sharing is calculated as the number of individual journeys sharing a car as a percentage of the total number of individual journeys. On the average, 30 per cent of all work travel took place in shared cars, the range being 20 to 41 per cent for different regions.

A higher percentage of S-workers than B-workers shared cars. This might be an effect of more concentrated logging areas.

The number of commuters per vehicle varied widely. As a rule, the workers

go in pairs but, because of larger vehicles in large-scale forestry (S-workers), up to nine workers have been observed in the same bus.

The frequency of car sharing increases with the commuting distance. If the distance exceeds 30 kilometers the frequency calculated is 75 per cent.

4.1.3 Type of work

Table 7 shows the type of work on the different observation days (per cent).

Table 7. Typ of work (per cent).

Observation day	1 Nov.	2 Dec.	3 Jan.	4 Feb.	5 May	All
Cutting	69	69	68	67	46	64
Skidding	18	22	23	24	16	21
Silviculture	4	1	—	—	27	5
Miscellaneous	9	8	9	9	11	10
Sum	100	100	100	100	100	100

4.2 Travel distance

4.2.1 General

Distances reported in this part always mean one-way trips. Total distances are given in kilometres and the walking distances in metres. The latter have generally been stated by the workers to within 100 metres.

4.2.2 Weekly commuting

Table 8 shows the distance between home and camp for campers. As the number of observations in the southern parts of the country are few, the figures representing regions S and G are uncertain.

The distribution in the distance classes is as follows (per cent).

Distance class (km)	Percentage distribution
— 10	17.0
11— 20	19.3
21— 30	24.3
31— 40	15.9
41— 50	11.2
51— 75	6.3
76—100	3.7
101—	2.3
	100.0

It can be seen that one-third of the observations includes distances shorter than 20 km. Those skidding by horse and forced to camp because of the horse, probably constitute a great part of these commuters.

Table 8. Weekly commuting distances (km).

Measure of location \ Region	nNi	nNk	sNi	sNk	S	G
mean value.....	35	49	22	28	(37)	(42)
median value.....	24	45	22	26	(13)	(44)

4.2.3 Daily commuting—total distance

Table 9 shows the mean commuting distance. The standard deviations are of the same magnitude as the mean values. This means—because of the absence of negative commuting distances—that the distributions are onesided and the variation range extended.

Table 9. Mean commuting distance (km) per region and category.

Category \ Region	nNi	nNk	sNi	sNk	S	G	All
S-workers.....	9.5	16.4	15.8	10.7	7.4	5.5	11.0
B-workers.....	9.0	11.5	8.8	12.1	10.5	12.7	10.8
All.....	9.3	14.5	12.4	11.3	8.7	9.0	10.9

The table shows that:

1. The two categories have on the average the same commuting distance.
2. The frequency of camping (high in nNi and sNi) causes the daily commuting distance to decrease. It will be noted that we had expected longer distances in the north and shorter in the south.
3. The difference between the categories in South Sweden is substantial, and probably depends on differences between the location (concentration) of forest areas and on the planning of the operations.

Camp-based workers had shorter commuting distances than home-based workers, the mean values being 3.4 km and 12.0 km respectively.

Median values were lower than the mean values in all regions. For all regions the median value (= 6.3 km) is calculated from the following distribution:

Daily commuting distance (km)	Percentage distribution
— 5	44.9
6—10	20.0
11—20	18.2
21—30	9.6
31—40	4.7
41—	2.6
	100.0

The distributions are quite similar for the two categories. The difference (S-workers 6.6 km and B-workers 5.8 km) is partly caused by the B-workers' more commonly working on their own holdings. Such work generally implies short commuting distances.

4.2.4 Daily commuting—walking distance

It was presupposed that the commuting of forest workers always includes walking. The walking (also skiing) distance was separately noted by the sampled workers. This part of the commuting is of interest because of its low speed (approx. one-tenth of the speed with vehicles).

Table 10. Mean walking distance (metres) per region and category.

Region / Category	nNi	nNk	sNi	sNk	S	G	All
S-workers	826	431	784	638	513	133	547
B-workers	1,036	627	723	771	470	246	628
All	915	506	755	695	493	188	583

Table 10 shows that:

1. There were small differences between the categories.
2. The walking distances are longer in the north and shorter in the south. This is mainly an effect of differences in road density.

Camp-based workers had longer walking distances than home-based workers, the mean values being 791 m and 552 m respectively. The difference was due to the fact that camping was concentrated in regions with a low road density.

Median values were lower than the mean values in all regions. For all regions the median value (= 370 m) was calculated from the following distribution:

Daily walking distance (metres)	Percentage distribution
—500	67.6
501—1000	17.6
1001—1500	4.4
1501—2000	5.9
2001—	4.5
	100.0

4.3 Travel time

4.3.1 General

The survey included both the time spent in commuting and the workers' attitude to different travelling times. Time expenditure always refers to one-way trips.

The workers were requested to work out on a scale the maximum acceptable commuting time expenditure. This was done using different assumptions regarding the duration of the work at any work place. The following table (11) shows the attitude to travel time given a duration of several weeks in the same work area.

Table 11. Attitude to travel time (per cent).

Max acceptable travelling time (single trip)	Per cent	Accumulated
15 min.	11.1	100.0
30 min.	47.8	88.9
45 min.	21.1	41.1
1 h.	14.8	20.0
1 h. 15 min.	2.8	5.2
1 h. 30 min.	1.4	2.4
1 h. 45 min.	0.2	1.0
2 h.	0.8	0.8

The table shows that for instance 20 per cent of the workers accepted a daily travelling time exceeding two hours. The distribution gives only small differences when classified with regard to categories, regions, ownership of vehicles, etc.

4.3.2 Weekly commuting

Time spent on weekly commuting was not investigated. This travel is exclusively undertaken with motor vehicles and with knowledge of the distance; thus the time taken is easily calculated.

4.3.3 Daily commuting—total time

Table 12 shows the mean commuting time. As with the commuting distance, the standard deviations are of the same magnitude as the mean values.

Table 12. Mean commuting time (min.) per region and category, one-way trip.

Region / Category	nNi	nNk	sNi	sNk	S	G	All
S-workers	29	30	35	31	27	16	28
B-workers	31	28	25	30	23	24	27
All	30	29	30	30	25	20	27

The table shows the same tendencies as that for the commuting distance. Differences between the northern and the southern parts in respect of distance tend to level out because:

(a) camp-based workers have longer walking distances
(b) terminal times (starting, packing, parking etc.) are relatively longer with decreasing distances.

Camp-based workers had slightly shorter commuting times than home-based workers, the mean values being 20.2 min. and 28.3 min. respectively.

Median values were lower than the mean values in all regions. For all regions the median value (=20.9 min.) is calculated from the following distribution:

Daily commuting time (min. one-way trip)	Percentage distribution
—10	16.4
11—20	31.7
21—30	21.8
31—40	12.0
41—50	9.7
51—60	5.2
61—	3.2
	100.0

The distributions are quite similar for the two categories.

The actual commuting times have been tabulated with regard to the attitude to time expenditure (table 13).

Twenty per cent of the workers had longer journeys than was acceptable. This means either that dissatisfaction with regard to time expenditure is fairly widespread, or that the workers have been somewhat conservative in their statements.

Table 13. Attitudes to commuting time and actual commuting times.

Max. acceptable time expenditure	15 m	30 m	45 m	1 h.	1 h. 15 m	1 h. 30 m	1 h. 45 m	2 h.
No. of journeys < accept..	135	907	478	346	72	28	8	18
„ „ „ > „	149	324	60	14	1	1	0	0
No. of journeys > „ in % of total.....	53	26	11	4	1	3	—	—

4.3.4 Daily commuting—walking time

The daily commuting time includes the time spent in walking. Walking times agreed closely with walking distances. Mean values are for S-workers 8.3 min. and for B-workers 8.9 min. Thus about one-third of the total time is spent in walking.

Home-based workers and camp-based workers had mean values of 8.1 min. and 11.5 min. respectively.

4.4 Travel frequency

In order to compute the total distance for work travelling, the frequency must be known. Frequency with respect to daily commuting describes only the number of days in work. For weekly commuting the frequency of travelling is shown in the following table (14).

Table 14. Number of nights outside home for camp-based workers.

Number of nights outside domicile	Percentage distribution
1	0.6
2	11.7
3	1.8
4	9.9
5	48.5
6	11.4
7—15	9.0
16—	7.1
	100.0

Most camp-based workers spent the whole working-week in camp, but there was a considerable group which divided the working-week into two parts, visiting their homes also in the middle of the week.

This distribution varied with regard to other factors. Spending the whole week in camp predominated in regions nNi and sNi and for both older workers and unmarried ones.

4.5 Vehicle—means of travel

4.5.1 General

The forest worker's means of travel depends on:

1. vehicle available
2. climate
3. distance to the working place.

The connection between means of travel and distance is not clear. It might happen that the foreman plans the job in such a way that a worker without a vehicle is given work close to his home.

Possession of vehicles is reported above (section 3.4.4).

4.5.2 Weekly commuting

Vehicles used for weekly commuting are shown in the distribution below (per cent):

Travel by bicycle	1.7
,, ,, motor-cycle, moped	13.7
,, ,, car	65.8
,, ,, long-distance bus	8.3
Other	10.5
	100.0

4.5.3 Daily commuting

Means of travel for daily commuting is shown in the following statement (per cent):

Walking only	13.4
Bicycle	4.0
Motor-cycle, moped	7.9
Car-single	25.4
Car (and bus) sharing	35.6
Horse	9.0
Tractor	2.2
Other	2.5
	100.0

Slightly more than 60 per cent of all travel to work took place in covered transport. No significant differences between the categories were found.

5. Results—Service travelling

5.1 Service travel

5.1.1 General

Information about the worker's service travels was gathered on two different occasions.

On the first occasion (observation day No. 1) data was submitted about the names of and distances to localities visited by the workers in order to buy different kinds of goods and services.

This information was computed and the localities were listed in order of significance in a new questionnaire (No. 3). In this questionnaire the workers were also asked to note the frequency of visits to the locality in question.

The goods and services chosen in the first step should be typical goods representing a special category of purchases. These "type goods" were selected and tested during the pilot study. The following principles guided the selection of type goods:

1. They should represent different levels in the order of significance of localitites.
2. They should represent closely related goods available in the same shopping area.
3. As type goods they should represent the greater part of goods and services demanded by forest workers.

It was shown that the average forest worker family spends its money in the following way (approximate figures):

Local utilities (food etc.)	38 per cent
Central utilities (clothes etc.)	31 ,,
Dwelling, travelling, other consumption	31 ,,

5.1.2 Local service

As may be seen above, local utilities constitute an important part of the consumption. Fifty-five per cent of money spent on goods and services was spent on food and other locally available articles (tobacco, newspapers, detergents etc.). Type goods are sugar and coffee.

5.1.3 Central service

Type goods selected to represent central utilities were divided into four groups, each describing different levels in the order of significance of localities.

Group	Share of expense	Type goods
1	5 per cent	working shirt
		rubber boots
2	10 ,,	cinema
		hairdresser
		motor-service
3	15 ,,	power-saw
		power-saw service
		dentist
		(advanced stage school)
4	15 ,,	"leisure" shirt
		"leisure" shoes
		"leisure" suit

5.2 Travel distance

5.2.1 General

In the following the distances always refer to one-way trips between home and service locality. Distances between camps and localities were not investigated.

The travelling distances to local and central services are exemplified with one article from each of the above groups. In the Swedish version of the text the complete tables—including all goods—are published.

5.2.2 Local service

Travelling distances to buy sugar were as follows (median, km.).

nNi	2.0
nNk	1.1
sNi	1.7
sNk	2.1
S	2.3
G	3.1

The upper quartile is in region nNi = 13.5 km. and in southern parts 4—6 km.

By combining the information concerning travelling distance and distance to the nearest shop it is shown that the buying habits were as follows:

Buying in (a) nearest shop	83.4	per cent
(b) nearer than nearest shop		
mobile shops	7.2	,,
other	1.9	,,
(c) other shop	7.5	,,
	100.0	,,

Mobile shops were more common in the north than in the south. Summing up it may be said that only one-quarter of the families of forest workers could reach local service within a comfortable walking distance (500 m). Half of them had to travel more than 2 km and, especially in region nNi, very long journeys occured.

5.2.3 Central service

In table 15 one article from each of the above groups is selected.

Table 15. Travelling distance to type goods, median, km.

Group	Type goods	nNi	nNk	sNi	sNk	S	G
1	rubber boots	8.9	4.4	4.5	6.6	4.3	6.0
2	cinema	21.9	15.7	7.2	6.8	7.9	7.5
3	dentist	34.6	30.8	19.0	10.8	12.0	12.3
4	"leisure" suit	29.0	44.1	33.8	18.3	17.1	16.5

The following comments can be made concerning distances for buying these type goods:

1. Different groups of central commodities were obtained at different levels in the order of significance of localitites. This also means different levels for travelling distances.
2. In obtaining goods and services in the lowest range (group 1) the distances were, on the average, relatively modest. However, considerable distances sometimes appeared.
3. Commodities in the medium range (group 2—3) required greatly increased travelling.
4. In the upper range only ten per cent of the workers could obtain the commodities within distances shorter than 2.5 km from home. Half of them had to travel distances exceeding 25 km to reach these type goods.
5. There were considerable regional differences with respect to travelling distances to central localities.
6. In comparing regions there was a great difference between regions in the north and west (nNi, nNk, sNi) and regions in the south and east (sNk, S, G). The first groups had substantially longer travelling distances.
7. S-workers had generally to travel further than B-workers. The difference by means of median values was 20 per cent for commodities in the lower and medium-range and about 10 per cent for commodities in the upper range.
8. Lower-range commodities were obtained to some extent by mail-order, but

for upper-range commodities it was rather uncommon. The share of mail-ordering was constantly higher in region nNi compared to other regions.

9. The part of type goods sold through mobile shops was so small that it is hardly worth mentioning.

5.3 Travel time

Commuting time for service-travelling was not asked for. Since the means of travel for service purposes were more homogeneous than for work travels, the time expenditure was easily calculated.

It was assumed that the service travels were made at a speed of 60 Kph, in which case the travelling time in minutes equals the distance in kilometres.

Table 16. Mean travelling distance (km) for buying different commodities (equals travel time in minutes for the assumed speed of travel).

Type goods	nNi	nNk	sNi	sNk	S	G
sugar	8	3	4	5	4	4
rubber boots	15	14	9	11	10	9
cinema	25	19	16	10	11	10
dentist	36	33	24	15	15	14
"leisure" suit	35	45	42	26	23	19

5.4 Travel frequency

5.4.1 General

In order not to mix the frequency-investigation with the other parts of the survey, it was performed on a separate questionnaire (No. 3). The workers (and their families) were requested to give the annual number of visits to certain stated localities.

Investigated journeys were:

1. to buy goods or services
2. to visit municipal and public authorities
3. to visit recreational facilities

The following travels were excluded from the computations:

1. those shorter than 2 km
2. those exceeding 300 km
3. travelling frequencies less than one per year

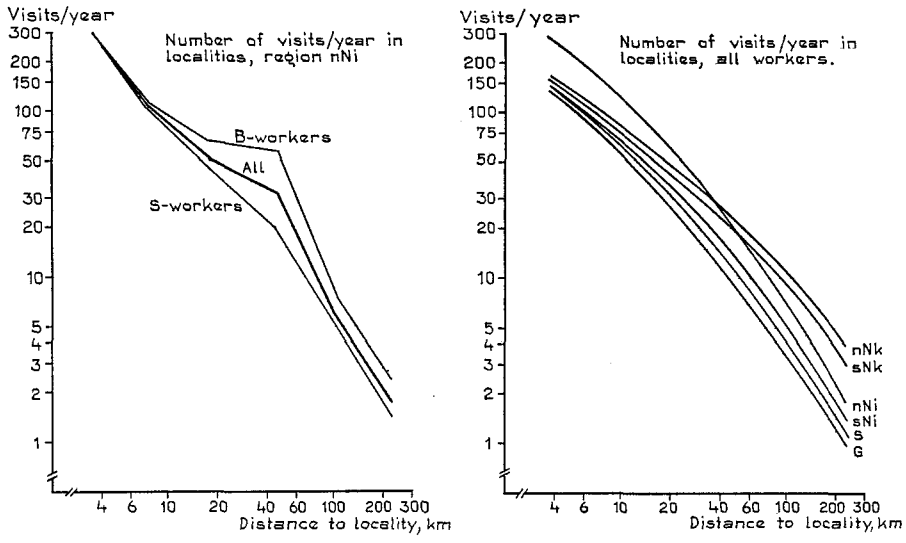
5.4.2 Travel frequency—distances

The annual number of visits to service establishments is exemplified in fig. 2, which shows the travel frequencies divided into

1. categories
2. regions

The closer such establishments were located to the worker's home, the more journeys per year occurred.

Fig. 2.



Regional differences were substantial. The frequencies were considerably higher in the northern parts of the country than in the southern. Workers in the north had, of course, the same need for goods and services as those in the south. Because of the structure of settlement, they must go further to reach central service establishments. The diagram thus shows less "distance-sensitivity" in the north than in the south.

5.4.3 Travel frequency—distances and availability of service

In this part of the report the travel frequency caused by the different availability of services in the localities is reported. Each journey is referred to the order of significance of the locality visited. Only visits to service establishments in congested areas were considered in the calculations.

The localities have been classified at different levels with regard to the "annual consumption of central utilities by an average person". This classification has earlier been used in Sweden (see list of references in the Swedish version: MICKLANDER 1964). Reasons for this classification are:

1. The method is valid for ranking localities in high as well as in lower levels.
2. The method is insensitive to regional differences.

The above-mentioned "annual consumption of central utilities by an average person" is called a "dapan", 1,000 such units a "kilodapan". In countries in which the income elasticity is close to 1, the monetary equivalence of dapans can be calculated as a constant percentage (P) of the per capita income (I_c). The turnover of central utilities (S_z) in a locality can then be transformed to "centrality" (C) in kilodapan by the formula

$$C = \frac{S_z}{1\,000 \cdot \frac{P}{100} \cdot I_c}$$

By this formula, Micklander calculated the centrality for Swedish business localities in 1950. The localities were classified according to the following scheme:

Type of centre	Centrality in kilodapans (lower class limit)	Number of localities
M — centre	640	1
R — centre	160	2
P — centre	40	31
K — centre	10	78
D — centre	2.5	159
B — centre	0.7	approx. 260
T — centre	0.2	—
L — centre	—	—

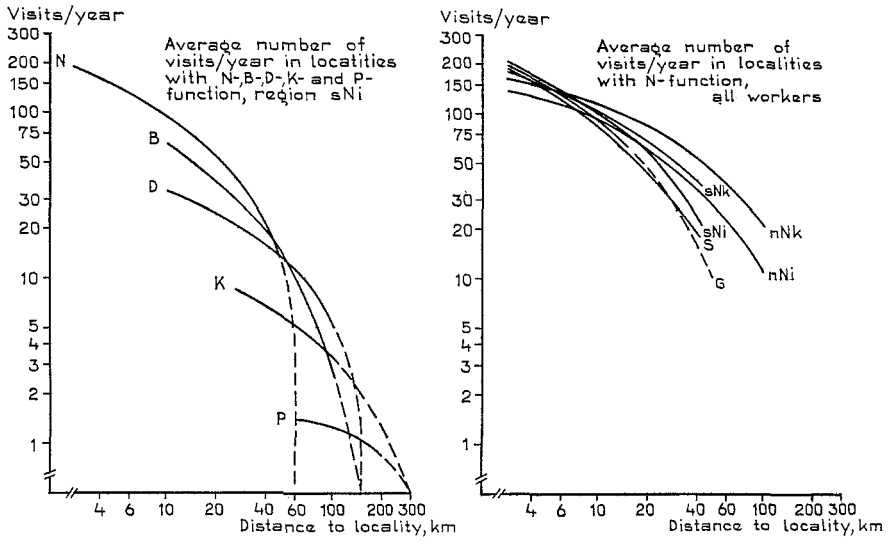
The capital letters only make sense in Swedish (for instance M = metropolis, L = local) and the localities are better defined by the centrality in kilodapan.

Because of difficulties in demarcation of the lower classes, the T—and L —types have been united and called N—centre (N = neighbour). The divisions in the upper parts are also unnecessary with respect to the population investigated. Thus the classes of centrality used refer to:

P — centre
K — centre
D — centre
B — centre
N — centre

Visits to localitites have been classified in regard to the service functions demanded. If, for instance, a worker has a B-centre as the nearest locality, it is considered that visits to this centre concern his N-function. The B-functions have been excluded in such a case. If the next locality visited in the order of significance is a K-centre, visits to this centre are regarded as "D-

Fig. 3.



function-visits". The number of visits to obtain a certain function have been added for every distance class, and the average travel frequency has been calculated.

Results are shown in fig. 3. In the left half of the figure the function-directed visits are drawn (region sNi only). The dashed line attaches the class medium value in the highest distance class to the upper class limit. As can be seen the functions demanded are introduced at different distances. The N-function is thus demanded on approx. every other day in the distance interval 2—10 km. After that the frequency rapidly decreases to zero at 60 km distance. The B-, D-, K- and P-functions generate frequencies that from the distance of introduction show a flattened curve. In other regions the functions are quite similar to that exemplified in fig. 3.

The right half of the figure shows the travel frequency sorted according to regions. The diagram exemplifies the N-function only. Similar diagrams can be made for all other functions. Once more, the minor "distance sensitivity" in northern parts of the country can be seen.

To summarize the analysis of travel frequencies to service establishments: it is shown that the frequency decreases when distances grow longer. It is also pointed out that the service functions are introduced at different travel distances. Comparisons between regions have shown that workers in the north are willing to accept longer service journeys than those in the south to obtain the same goods.

5.4.4 Purpose of travelling

A minor part (approx. 10 per cent) of the workers were investigated with respect to the purpose of service travelling. Though they are not representative of all workers, the following figures are of some interest:

Purpose	Distribution of number of visits per cent	Distribution of travel volume per cent
to buy goods and services	92	64
to visit municipal and public authorities	4	15
to visit recreation establishments	4	21

6. Analysis

6.1 General

This report is limited by the survey executed. Some indications of possible ways of using the results will be made in this chapter. The final goal of the research programme is to give some answers to the question "where shall the forest labour be encouraged to settle?"

6.1.1 Travel volume

Travel volume means the total annual distance in kilometres travelled for different purposes and is computed for work travelling as well as service travelling. The following tables (17 and 18) show the results of these computations. The travel volume is calculated on the basis of data given in the above text.

In work travel, daily as well as weekly commuting is included. The number of working days is assumed to be 220 per year.

Table 17. Calculated annual work travel, km/worker.

Region / Category	nNi	nNk	sNi	sNk	S	G
S-workers	5,000	7,800	7,500	5,000	3,400	2,300
B-workers	4,700	5,700	4,500	5,600	4,800	5,600
All	4,900	7,000	6,000	5,300	4,000	4,000

Table 18. Calculated annual service travel, km/household.

Region / Category	nNi	nNk	sNi	sNk	S	G
S-workers	3,800	4,400	2,700	3,000	2,900	2,700
B-workers	5,500	6,900	3,400	4,500	3,700	3,300
All	4,400	5,200	3,000	3,500	3,100	2,900

It will be noted that childrens' school travel is not included in table 18. The volume of these travels may be considerable.

6.2 Theory

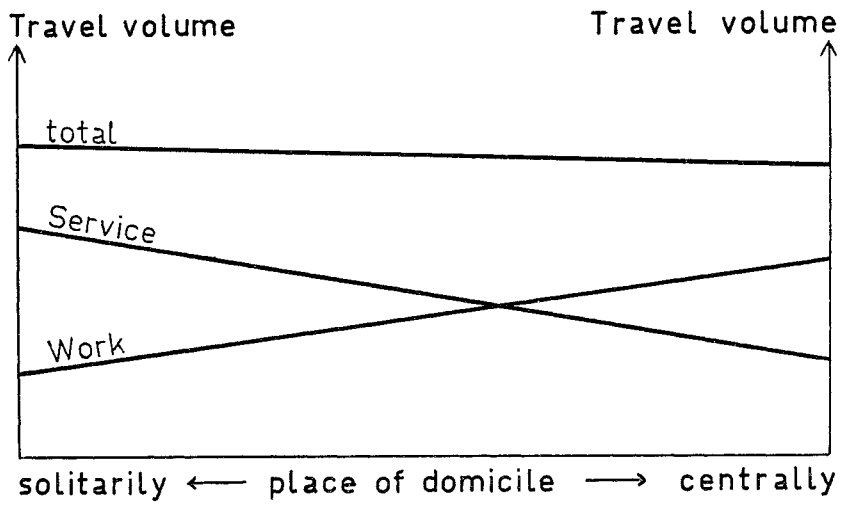
With the home as the starting-point, travel to work may be symbolised as travel "outward", and the service travel as travel "inward". This means that the home of the worker may be thought of as situated somewhere on a scale with the work site at one end (= far from populated areas) and the higher service establishment visited at the other.

The relationship between amount of travelling and location of the home would thus be:

1. The work travelling volume increases the more centrally the home is situated.
2. The service travelling volume decreases the more centrally the home is situated.

Fig. 4 shows schematically this hypothesis. Linear connections are provided.

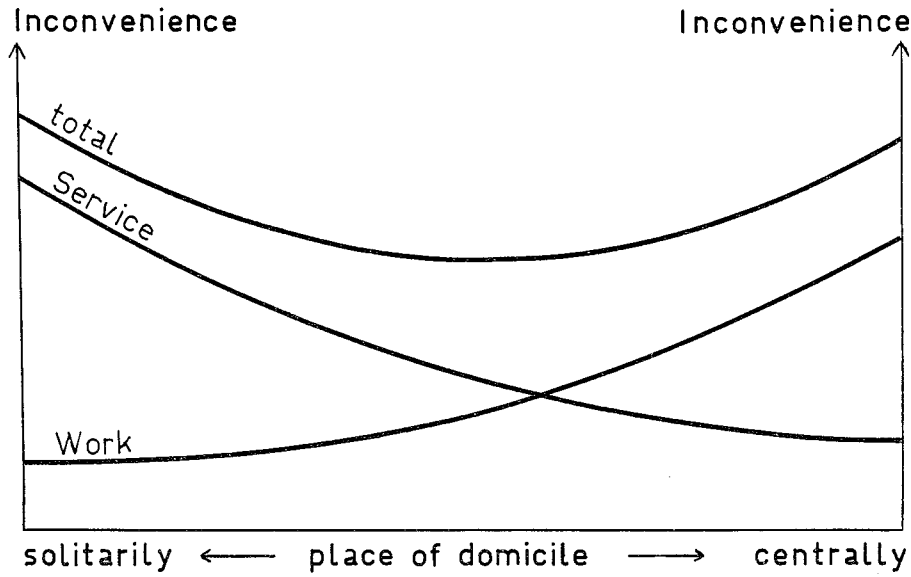
Fig. 4



Forest workers have certain sacrifices (costs) for the travelling. These mainly involve time and expenditure. Within the limits of the generally moderate distances travelled, the costs are assumed to be approximately proportional to the distance. If so, since the costs increase with increasing distance, the workers try to minimize the travel volume and thus the costs.

In addition to costs other inconveniences are attached to travelling. Reduced leisure, discomfort caused by long journeys and other things make the added inconvenience non-linear. Limited inconvenience is acceptable, but—with increasing distance—the inconvenience increases. This is shown schematically in fig. 5.

Fig. 5



According to this hypothesis the forest worker endeavours to minimize the total inconvenience. The location aimed at is the one where marginal inconvenience for "outward" travelling equals marginal inconvenience for "inward" travelling. Fig. 5 is an example of these conditions.

To perform a quantitative analysis of the stated hypothesis more research is needed. Primarily this concerns measuring attitudes and preferences to different consumption choises and the interaction with different home locations. This report is merely the first step in elucidating the complex question of optimum home location of forest labour.

Sammanfattning

Skogsarbetskraftens arbets- och servicefärder

Bakgrund och planläggning (avsnitt 1—2)

Uppsatsen behandlar dels skogsarbetarnas *arbetsfärder*, dels deras färder för erhållande av *service* av olika slag. Målsättningen för den *enkätundersökning*, som genomförts, har varit att ge en översiktlig bild av hur dagens skogsarbetare färdas för de två nämnda ändamålen, samt att belysa de förhållanden som påverkar dessa färder. Undersökningen har omfattat 720 slumpmässigt utvalda arbetare spridda över hela landet. De representerar anställda i »*storskogsbruk*» respektive hos *skogsägareförening*.

Uppsatsen inleds med en redogörelse för den litteratur som publicerats beträffande arbets- och servicefärder.[1]

Resultat — allmänt (avsnitt 3)

De utvalda arbetarna har insänt *data* på tre olika blanketter, varvid en av dessa (avseende arbetsfärder) distribuerats vid fem olika *observationsdagar* under tiden november 1964—maj 1965. Vissa av de inhämtade uppgifterna har *kontrollerats* med hjälp av det lokala arbetsbefälet. *Svarsprocenten* har, genom olika åtgärder, kunnat hållas på en i dessa sammanhang hög nivå (avsnitt 3.3). Resultaten av undersökningen redovisas områdesvis varvid landet indelats i sex *delområden* (se fig. 1, sid. 9).

Resultaten behandlas i tre olika avsnitt. I avsnitt 3.4 lämnas allmänna data om uppgiftslämnarna. Ur detta mera *sociologiskt* betonade avsnitt framgår åldersfördelning, civilstånd, barnantal, fordonsinnehav m. m. Vidare diskuteras olika mått för beskrivning av *bostadens belägenhet*. Dessa jämte andra parametrar återkommer senare som indelningsgrunder för färdtids- och färdavståndsuppgifter.

Resultat — arbetsfärder (avsnitt 4)

Inledningsvis behandlas *bortaliggning*, *samåkning* och uppgiftslämnarnas *sysselsättning* (arbetsuppgifter) under observationsdagarna. Speciellt bortaliggningen — förekommande i Norrlands inland i 25—30 %, Norrlands kustland i ca 10 % och södra delarna av landet i ca 5 % av antalet undersökta arbetsdygn — har intresse för den följande framställningen.

I denna har färdparametrarna (avstånd, tid, färdmedel m. fl.) beskrivits efter uppdelning av färden på *dags-* respektive *veckopendling*.

Genomsnittliga *färdavstånd* och *färdtider* framgår av nedanstående tabeller.

[1] För en fullständig redogörelse för undersökningen samt litteraturförteckning hänvisas till publikationen *Bendz, M. & Yttermyr, B.:* Skogsarbetskraftens arbets- och servicefärder. Rapport nr 30/1966 från institutionen för skogsteknik, Skogshögskolan.

Enkelt färdavstånd (aktuell bostad—arbetsplats) i kilometer, medelvärden

Område	nNi	nNk	sNi	sNk	S	G
storskogsbruk	9,5	16,4	15,8	10,7	7,4	5,5
skogsägareförening	9,0	11,5	8,8	12,1	10,5	12,7

Enkel färdtid (aktuell bostad—arbetsplats) i minuter medelvärden

Område	nNi	nNk	sNi	sNk	S	G
storskogsbruk	29	30	35	31	27	16
skogsägareförening	31	28	25	30	23	24

Färdavstånds- och färdtidsuppgifterna har analyserats ingående genom olika indelningar och sorteringsgrunder.
Beträffande *färdsättet* kan bilens (och arbetarbussens) stora betydelse noteras; 61 % av alla färder.
Jämförelser med annat tillgängligt material visar att skogsarbetarna genomsnittligt har ca 3 gånger så lång väg till arbetet som gruppen »samtliga förvärvsarbetande».

Resultat — servicefärder (avsnitt 5)

Inledningsvis diskuteras *konsumtionens fördelning* på olika grupper av nyttigheter och beräknas *utgiftsandelar* för *lokal* och *central service*. Härvid har de typvaror om vilka uppgifter inhämtats i undersökningen uppdelats i grupper. *Färdavstånden* mellan bostad och olika *serviceinrättningar* redovisas i det följande utifrån denna uppdelning. För inköp av livsmedel (lokal service) varierar medianavstånden områdesvis mellan 1,1 och 3,1 kilometer. Avstånden vid inköp av varor av högre rang varierar inom vida gränser beroende på vilken *typvara* som beskrivs. Genomgående är dock avstånden avsevärt längre i de norra än i de södra delarna av landet (se tab. 15, sid. 28 och tab. 16, sid. 29). Uppgifter om *färdfrekvenser* vid servicefärder har inhämtats på särskild blankett. De bearbetningar som företagits visar att besöksfrekvensen snabbt avtar med ökande avstånd till serviceorten och att uppgiftslämnare i norra Sverige är genomsnittligt mindre känsliga för avstånden än i de södra delarna av landet (se fig. 2, sid. 30).
Vissa bearbetningar har genomförts för att visa färdfrekvensens beroende av den efterfrågande *servicefunktionen*. För att beskriva denna har besökta orter indelats i en *hierarkisk ordning* efter grad av *centralitet* (se fig. 3, sid. 32).

Analys (avsnitt 6)

I detta avslutande avsnitt har den volym färder beräknats som de olika färdändamålen genererar. För arbetsfärder varierar denna *färdvolym* områdesvis mellan ca 4 000 och 7 000 km/arbetare och år. Motsvarande volym servicefärder (exkl. skolfärder m. m.) varierar mellan ca 2 900 och 5 200 km/hushåll och år. Mot bakgrund av färdvolymer och uppoffringar för olika färder presenteras avslutningsvis en *teori* för hur skogsarbetaren upplever sambandet mellan dessa uppoffringar och bostadens belägenhet (se fig. 5, sid. 36).

DEFINITIONS

Travelling	=	the transferring of a person from one place to another
Commuting	=	regular travelling between residence and work place
Daily commuting	=	regular daily travelling between current residence and work place
Weekly commuting	=	travelling, usually weekly, between home and camp
Home	=	permanent residence
Camp	=	temporary residence near place of work
Camp-based worker	=	employee spending the night in camp
Home-based worker	=	employee spending the night in his home
Work travel	=	travel to obtain income
Service travel	=	travel to obtain (purchase) commodities or services
Car sharing	=	work travel with two or more persons per vehicle
Threshold	=	minimum population basis (e. g. purchase power) required to allow goods to be economically available
Range	=	the distance to the boundary, computed from a buying centre, beyond which the utility will not attract buyers
Central utility	=	commodity or service with such a high threshold, that its supply is concentrated, in relationship to the populations distribution, in a small number of places
Central function	=	provisions of central utility
Central establishment	=	enterprise or institution with central function
Local utility	=	commodity or service with lower threshold than central utility
Congested area	=	densely populated area with more than 200 inhabitants (provided that the normal distance between the residences does not exceed 200 metres)
Locality	=	congested area
Population centre	=	place fulfilling the requirements of a congested area
Densely populated area	=	area with connected settlement, villages and communities with regular communications, shops, post and telephone
Sparsely populated area	=	area that is not a densely populated area
Central place	=	population centre with accumulation of central establishments
S-worker	=	forest worker employed in forestry organised into ranger districts (large scale forestry)
B-worker	=	forest worker employed by forest owners association