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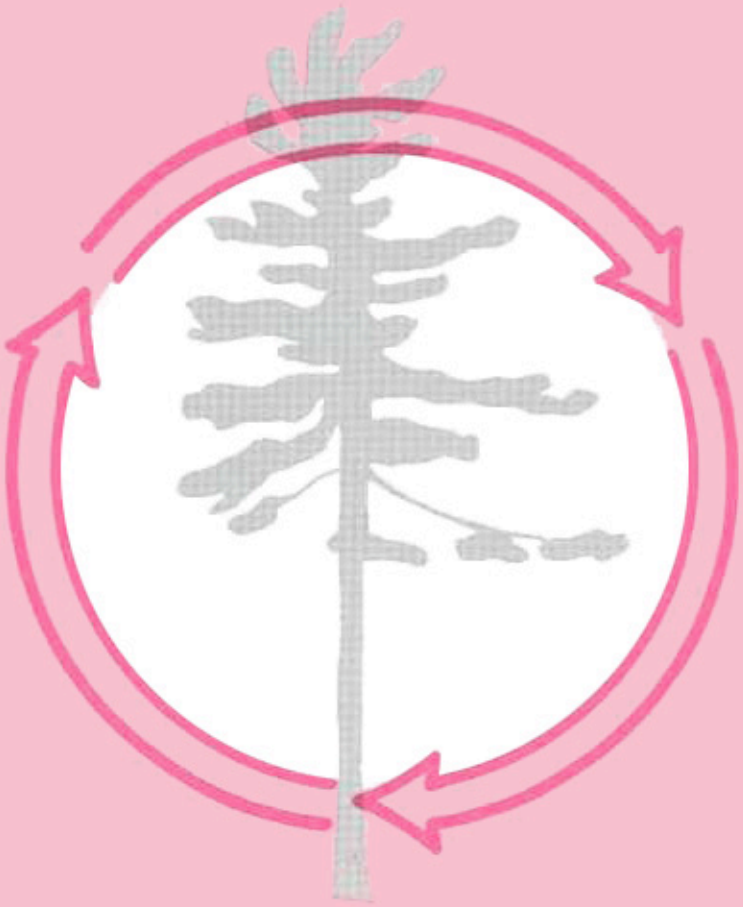
Service canadien des forêts

Biogeochemistry of temperate forest ecosystems : Literature on inventories and dynamics of biomass and nutrients

Biochimie des écosystèmes des forêts tempérées : publications sur les inventaires et la dynamique de la biomasse et des éléments nutritifs

Rapport d'information
Information Report PI-X-47 E/F

PNFI



BIOGEOCHEMISTRY OF TEMPERATE FOREST ECOSYSTEMS: LITERATURE ON INVENTORIES AND DYNAMICS OF BIOMASS AND NUTRIENTS

BIOCHIMIE DES ÉCOSYSTÈMES DES FORÊTS TEMPÉRÉES: PUBLICATION SUR LES INVENTAIRES ET LA DYNAMIQUE DE LA BIOMASSE ET DES ÉLÉMENTS NUTRITIFS

Information Report/Rapport d'information

PI-X-47E/F

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Petawawa National Forestry Institute/
Institut forestier national de Petawawa
Canadian Forestry Service/Service canadien des forêts
1985

Catalogue No. Fo46-11/47-1985
ISSN 0706-1854
ISBN 0-662-53946-X

N° de catalogue Fo46-11/47-19 85
ISSN 0706-1854
ISBN 0-662-53946-X

Additional copies of this publication can be obtained from

Technical Information and Distribution Centre
Petawawa National Forestry Institute
Canadian Forestry Service
Chalk River, Ontario
K0J 1J0

Telephone (613) 589-2880

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Institut forestier national de Petawawa
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Chalk River (Ontario)
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This report is based on ENFOR project P-197 which was carried out under contract (DSS File No. KL011-1-0021) by the Canadian Forestry Service and the University of British Columbia.

ENFOR is the acronym for the Canadian Government's ENergy from the FORest (ENergie de la FORêt) program of research and development aimed at securing the knowledge and technical competence to facilitate, in the medium to long term, a greatly increased contribution from forest biomass to our nation's primary energy production. This program is part of a much larger federal government initiative to promote the development and use of renewable energy as a means of reducing dependence on petroleum and other non-renewable energy sources.

The Canadian Forestry Service (CFS) administers the ENFOR Biomass Production program component which deals with such forest-oriented subjects as inventory, harvesting technology, silviculture and environmental impacts. (The other component, Biomass Conversion, deals with the technology of converting biomass to energy or fuels, and is administered by the Renewable Energy Branch of the Department of Energy, Mines and Resources). Most Biomass Production projects, although developed by CFS scientists in the light of ENFOR program objectives, are carried out under contract by forestry consultants and research specialists. Contractors are selected in accordance with science procurement tendering procedures of the Department of Supply and Services. For further information on the ENFOR Biomass Production program, contact

ENFOR Secretariat
Canadian Forestry Service
Ottawa, Ontario
K1A 1G5

or a CFS research laboratory.

Le présent rapport a été rédigé suite à l'étude ENFOR P-197 qui a été réalisée à contrat (dossier MAP: KL011-1-0021) par le Service canadien des forêts et l'Université de la Colombie-Britannique.

ENFOR est l'acronyme employé pour désigner le programme de recherche et de développement ENergie de la FORêt (ENergy from the FORest) du gouvernment canadien dont l'objectif est d'acquérir des connaissances et des compétences techniques pour faciliter à moyen et à long terme un accroissement important de l'utilisation de la biomasse forestière pour la production d'énergie au pays. Ce programme fait partie d'une initiative beaucoup plus vaste du gouvernement fédéral en vue de favoriser l'exploitation et l'utilisation des formes d'énergie renouvelables de façon à réduire la dépendance vis-à-vis le pétrole et d'autre sources d'énergie non renouvelables.

Le Service canadien des forêts (SCF) est responsable de la partie du programme consacrée à la production de biomasse où l'on se penche sur des questions intéressant la forêt telles que les inventaires, les techniques de récolte, la sylviculture et les incidences environnementales. (L'autre partie du programme, intitulée "Transformation de la biomasse", porte sur les techniques de transformation de la biomasse en énergie ou en combustibles; elle est la responsabilité de la Direction des énergies renouvelables du ministère de l'Énergie, des Mines et des Ressources.) La plupart des études sur la production de la biomasse, même si elles ont été élaborées par des scientifiques du SCF compte tenu des objectifs du programme ENFOR, sont réalisées à contrat par des consultants en foresterie et des chercheurs spécialistes. Les contrats sont octroyés conformément aux méthodes suivies par le ministère des Approvisionnements et Services pour les marchés scientifiques. On peut obtenir plus d'informations sur le sous-programme de production de la biomasse en s'adressant à un laboratoire de recherche du SCF ou en écrivant à l'adresse suivante:

Secrétariat du programme ENFOR
Service canadien des forêts
Ottawa (Ontario)
K1A 1G5

Table of Contents/Table des matières

viii Preface/Préface

xi Glossary/Glossaire

203 Acknowledgments/Remerciements

Tables/Tableaux

1 1. Atmospheric inputs/Apports atmosphériques

10 2. Inputs - nitrogen fixation/Apports - fixation d'azote

15 3. Inputs - rock weathering/ Apports - altération des roches

16 4. Standing crop biomass and nutrient content/Biomasse et teneur en éléments nutritifs du matériel sur pied

56 5. Forest floor biomass and nutrient content/ Biomasse et teneur en éléments nutritifs de la couverture morte

74 6. Forest soil nutrient content/Teneur en éléments nutritifs du sol forestier

91 7. Litterfall biomass and nutrients/Biomasse et éléments nutritifs des chutes de litière

116 8. Defoliation/Défoliation

117 9. Throughfall and stemflow/ Précipitation au sol et écoulement sur écorce

127 10. Litter decomposition/Décomposition de la litière

136 11. Annual uptakes/Absorptions d'éléments nutritifs

140 12. Nutrient concentrations - overstorey/Concentrations d'éléments nutritifs - étage dominant

177 13. Nutrient concentrations - understorey/Concentrations d'éléments nutritifs - sous-étage

189 14. Annual outputs/ Pertes d'éléments nutritifs

193 15. Outputs - denitrification/Pertes - dénitrification

195 16. Water chemistry profiles/Profils chimiques de l'eau

201 17. Fire nutrient outputs/Pertes d'éléments nutritifs attribuables aux incendies

203 References/Références

PREFACE

As the continuing expansion of human population exerts growing pressure on the world's forest resources, the intensity with which forests are managed and harvested must increase. Strategies for the establishment and culture of forest crops will increasingly resemble those of agriculture, and forest management will encounter and have to deal with new problems that have long been recognized by farmers.

The most fundamental aspect of the resource in both forestry and agriculture is the soil. Not only is it a relatively non-renewable or very slowly renewed resource; without adequate soil conditions most forest and agricultural crops simply cannot be grown. Climate is certainly very important but, with a number of notable exceptions, regional climate is not thought to be significantly altered by local land management. The genetic make-up of the biota (crop and non-crop), and the species composition and structural organization of the biotic community, are also very important. But such factors can be manipulated to achieve land management objectives only if there is a soil of adequate fertility. Thus, the character of the soil can be considered the "Achilles heel" of the intensively managed forest ecosystem.

Many characteristics of soil are important to crop production. Physical attributes such as moisture status, structure, aeration, and temperature exert a very significant control on crop growth. They are certainly subject to modification by low- and moderate-intensity management (in certain areas such modifications may be of preeminent importance) but, generally, the physical attributes of the soil are mainly determined by regional climates, geology, and landform position. In unmanaged or low intensity-managed forests, the chemical characteristics of soil also reflect regional climate, geology, and landform position, as well as the past history of ecological succession. As the intensity of forest management increases, there is a potential for adverse changes to both physical and chemical aspects of the soil. The physical changes can be serious, long-lasting, and difficult to rectify. However, they have a lower probability of occurrence than changes in soil chemistry. Loss of soil organic matter, changes in pH, and alterations in site nutrient status are an almost inevitable outcome of the switch from low to high intensity forest management; these changes will often have a negative impact on future crop production unless appropriate soil amelioration activities and/or site nutrient management are undertaken.

Due to the important implications of intensification of forest management on soil fertility, site nutrient management will become an increasingly vital component of forest crop production in the future. In recognition of this, the ENFOR program supported the development of the FORCYTE computer simulation model (Kimmins and Scoullar 1983, 1984). Users of FORCYTE are required to supply a variety of input data. Because, in some cases, it may be difficult to obtain all of the necessary data, at least nitially, it was felt desirable to assemble published estimates of a variety f ecosystem attributes from which estimates could be obtained for various nput parameters. Such an assemblage of data would facilitate initial use of ORCYTE while additional data collection is undertaken.

The tables in this report summarize some of the available literature on nutrient inputs to ecosystems, the organic matter and nutrient content of forest ecosystems, nutrient dynamics within ecosystems, internal cycling of nutrients within trees, and outputs of nutrients from forest ecosystems. This job of data assembly is far from complete, and apologies are made to authors whose data have either been missed or have not yet been included. It is intended to bring the tables up to data every few years, and the senior author would be most grateful to receive tabular summaries from authors of data that should be included in the next update of the tables. The tables cover mainly temperate and high latitude/altitude forests. A similar compilation will be undertaken for low latitude forests at some time in the future.

Any comments or suggestions concerning the tables would be welcome, as would notification of any errors that are discovered. A number of additional tables are planned for a subsequent edition. These cover published estimates of a number of parameters added to the tables recently.

À cause de la pression démographique sans cesse croissante sur les ressources forestières du globe, celles-ci doivent être aménagées et exploitées de façon plus intensive. Les stratégies d'implantation et de culture ressembleront de plus en plus à celles de l'agriculture, et les aménagistes auront à régler de nouveaux problèmes qui sont depuis longtemps le lot des agriculteurs.

Le facteur capital, en foresterie et en agriculture, est le sol. Non seulement s'agit-il d'une ressource qui se renouvelle relativement peu ou très lentement, mais, si ses caractéristiques ne conviennent pas, la plupart des cultures forestières et agricoles végéteront tout simplement. On ne peut nier l'importance du climat, mais, sauf pour un certain nombre d'exceptions notables, on ne pense pas que, à l'échelle régionale, il soit considérablement modifié par l'aménagement local des terres. Le génotype des espèces (cultivées ou non) ainsi que la composition des espèces et la structure de la communauté biotique sont aussi très importants, mais ces facteurs peuvent être manipulés en fonction des objectifs de l'aménagement seulement si le sol est d'une fertilité convenable. Ainsi, on peut considérer le sol comme le talon d'Achille des écosystèmes forestiers aménagés en intensive.

Beaucoup de caractéristiques du sol sont importantes pour la production végétale. Les caractéristiques physiques telles que l'humidité, la structure, l'aération et la température déterminent la croissance. Elles sont certainement modifiables par l'aménagement peu et moyennement intensif (dans certains endroits, ces modifications peuvent être d'une importance prédominante), mais, en général, elles sont surtout gouvernées par le climat, la géologie et la position des formes du terrain à l'échelle régionale. Dans les forêts non aménagées ou aménagées peu intensivement, les propriétés chimiques du sol traduisent aussi l'influence régionale du climat, de la géologie et de la position des formes du terrain de même que les antécédents des successions écologiques. À mesure que l'aménagement forestier s'intensifie, les caractéristiques physico-chimiques des sols peuvent se dégrader. Les modifications physiques peuvent être graves, durables et difficiles à corriger. Toutefois leur probabilité est moindre que les modifications chimiques. La perte de matière organique du sol, les modifications du pH et le déséquilibre nutritif des stations sont un résultat presque inévitable du passage de l'aménagement peu intensif à l'aménagement très intensif des forêts; ces modifications auront souvent un effet négatif sur les récoltes ultérieures à moins que des mesures appropriées d'amendement ou de maîtrise de l'équilibre nutritif des stations ne soient adoptées.

À cause des conséquences importantes de l'intensification de l'aménagement forestier sur la fertilité, la maîtrise de l'équilibre nutritif des stations deviendra de plus en plus capitale pour la production forestière. C'est à partir de ce constat que, par le programme ENFOR, on a financé la construction du modèle de simulation informatisée FORCYTE (Kimmins et Scoullar, 1983 et 1984). Les utilisateurs de ce modèle doivent fournir une foule de données d'entrée. Comme, parfois, il peut être difficile d'obtenir toutes les données nécessaires, du moins au début, nous avons pensé qu'il était souhaitable de réunir les estimations publiées sur une foule de caractéristiques des écosystèmes, à partir desquelles on pourrait estimer les divers paramètres d'entrée. Un tel ensemble de données faciliterait au départ l'utilisation du modèle, en attendant l'obtention de données supplémentaires.

Les tableaux réunis dans le rapport résument certaines des données publiées sur les apports d'éléments nutritifs dans les écosystèmes, les concentrations de ces éléments et de matière organique dans les écosystèmes forestiers, la dynamique de ces éléments à l'intérieur des écosystèmes, leur cycle interne dans les arbres et leur exportation à partir des écosystèmes. L'ensemble de données est loin d'être complet, et nous demandons aux auteurs dont nous avons omis ou non encore inclus les données de nous excuser. Nous avons l'intention de mettre à jour les tableaux à des intervalles de quelques années, et l'auteur principal saurait énormément gré à ceux qui lui transmettront des tableaux sommaires de données pour les faire insérer dans les prochaines mises à jour. Les tableaux portent surtout sur les forêts tempérées et les forêts des hautes latitudes et altitudes. Une compilation semblable sera

entreprise pour les forêts des latitudes inférieures, ultérieurement.

Nous serons attentifs à toute observation ou proposition concernant les tableaux ainsi qu'à tout signalement des erreurs qui pourraient s'y trouver. Nous prévoyons pour une édition ultérieure l'ajout d'un certain nombre de tableaux. Ils porteront sur les estimations publiées d'un certain nombre de paramètres qui viennent d'être ajoutés aux tableaux.

GLOSSARY/GLOSSAIRE

A	
aboveground	épigée
aboveground parts	parties épigées
acid	acide
acorns	glands
additional input due to impaction	apports additionnels attribuables à l'impact
adv. decay	carie avancée
aerial	aérienne
aerial parts	parties aériennes
aerobic scenario	aérobiose
after --	d'après --
after burn	après brûlage
age	âge
alder	aulne
all potentials	tous les potentiels
anaerobic scenario	anaérobiose
andesite parent material	roche-mère andésitique
andesitic tuffs	tufs andésitiques
annual outputs	pertes d'éléments nutritifs
annual shoots	pousses annuelles
annual uptakes	absorptions d'éléments nutritifs
arboreal lichens	lichens corticoles
ash	cendres
atmosphere particulates	particules de l'atmosphère
atmospheric inputs	apports atmosphériques
Aug.	août
avail.	assim.
average	moyenne
av. -- plots	moyenne de -- parcelles
B	
bark	écorce
basalt parent material	roche-mère basaltique
based on accretion studies	d'après des études d'accélération de croissance
based on acetylene reduction assays	d'après des mesures de la réduction de l'acétylène
based on greenhouse accretion per gram nodule times nodule biomass in field	d'après l'accélération de croissance divisée par le poids (grammes) des nodules en serre multipliée par la biomasse des nodules sur le terrain
based on 9 months data	d'après des données pour 9 mois
basic	basique
before burn	avant brûlage
below-ground roots	racines sousterraines
biomass & soil	biomasse & sol
birch	bouleau
bird droppings	excréments d'oiseaux
Black cottonwood	peuplier occidental

bogwhortleberry forest	forêt à airelle des marécages
bole	fût
bole harvest	fûts récoltés
bolewood	bois des fûts
boreal	région boréale
branchfall	chutes de branches
broad-leaved	à larges feuilles
broadleaves	larges feuilles
brown	brune
bud scales	écailles de bourgeons
buds	bourgeons
bulk precipitation (rain & dry fallout)	précipitations globales (pluies & retombées sèches)
buried wood	bois enfoui
burn	brûlage

C

calculated from	teneurs calculées d'après les données de
calculated from per cent weight loss	calculé d'après le pourcentage de diminution du poids
caralloid roots	racines coralliformes
carbohy. fert.	engrais glucidique
catkins	chatons
central Europe	Europe centrale
central Sweden	centre de la Suède
cited in	in
clear-cut	coupe rase
clear-cut plot	parcelle coupée à blanc
coarse roots	racines épaisses
coastal	région côtière
collector no.	N^{bre} de collecteurs
component	composante
cones	cônes
conifers	conifères
content	teneur
control	témoin
coralloid roots	racines coralliformes
cornus fol.	feuill. de cornus
crown	cime
current needles	aiguilles de l'année
current twigs + leaves	rameaux de l'année + feuilles
cut	coupe

D

dark wood	bois foncé
dead branches	branches mortes
dead roots	racines mortes
dead standing wood plus bark	bois mort sur pied + écorce
decaying logs	grumes en putréfaction
decid. fol.	feuill. caduc
deep	profondément
defoliation	défoliation

denitrification	dénitrification
depth	profondeur
detritus	détritus
dom. veg.	vég. dom.
downslope from cornfields	en aval de champs de maïs
downslope from hogpens	en aval de porcheries
dry	sec
dry fallout only	retombées sèches seulement
dry soil	sol sec
duff	litière feuillue
duration	durée
dust	poussières
dwarf shrubs	arbrisseaux nains

E

early success	phase initiale
ecosystem	écosystème
ecosystem with Douglas-fir	écosystème à douglas taxifolié
entire	total
epilobium against stems	epilobium sur tiges
epiphytes	épiphytes
estimated from graphs	estimations à partir de graphiques
estimated from graphs which are adjusted to normal stocking	estimations à partir de graphiques, ajustées en fonction d'une densité normale
everg. fol.	feuill. semperv.
evergreen	sempervirante
exch.	échang.
extract	extrait
extr. cations	cations extr.

F

fallen logs	grumes tombées
feldspar	feldspath
fert.	engrais
field layer	couverture vivante au-dessus du sol
figures may not be additive due to rounding errors	les sommes des chiffres peuvent ne pas correspondre aux totaux à cause des erreurs d'arrondissement
fine litter	litière fine
fine material	matières fines
fine roots	racines fines
fire nutrient outputs	pertes d'éléments nutritifs attribuables aux incendies
fire type	type d'incendie
floodplain forest stand	peuplement forestier de zone inondable
flowers	fleurs
foliage	feuillage
foliage & twigs	feuillage & rameaux
foliage - mid crown	feuillage - milieu de la cime
forest	forêt
forest floor	couverture morte

forest floor biomass and nutrient content	biomasse et teneur en éléments nutritifs de la couverture morte
forest floor burning	brûlage de la couverture morte
forest soil nutrient content	teneur en éléments nutritifs du sol forestier
frass	excréments d'insectes
free-living aerobic	aérobies libres
free-living anaerobic	anaérobies libres
fresh	frais
fruit	fruits
fruiting bodies	fructifications
fruit-stalks	pédoncules des fruits

G

good	bon site
granitic	granitique
grasses	graminées
green	verte
greenhouse study	étude en serre
ground layer	couverture vivante au niveau du sol
ground veg.	couverture vivante

H

hardwood	feuillu
heavy poll.	poll. élevée
heavy thinned	forte éclaircie
hemicell	hémicellulose
herbaceous	pl. herbacées
herbs	herbes
high elev. site	stat. de haute alt.
high fert.	fert. élevée
high productivity	productivité élevée
high site	station élevée

I

in prep.	en prép.
in review	en révision
in root zone	dans la zone des racines
in top -- cm	dans les premiers -- cm
inputs - nitrogen fixation	apports - fixation d'azote
inputs - rock weathering	apports - altération des roches
insect bodies	corps d'insectes
insects	insectes
in/mass	apports/masse
irrigated waste water	eaux usées d'irrigation

J

July	juillet
June	juin

K

kg/ha/yr	$kg.ha^{-1}.an^{-1}$
known age	âge connu

L

late success	phase avancée
late summer	fin de l'été
lateral root bark	écorce des racines latérales
lateral root wood	bois des racines latérales
lateral roots	racines latérales
layer	couche
leachate	percolat
leaching	lessivage
leaf fall	chute des feuilles
leaf litter	litière feuillue
leaves	feuilles
lge. branches	grosses branches
light wood	bois clair
lignin	lignine
lignin regress	régression d'après la lignine
limbs	grosses branches
lime	tilleul d'Amérique
limestone parent material	roche-mère calcaire
litter bag	sac à litière
litter decomposition	décomposition de la litière
litterfall	chutes de litière
litterfall biomass & nutrients	biomass & éléments nutritifs des chutes de litière
live branches	branches vivantes
live crown	cime vivante
living biomass	biomasse vivante
location	endroit
logs	grumes
low elev. site	stat. de basse alt.
low. crown	bas de la cime
low fert.	fert. faible
low poll.	poll. faible
low productivity	faible productivité
low site	station basse
lowerslope	pente inférieure
lysimetry	lysimétrie

M

May	mai
male fl.	fl. mâles
mats-bark	grosses racines - écorce
mats-wood	grosses racines - bois
maximum values	valeurs maximales
may be revised before publication	pourraient être révisées avant publication
mean as in [1] & includes large woody components, eg, down tree & branches as well as other 01 and 02 components	moyenne (comme en [1]) comprenant les composantes ligneuses importantes, p. ex. les arbres et les branches tombés, ainsi que d'autres composantes (01 et 02)

mean values from two watersheds, based on 0.04 ha plots per watershed	valeurs moyennes pour deux bassins versants pour des parcelles de 0,04 ha dans chaque bassin
medium roots	racines moyennes
med. site	station moyenne
med. thinned	éclaircie moyenne
mesic	mésoïque
metashale	métashale
method	méthode
mid elev. site	stat. de moy. alt.
mid-slope	milieu de pente
middle success	phase intermédiaire
mid. crown	milieu de la cime
min. horizons	horizons minéraux
min. soil	sol minéral
misc.	divers
mix	mélangée
mixed	mélangée
mixed broad.	mélangée, feuillue
mixed decid.	mélangée à feuillage caduc
mixed hardwoods	mélangée de feuillus
mod. decay	carie modérée
mod. poll.	poll. mod.
moist	humide
moist soil	sol humide
monthly mean	moyenne mensuelle
months	mois
mortality	mortalité
moss & lichens	mousses & lichens
muck	tourbe évoluée

N

needles	aiguilles
new fol.	nouv. feuill.
no date	sans date
no poll.	sans poll.
no thinning	sans éclaircie
no value	aucun chiffre
none detected	aucune décelée
non-woody	non ligneuse
not given	non donné
note: some totals do not add up precisely due to conversion of pound/acre to kg/ha	remarque: une conversion des lb/acre aux kg/ha ayant été effectuée, il se peut que certains totaux ne correspondent pas aux chiffres indiqués
nutrient concentrations - overstorey (% of dry weight)	concentrations d'éléments nutritifs - étage dominant (% poids humide)
nutrient concentrations - understorey	concentrations d'éléments nutritifs - sous-étage

O

oak	chêne
oakwood	chênaie
old fol.	vieux feuill.
old growth	vieux peuplement
older	d'années antérieures
older leaves	feuilles plus vieilles
open	terrain dégagé
openland ppt.	précipitations sur terrain dégagé
organic layers	couches organiques
org. horizons	horizons org.
org. layer	couche organique
org. mat.	mat. org.
other	autres
other OM	autres mat. org.
output type	types de pertes
outputs-denitrification	pertes-dénitrification
overstorey	étage dominant

P

parts per million	parties par million
peat	tourbe
periodic ground fires	feux de profondeur périodiques
phyllosphere	phyllosphère
pine needles	aiguilles de pin
Pinus sylvestris on sphagnum	Pinus sylvestris sur sphaigne
poor	médiocre
poor site	station médiocre
precip.	précip.
prelim. data	données prélim.
prescribed broadcast fire	brûlage extensif dirigé
primary branch bark	écorce des branches principales
primary branch wood	bois des branches principales
pumice soil	sol ponceux

R

red alder	aulne rouge
reference	référence
regress C/N	régression sur C/N
reproductive	org. reprod.
reprod.	org. reprod.
resin	résine
rhizomorphs	rhizomorphes
rhyolite parent material	roche-mère rhyolitique
ridgetop	faîte
rock type	type de roches
root crown	collets des rac.
root crown bark	écorce du collet des racines
root crown wood	bois du collet des racines
root depth	profondeur des racines
roots	racines
roots overstorey + understorey	racines - ét. dom. + sous-ét.
root-zone	zone des racines

S

schist	schiste
sandstone	grès
sasa litter	litière à sasa
saturated zone	zones saturées
secondary	secondaire
secondary branch bark	écorce des branches secondaires
secondary branch wood	bois des branches secondaires
sedimentary	sédimentaire
seedling	semis
seeds	graines
seeps	infiltrations
senescent leaves	feuilles sénescentes
Sept.	septembre
sev. poll.	poll. sévère
shallow	peu profondément
shrub leaves	feuilles des arbrisseaux
shrub stems	tiges des arbrisseaux
shrub twig	rameaux des arbrisseaux
shrublayer	arbrisseaux
shrubs	arbrisseaux
sites	stations
sitka alder	aulne de sitka
slash	rémanents
slash fire	feu de rémanents
slash fire-hot	feu de rémanents - chaud
slash fire-medium	feu de rémanents - moyen
slight-mod. decay	carie légère à modérée
sm. branches	petites branches
sm. trees	petits arbres
soil	sol
soil leachate	percolat du sol
soil org. matter	mat. org. du sol
soil to -- cm	sol jusqu'à -- cm
species	espèce
spr. needles	aiguilles d'épinette
springs	sources
sprouts	rejets
stand	peuplement
stand age	âge du peuplement
standing crop biomass & nutrient content	biomasse & teneur en éléments nutritifs du matériel sur pied
States' avg.	moy. de -- Etats
stem divided into 10 equal sections	tige divisée en 10 sections égales
stem heart	coeur de la tige
stem sap	sève de la tige
stembark	écorce des tiges
stemflow	écoulement sur écorce
stems	tiges
stemwood	bois des tiges
SW Western Australia	Australie occidentale (S.-O.)
streamflow	cours d'eau
stream-water	cours d'eau
strobili	strobiles

stumps	souches
successional sere	série
sugars	sucres
summary	résumé
surface runoff	ruissellement

T

tap root bark	écorce des racines principales
tap root wood	bois des racines principales
terminal shoots	pousses terminales
tertiary (termi.) branch bark	écorce des branches tertiaires (term.)
tertiary (termi.) branch wood	bois des branches tertiaires (term.)
tether	attache ("tether")
thinning	éclaircie
thinning residue piled and burned	brûlage de résidus d'éclaircie en tas
to sampled depth	jusqu'à la profondeur d'échantillonnage
top root	rac. princ.
total annual prec.	préc. ann. tot.
total in zone of max. rooting	total dans la zone d'enracinement maximal
total litter	litière totale
total non-symb.	total - non-symb.
total rooting zone	total - horizon racinaire
total to -- m	total jusqu'à -- m
trees	arbres
tree mortality	arbre mortalité
trees-shrubs	arbres-arbrisseaux
trees - deep	arbres - profondément
trees - shallow	arbres - peu profondément
trenched plots	parcelles creusées de sillons
tropical forest	forêt tropicale
trunks	troncs
tuffs/breccias	tufs/brèches
twigs	rameaux
twigs & foliage	rameaux & feuillage
throughfall	précipitation au sol

U

ultrabasic	ultrabasique
underground parts	parties souterraines
understorey	sous-étage
uneven	divers
unfert.	sans fert.
unid'd	non id.
unplanted	terrain non planté
unpubl. data	données inédites
upper slope	pente supérieure
upp. crown	haut de la cime
urban	milieu urbain

V

vacc. myrt.	vacc. myrt.
vacc. vitis	vacc. vitis
varied	variée
various	varié
vines	lianes
volcanic	volcanique
volume loss	perte en volume

W

water chemistry profiles	profils chimiques de l'eau
waxes	cires
weight	poids
wet	mouillé
whole tree crop	arbres entiers
-- whorl from top	-- verticille du haut
wildfire	incendie involontaire
wire screen	tamis métallique
wood	bois
woodpecker	pic-bois
woody	ligneuse
woody litter	litière ligneuse

X

xeric	xérique

Y

yellow	jaune

1 yr. needles	aiguilles de l'année

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
Ontario, Canada			4.95	.09	8.09	11.18	.84			Foster 1974[1]
Ontario, Canada			6.53	.20	2.11	9.5	8.76	10.48	Fe 1.38 SO4 26 Cl 2.69	Kramer 1976[1]
Ontario, Canada			6.8	.06	1.56	4.01	.68	1.82	Fe 1.18 SO4 26.70 Cl 6.66	Swanson 1976[1]
N. Carolina, USA			8.8		.11	2.1	4.8			Swank 1979
Denmark		60	6.9		3.1	6.5	3.0			Jensen 1962
Washington, USA		75	1.2	-	0.27	2.63	0.17	0.49		Tiedeman et al. 1978
Santa Ynez Mt., California, USA		77	NH4 0.1 NO3 1.1	-	0.5	1.9	1.0	6.1		Schlesinger & Hasey, 1980
Ontario, Canada		99.3	10.1 10.8	.41 .28	1.59 1.14	6.76 5.78	1.02 .81	4.02 3.93	Fe 1.47 Fe .85 SO4 29.60 SO4 30.80 Cl 3.14 Cl 2.29	Scheider et al. 1979
New York, USA		116			7.3	9.8	19.1	141.5		Art et al., cited in Gray and Schlesinger 1981
Kyoto, Japan		174	6.42	.56	2.8	10.35	2.15			Maruyama et al. 1965
Kiryu, Japan		193	5.39	.62	2.59	10.72	2.64	5.42		Tsutsumi 1978
		197		.57	7.34	9.8	1.91	10.82		
		181		.9	5.2	5.0	1.9	4.7		
		197				3.95	1.14	5.32		
Jaku, Japan		179	1.72	.52	6.42	9.2	1.77	18.45		
Hier, Japan		260	4.37	1.89	7.8	5.28	2.19	11.8		
Kawigamo, Japan		141	4.77	.28	1.67	8.72				
		169	6.11	.53	3.19	9.93	1.13			
		169	2.99	.24	4.52	10.57	1.11			
Kyoto U., Japan		94	8.06	.85	3.57	11.5	2.03			
		171	9.35	.70	6.98	21.0	9.93			
Ashiu, Japan		140	8.71	.31	3.68	3.93	3.57			

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
Ontario, Canada			16	.74						Nichols & Cox 1978[1]
Ontario, Canada				.44					Fe 4.54	Cross 1977[1]
Michigan, U.S.A.	?	79	NH4-N 3.1 NO3-N 4.9	0.25	2.7	10.5	1.7	3.8	Cl 9.4 SO4 18.2 pH 5.35	Richardson and Merva 1976
	?	73	NH4-N 2.1 NO3-N 3.2	0.31	3.2	9.5			Fe 0.4 pH 5.27	
	Urban	69	NO3-N 4.4	1.21					SO4 69	
Washington, USA	Abies amabalis	273	1.3	.4	.8	.6	.1			Turner & Singer, 1976
B.C., Canada	Abies, Tsuga	315	2.7	.11	2.5	3.7	3.0			Scrivner, 1975[1]
New Hampshire, USA	Acer, Betula, Fagus		6.5	.04	.9	2.2	.6			Whittaker in Cole Rapp 1980
New Hampshire, USA	Acer, Fagus	130	20.7	.04	.09	2.2	.6	1.6		Likens et al. 1977
New York, USA	Acer, Tilia	96	9.7	.07	.8	14.9	1.4	2.3		Likens, 1972[3]
Washington, USA	Alnus rubra	137	1.7	.3	2.2	2.2	.5			Turner et al.1977
Alaska, USA	Betula papyrif.		2.1	.09	.16	.98	.06		Org.Mat. 37.21	Van Cleve in Cole & Rapp 1980
Norway	Betula, Picea Pinus	39	NH4 1.5	tr.	0.5	0.5	0.5	4.3	Cl 6.6	Horntvedt and Joranger 1974[1]
Minnesota, U.S.A. White	Betula, Pinus	36	2.85	0.31	1.92	6.03	0.82			Comerford and 1977[1]
Birskenes Watershed, Norway	Betula, Pinus	134	14.5		2.2	2.7	2.3			Gjessing et al, 1976
Japan	Campothecci Mixed		9.4 3.5	.7 .24	7.0 4.5	19.6 10.6	10.0 1.1			Tsutsumi 1977

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
Norway	Conifers	77	-	-	8-20	5-17	2	7-22		Haughbotn 1973[1]
Mt. Disappointment, Victoria, Australia	Eucalyptus obliqua	98			2.0	2.74	5.4	16.8		Attiwill, 1966,
California, USA	Eucalyptus	57	2.0	0.8	1.7	2.2	0.3	6.6		McColl & Bush, cited in Schlesinger & Gray, 1981
Stradbroke Is., Queensland, Australia	Eucalyptus	165	60	<.2	3.4	3.2	5.9	50		Westman 1978
Maroondah, Victoria Australia	Eucalyptus regnans	151	1.2	.2	3.9	6.6	2.9	14.1		Feller unpubl. data
	Eucalyptus obliqua	102	.7	.2	1.3	4.1	1.8	11.2		
Stewarts Creek, Victoria Australia	Eucalyptus obliqua	130			4.2	1.3	1.4	17.9		Guthrie et al. 1978
A.C.T., Australia	Eucalyptus	150		.33		7.0	2.0	2.5		Hallam, 1976[1]
Denmark	Fagus	?	-	2.20	15.1	18.0	5.3	18.9		Astrup and
	Fagus	?	-	2.20	15.1	18.0	5.3	18.9		Bulow-Olsen 1972[1]
France	Fagus	55	NH4 5.1 NO3 4.7	0.3	2.4	9.0	2.9			Lemee 1974[2]
Central Europe	Fagus		23.7	.71	3.8	13.9	2.2	8.2		Ulrich 1975
W. Germany	Fagus silvatica		23.9[1]	.48[1]	2.0[1]	12.4[1]	1.79[1]	7.3[1]	Al 3.1[1] Cl 17.8[1] Fe 1.17[1] H .83[1] Mn .22[1] S 24.8[1]	Ulrich & Mayer 1972
Solling, W. Germany	Fagus silvatica	93.8	21.9[1,2]	.17[1,2]	12.1[1,2]	21.2[1,2]	3.9[1,2]	12.4	S 48.4 Cl 30.1	Ulrich et al. 1979
	Picea abies	93.8	21.9[1,2]	.17[1,2]	21.5[1,2]	27.3[1,2]	4.8[1,2]	16	S 85.3 Cl 35.9	

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
S. Sweden	Fagus, Picea	95	8.2	.07	1.9	3.5	.91			Nihlgard 1970
New Zealand	Hardwood	260	2.81	.26	5.72	2.08	3.9	28.9		Neary et al. 1978
Tennesse, U.S.A.	Hardwoods	?							SO4 13	Lindberg et al. 1979[4]
Florida, U.S.A.	Hardwoods	112	-	0.9	8.2	19.3	2.9			Ewel et al. 1975[4]
N. Carolina, U.S.A.	Hardwoods		3.5	.88	.28	3.4	1.7			Wells et al 1972
New York, USA coastal	Ilex				6.2 6.2[2]	8.6 7.4[2]	11.5 19.8[2]			Art et al. 1974
Tennessee, USA	Liriodendron		7.7	.06 .7[3]	.73 2.56[3]	6.1 6.1[3]				Harris in Cole & Rapp 1980
Tennessee, USA	Liriodendron, Carya, Quercus		8.7	.06 .48[3]	1.0 2.2[3]	9.1 5.3[3]	1.0 1.1[3]			Harris in Cole & Rapp 1980
Ohio, U.S.A.	Locust, Pinus	89		.18						Taylor et al. 1971[3]
Kyoto, Japan	Mixed broad Chamaecyparis Camptotheca	146 169 171	5.5 3.5 9.4	.5 .2 .7	2.7 4.5 7.0	8.8 10.6 19.6		1.3 1.1 9.9		Iwatsubo 1976
Great Britain	Mixed decid		5.8	.2	3.3	6.9	5.4			Satchell in Cole & Rapp 1980
Tennessee, USA	Mixed hardwoods	150	6.9	0.6	4.2	4.6				West et al. 1981 (prelim. data)
New Hampshire, USA	Mixed hardwoods		NO3-N 6.0 NH4-N 2.8		2.4	3.1	0.7	1.3	SO4-18 SO4-S-18	Martin 1979
Silverstream, New Zealand	Nothofagus	135	2.2	.20	5.3	6.0	9.0			Miller 1963
Alberta	Picea	?							SO4 0.3-2.4	Baker et al. 1977[4]

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
USSR	Picea abies		1.1		1.0	2.3	.9			Kazimirov & Morozova 1973
Scotland	Picea sitch.	1530				1	10	41		Miller 1979
	Picea sitch.	1620				4	9	23		
	Picea sitch.	1020				2	8	21		
	Picea sitch.	1120				2	10	45		
N. Carolina, USA	Picea, Abies	117			4.1	6.3	.9			Weaver 1972
	Betula lutea				5.6	7.8	1.0			
New Mexico, U.S.A.	Picea, Abies	74			1.4	6.4	.6			Gosz 1977[1]
Norway	Picea, Pinus, Betula	47	NH4 1.4 NO4 1.6	0.02	0.6	0.9	0.7	7.0	Cl 9.9 SO4 4.9	Abrahamson et al. 1976[1]
Sweden	Pinus	?	1.8	-	0.51	0.76	0.14	0.57	Cl 2.59	Bringmark 1980[2]
England	Pinus	12							SO4 5.8	Bache 1977[3]
New Zealand	Pinus	69	-	0.3	4-8	3-4		30		Will 1959[4]
Scotland	Pinus	79	-	-	-	5.6	4.0		SO4 14	Nicholson et al. 1980[5]
Ireland	Pinus	85	-	-	11	11	5.3	118		O'Hare 1967[6]
New Mexico, U.S.A.	Pinus	48			1.6	6.7	.7			Gosz 1977[1]
Ontario, Canada	Pinus banksiana	86	7.9	.1	4.0	5.6	.8			Foster & Morrison 1976
Tennessee, USA	Pinus echinata		8.7	.06	1.0	9.1	1.0			Harris in Cole & Rapp 1980
Scotland	Pinus nigra	630	4.8	.04	2.8	2.9	2.6	25.2		Miller, Cooper & Miller 1976
	Pinus nigra		tr[2]	tr[2]	6.9[2]	3.5[2]	2.1[2]	15.2[2]		
New Zealand	Pinus radiata	141			7.6	1.6	1.4	9.6		Knight & Will 1977

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
N. Carolina, USA	Pinus strobus		5.5 3.3[4]		2.0	4.1				Swank in Cole & Rapp 1980
Washington, U.S.A.	Pinus taeda		5.4	.21	1.6	2.8				Wells & Jorgensen 1975
Georgia, U.S.A.	Pinus, hardwoods	?	-	-	0.8	1.4	0.2	3.2		Torreneuva 1975[3]
Finland	Pinus, Picea Pinus	57 28	6.0 6.6	.1 .14	2.4 3.9	2.0 4.9	1.0			Viro 1953[1] Malkonen 1974
Minn, USA	Pinus, Picea	70		.14						Wright 1974[1]
Storsjon, Sweden	Pinus, Picea	87		.14	1.7	3.6	1.9			Dickson 1976[1]
Velen, Sweden	Pinus, Picea	72			1.6	5.9	1.2			Eriksson 1974[1]
Ontario, Canada	Pinus, Picea	83	6.4	.32	1.1	3.8	.9			Schindler et al. 1976
Michigan, USA	Populus tremuloidas	80	NH4-N 4.1 NO3-N 2.1	0.2	2.5	8.3	1.7	3.3		Richardson & Lund 1976
New Mexico, USA	Populus	72			1.3	6.8	.7			Gosz 1977[1]
Minn, USA	Populus, Picea	76	7.3	.5	1.0	3.5	.7	1.1		Verry & Timmons 1977
Washington, U.S.A.	Pseudotsuga	140							SO4 12.5	Cole and Johnson 1977[4]
Washington, USA	Pseudotsuga menziesii		1.7	2.3	2.5	0.3	.5			Turner, Cole in Cole & Rapp 1980
Washington, USA	Pseudotsuga menziesii		2.0	0.3	1.2	3.1	1.2			Grier in Cole & Rapp 1980
New Zealand	Pseudotsuga			.6	10	4.		40		Will 1959
Oregon, USA	Pseudotsuga	251 215	1.1 .9	.27	.3 .1	7.6 2.3	.7 .1	1.2 2.3		Fredriksen 1972

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
Washington, USA	Pseudotsuga	136	1.1	Tr.	.8	2.8	.7			Cole et al. 1967
Oregon, USA	Pseudotsuga	230		.23	.1	2.1	2.1			Abee & Lavender 1972
France	Quercus	?	25	0.04	7.5	2.5	-	-		Aussenac et al. 1972[4]
Hungary	Quercus	60	20	1.3	7.4	17	2.3	1.5	Cl 13 SO4 18	Szabo and Csortos 1975[5]
Oklahoma, U.S.A.	Quercus	86	3.9	1.07	4.0	3.9	0.86			Johnson and Risser 1974[6]
England	Quercus	110	5.8	0.5	3.0	4.8	1.4		SO4 5.6	Brown 1974[7]
Belgium	Quercus		8.7		4.0	15.0				Duvigneud, Denaeyer in Cole & Rapp 1980
Meathop Wood UK - coastal	Quercus			.34 .12[11]	4.0 6.3[1]	8.8 4.2[1]	6.8 16.2			White and Turner 1970
Belgium	Quercus	85	6.0		2.9	9.1	2.3			Duvigneaud & Denaeyer-de Smet 1967
Lancashire, UK	Quercus	162	9.5	.43	3.0	7.3	4.6	35.3		Carlisle et al. 1967
France	Quercus Quercus Quercus Pinus	477 601 662 709		.70 .80 1.00 1.10	3.1 3.8 2.0 3.8	14.7 10.2 10.5 11.7	2.1 1.7 1.5 1.0			Rapp 1969
Tennessee, USA	Quercus alba		8.7	.06 .48[8]	1.0 2.2[1]	9.1 5.3[1]	1.0 1.1[1]			Harris in Cole & Rapp 1980
France	Quercus ilex		15.6	1.0	2.4	11.7	2.1			Loissant, Rapp in Cole & Rapp 1980

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
Belgium	Quercus mixed		13.0	5.8	5.0	19.0			Org.Mat. 1	Duvigneud, Denaeyer in Cole & Rapp 1980
Tennessee, USA	Quercus prinus		8.7	.06 .48[1]	1.0 2.2[1]	9.1 5.3[1]	1.0 1.1[1]			Harris in Cole & Rapp 1980
Illinois, USA	Quercus, Carya		17.7	1.3	12.1	11.1	1.7			Rolfe, Akhtar & Arnold 1978
N. Carolina	Quercus, Carya	170	-	-	4.8	4.4	0.8	6.8		Best and Monk 1975[1]
N. Carolina, USA	Quercus, Carya		4.9 3.3[1]		2.1	4.8				Swank in Cole & Rapp 1980
N. Carolina, USA	Quercus, Carya	185			3.2	6.2	1.3			Nat'l Acadamy of Sciences 1974[1]
Illinois, USA	Quercus, Carya Liriodendron	98	1.8	1.0	.5	6.7	.02			Brown 1980
Tennessee, USA	Quercus, Carya	155		.54	3.1	14.3	2.1			Henderson 1976[1]
N. Carolina, USA	Quercus, Carya	170-250	3.02 .32[1]	.17 .02[1]	1.11 .51[1]	5.84 .96[1]				Swank & Henderson 1976
Tennessee, USA	Quercus, Mix	153	7.8	.06	1.09	5.82	1.0			Swank & Henderson 1976, Henderson 1977
Spain	Quercus, Pinus	63	8.1	-	3.8	7.2	1.3	25.6	Cl 9.1	Calvo de Anta et al. 1979[1]
New York, USA	Quercus, Pinus	124			2.4	3.3	2.0			Woodwell & Whittaker 1967
SE. USA	Quercus, Pinus	127			1.0	6.0	2.0			Gambell & Fisher 1966[1]

Table 1 Atmospheric Inputs (Kg/ha/yr.)[1]

Location	Dom. Veg.	Total Annual Prec. (cm.)	N	P	K	Ca	Mg	Na	Other	Reference
U.S.A.	Taxodium	110.5	5.8	0.49	3.0	4.8	1.43		S 0.49	Brinson et al. 1980
B.C., Canada	Tsuga, Thuga	225-255	3.5-3.9	.0	.8-.9	3.4-3.9	.8-.9	4.1-4.6		Feller & Kimmins 1979
Sweden	Varied	42-65			.6-3.7	2.6-13.9	.6-2.6			Tamm 1958
SE. England	Varied	83			2.8	10.7	<4	19.3		Madgewick & Ovington 1959

[1] Bulk precipitation (rain & dry fallout)
[2] Additional input due to impaction
[3] In Likens et al, 1977
[4] Dry fallout only
[5] In Scheider 1979
[6] Atmosphere particulates
[7] Openland ppt.
[8] Cited by Parker 1983.

Table 2 Inputs - Nitrogen Fixation

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
Quebec, Canada			Free living aerobic		Knowles 1965
			St. Bernard	34.6	
			muck	7.0	
			muck	9.3	
			mull A1	5.0	
			Free living anaerobic		
			St. Bernard	31.7	
			St. Bernard	73.0	
			Muck	19.8	
			Muck	39.0	
			Mull L+F	.1	
			Mull A1	44.0	
			Mull A1	55.2	
			Mor L	.8	
			Mor F+H	.9	
Alaska, USA	Alnus cri.	5		362	van Cleve et al,1971
Alaska, USA	Alnus cri.	10-60	Nodules	40	Crocker & Dickson, 1957
Alaska, USA	Alnus cri.	0-40		62	Crocker & Major, 1955
Quebec, Canada	Alnus glutinosa	2	Ecosystem'	53	Cote and Camire, 1984
	Alnus glutinosa & Populus	2	Ecosystem'	16-34	
England, UK	Alnus glutinosa	5-20	Ecosystem'	58	Akkermans and van Dijk, 1976
England, UK	Alnus glutinosa	7	Greenhouse study'	30	Virtanen 1957 (cited in Tarrant and Trappe, 1971)
England, UK	Alnus glutinosa	11	Soil to 5cm'	12	Holmsgaard 1960 (cited in Tarrant and Trappe, 1971)
Norway	Alnus incana	30	Ecosystem'	43	Johnsrud, 1979
Norway	Alnus incana	30	Ecosystem'	43	Johnsrud, 1978
Washington, USA	Alnus rubra	23	Ecosystem'	42	Binkley, 1983
Washington, USA	Alnus rubra	10-30	Soil to 120 cm'	60	Heilman, 1983

Table 2 Inputs - Nitrogen Fixation

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
Washington, USA	Alnus rubra	2-5	Ecosystem[2]	150	Heilman and Ekuan, 1983
Oregon, USA	Alnus rubra	0-40	Soil to 90 cm[1]	140	Franklin et al., 1968
Washington, USA	Alnus rubra	0-14 14-24 24-65	Ecosystem[1] Ecosystem[1] Ecosystem[1]	160 75 30	Luken and Fonda, 1983
Washington, USA	Alnus rubra	5	Ecosystem[2]	70	Bormann, 1981
Washington, USA	Alnus rubra	38	Ecosystem[1]	85	Cole et al., 1978
B.C., Canada	Alnus rubra	23	Ecosystem with Douglas-fir	130[1] 65[1]	Binkley, 1981/1983
Oregon, USA	Alnus rubra	4	Soil to 15cm[1] with black cottonwood	32	DeBell and Radman, 1979
Oregon, USA	Alnus rubra	0-30	Soil to 90 cm[1]	40	Tarrant & Miller, 1963
Oregon, USA	Alnus rubra	0-17	Soil to 15cm with Douglas-fir	13	Berg and Doerksen, 1975
	Alnus rubra	0-17	Soil to 15 cm with Douglas-fir	51	
Oregon, USA	Alnus rubra Alnus rubra Alnus rubra	0-1 7 30	Ecosystem[1] Ecosystem[1] Ecosystem[1]	100 140 209	Zavitkovski and Newton, 1968
Washington, USA	Alnus rubra	2-3	Ecosystem[1]	62	Tripp et al., 1979
Washington, USA	Alnus rubra	0-40	Ecosystem Forest floor[+] Soil to 20 cm[1]	100+	Bormann and DeBell, 1981
Oregon, USA	Alnus rubra	0-40	Soil to 90cm[1] with Douglas-fir	26	Franklin et al., 1968
Washington, USA	Alnus rubra	0-4	Soil to 15 cm[1]	80	DeBell and Radwan, 1979
Oregon, USA	Alnus rubra		Symb.	320	Newton et al. 1968

Table 2 Inputs - Nitrogen Fixation

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
Alaska, USA	Alnus rugosa	0-16	Ecosystem[1]	85	Voight and Steucek, 1969
Quebec, Canada	Alnus rugosa	18		170	Daly, 1966
Alaska, USA	Alnus rugosa	0-30	Soil to 20 cm[2]	56	von Oberforter et al. 1925 (cited in Tarrant & Trappe)
Alaska, USA	Alnus rugosa	0-22	Soil to 70 cm[2]	56	Ovington, 1956b
Washington, USA	Alnus sinuata	2-5	Ecosystem[3]	150	Heilman and Ekuan, 1983
	A. sinuata & Pseudotsuga	2-5	Ecosystem[3]	17-63	
B.C., Canada	Alnus sinuata	5	Ecosystem[3]	35	Binkley, 1982
B.C., Canada	Alnus sinuata	21	Ecosystem	20[3]	Binkley, 1981/1984
			with Douglas-fir	35[1]	
Alaska, USA	Alnus sinuata		Forest floor + A horizon	24	Ugolini 1968
Australia	Casuarina	0-13	Biomass & soil[1]	58	Dommergues, 1963
Oregon, USA	Ceanothus velutinus	0-12	Soil[1] to 30 cm	41-48	Binkley et al., 1982
			Ecosystem[1]	94-100	
Oregon, USA	Ceanothus velutinus	0-10	Ecosystem[1]	110	Youngberg & Wollum, 1976
		10-15	Ecosystem[1]	40	Youngberg et al., 1979
B.C., Canada	Ceanothus sanguineus	0-14	Soil[1] to 15 cm	40-60	Binkley and Husted, 1983
			Ecosystem[1]	60-90	
Oregon, USA	Ceanothus velutinus	0-17	Ecosystem[1]	0-20	Zavitkovski and Newton, 1968b
		17-32	Soil[1] to 15 cm	0-17	Binkley, unpublished
Oregon, USA	Ceanothus velutinus	11	Ecosystem[3]	32	McNabb et al., 1979
Montana, USA	Conifer		Logs	.75	Larsen et al. 1978
Norway	Conifers		Total non-symb.	1.2	Hovland, 1978

Table 2 Inputs - Nitrogen Fixation

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
Oregon, USA	Conifers	450	Arboreal lichens	3-4	Denison, 1979
New Zealand	Coriaria	14-25	Biomass & soil[1]	130-190	Silvester, 1969
Australia	Eucalyptus & Daviesia	?	Ecosystem[3]	5-7	McColl and Edmonds, 1983
Georgia, USA	Hardwood		Logs	.89	Cornaby and Waide, 1973
Europe	Hippophae	3-16	Ecosystem[1]	4-180	Stewart and Pearson, 1967
Europe	Hippophae	2-15	Ecosystem[3]	2-15	Akkermans, 1971
Western Australia	Macrozamia riedlei		Coralloid roots	18.7	Holliday and Pate, 1976
Tennessee, USA	Mix dec.		Twigs	.27	Todd et al., 1975
			Branches	.08	
				.09	
			Logs	.30	
				.92	
			L horizon	.03	
			H horizon	.63	
			Soil 0-10 cm	4.04	
			10-20 cm	1.77	
			20-40 cm	2.72	
			Total	10.85	
Massachusetts, USA	Myrica gale	?	Ecosystem[1]	37	Schwintzer, 1983
Scotland	Myrica gale		Symb.	30	Sprent & Scott, 1979
Oregon, USA	Pesudotsuga	450	Decaying logs[1]	1.4	Silvester et al. 1982
New Zealand	Pinus		Symb. (Coriaria)	90	Harris & Morrison, 1958
New Zealand	Pinus radiata	4			
		0-4	Lupinus	90	Gadgil, 1976
			Lupinus	160	
England, UK	Pinus sylvestris		Total system	48.2	Ovington, 1951 (from Moore, 1966)
Clemson, S.C., USA	Pinus taeda	40	Forest floor	0.15	West et al., 1981
			Soil	1.60	
		clearcut	Forest floor	0.11-0.31	
			Soil	1.73-1.79	

Table 2 Inputs - Nitrogen Fixation

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
S. Carolina, USA	Pinus taeda		Soil	1.0	Jorgensen & Wells, 1971
Sweden	Pinus, Picea	15-16	Phyllosphere	0-0.15	Granhall and Lindberg, 1980
			Forest floor	0-7.5	
			Soil	0-0.5	
England, UK	Pseudotsuga		Phyllosphere	5-12	Jones, 1970
Oregon, USA	Purshia trid.		Symb.	.06	Dalton & Zobel, 1979
N. Carolina, USA	Quercus, Carya		Phyllosphere	.22	Swank, 1979
			Bole	1.00	
			Woody litter	1.66	
			Leaf litter	.63	
			Soil	8.55	
N. Carolina, USA	Robinia Pseudoacacia	4-38	Ecosystem[1,3]	30-75	Boring and Swank a&b
England, UK	Varied		Non-symbiotic	55.7	Ovington, 1956 (from Moore, 1966)

[1]Based on accretion studies
[3]Based on greenhouse accretion per gram nodule times nodule biomass in field.
[1]Based on acetylene reduction assays.

Table 3 Inputs - Rock Weathering (kg/ha/yr)

Location	Dom. Veg.	Rock type	P	K	Ca	Mg	Na	Other	Reference
Idaho, USA	Conifers	Plagioclase, K-Feldspar		23	26	10	52	Fe 11	Clayton, 1979
Maroondah, Victoria, Australia	Eucalyptus	Dacite	2.7	20.8	18.6	8.4	16.9		Feller 1981
New Hamp. USA	Mixed	Quartz Plagioclase Biotite		7.1	21.1	3.5	5.8	Al 1.9 Si 18.1	Likens et al., 1977
Maryland, USA	Mixed	Schist		2.3	1.3	1.7	2.6	Si 119	Cleaves et al., 1970
Maryland, USA	Mixed	Serpentinite		tr	tr	34.1	tr	Si 55.8	Cleaves et al., 1974
California, USA	Pinus arist.	dolomite Adamellite		4 8	86 17	52 2	2 1	Si 32 21	Marchand, 1971
Washington, USA	Pseudotsuga			15.2	17.4				Cole et al., 1967
Oregon, USA	Pseudotsuga menziessi	Andesitic tuffs	0.2	4.7	120	7.2	47		Sollins et al., 1980
Oregon, USA	Pseudotsuga	Tuffs/ breccias		1.6	47	11.6	28	Si 213	Fredriksen, 1972
Luxembourg	Quercus, Fagus	Metashale		.2	8.7	15.7	9		Verstraten, 1977
New York, USA	Quercus, Pinus			11.0	24.3	8.3	6.8		Woodwell & Whittaker, 1967

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Japan	Abies (forest)		Aboveground	129000	527	63	278	515	415		Tsutsumi 1971
Oregon, USA	Abies amab.	175	Aboveground	469000	372	67	980	1046	160		Turner & Singer, 1976
Minnesota, USA	Abies balsamea	60	Understory	942	10.1	1.7	13.1	7.6	1.3		Outcalt & White 1981
		cut	Understory	4181	50.3	7.9	64.3	42.8	7.7		
		cut+ burn	Understory	2604	36.4	5.8	55.4	21.7	5.2		
Oregon, USA	Abies concolor	23	Foliage		89.0	11.0	61.0	57.0	12.0		Grier unpublished in Cole et al., no date
			Branches		52.0	4.0	54.0	28.0	7.0		
			Stems		29.0	11.0	27.0	37.8	10.0		
			Understory		29.0	14.0	35.0	35.0	2.0		
			Roots		23.0	4.0	17.0	26.0	4.0		
Oregon, USA	Abies concolor Tsuga heterophylla	180	Foliage		170.0	21.0	117.0	260.0	41.0		Grier unpublished in Cole et al., no date
			Branches		20.0	9.0	120.0	120.0	40.0		
			Stems		150.0	40.0	650.0	640.0	75.0		
			Understory		12.0	2.0	16.0	15.0	1.0		
			Roots		133.0	25.0	100.0	154.0	25.0		
Japan	Abies firma	97-145	Overstory:								Ando in Cole & Rapp 1980
			Foliage Total	15134	145.7	12.3	157.4	125.6	14.4		
			Branches	57760	173.7	22.5	255.8	315.5	33.8		
			Boles	306668	254.0	46.9	1012.3	961.0	81.7		
			Roots	145647							
			Understory veg.	121957	363.4	40.0	436.9	851.6	52.4		
Colorado, USA	Abies lasiocarpa		Trees >1.4m								Snell et al, 1979
			Needles	22730	223	6	123	201	20		
			Branches	31450	79	13	44	152	13		
			Bole,Bark	172570	384	64	224	481	42		
			Roots	57818	72	12	40	140	12		
			Trees <1.4m	1091	5	1	3	7	2		
			Shrubs	337	4	<1	1	2	1		
			Herbs	39	1	<1	1	1	<1		
Prince George, B.C., Canada	Abies lasiocarpa	110-350	Total		103.9	19.3	63.0	131.1	18.0		Kimmins, 1974
			Wood	2767	14.4	1.2	22.7	21.2	5.1		
			Bark	6459	21.3	3.8	9.4	49.5	3.3		
			Lge. branches	1696	2.9	.4	1.4	8.5	.7		
			Sm. branches	3514	6.3	1.0	3.5	11.0	1.2		
			Twigs&foliage	4454	35.1	5.6	10.4	16.0	3.4		
			Crown	9662	44.3	7.0	15.3	35.5	5.3		
			Bole	34106	35.7	5.0	32.1	70.7	8.4		
			Roots		23.9	7.3	15.6	24.9	4.3		
			Total aboveground		80.0	11.9	46.7	106.2	13.7		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Japan	Abies mayriana	Not Given	Leaves	28500	324	34.6	144	163	146		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	19400	89	15.5	52.4	109	81.5		
			Trunks	81500	114	13.0	81.5	243	187		
Oregon, USA	Abies nobilis	130	Foliage		149.0	44.0	96.0	144.0	18.0		Grier unpublished in Cole et al.
			Branches		75.0	20.0	63.0	170.0	19.0		
			Stems		390.0	40.0	72.0	510.0	80.0		
			Understory		2.0	t	2.0	15.0	2.0		
U.S.A.	Abies, Tsuga	175	Aboveground	337000	320	50	819	992	130	Mn 258	Turner & Singer 1976
New Hampshire, USA	Acer, Betula	55	Stand	161070	532	87	218	484	49		Whittaker et al. 1974
New Hampshire, USA	Acer, Betula, Fagus	110	Overstory:								Whittaker in Cole & Rapp 1980
			Foliage Total	3180	70.1	5.5	30.0	19.5	4.8		
			Branches	38980	162.5	16.2	52.9	189.3	13.8		
			Boles	91840	134.6	11.0	70.8	193.2	18.9		
			Roots	28560	181.0	52.7	63.2	101.0	13.5		
			Understory veg.	54	9.0	.8	2.2	3.4	1.6		
Ohio, USA	Alnus glutinosa	4	Aboveground								
			Foliage	2600	82	5	28	50	8	Mn 0.78	Wittwer & Immel 1980
			Branches	5500	56	3	22	49	4	Mn 1.56	
			Stem	16300	43	4	26	15	5	Mn 0.43	
			Bark	4100	45	3	12	68	2	Mn 1.65	
			Total tree	28500	226	15	88	182	19	Mn 4.42	
England	Alnus incana	22	Leaves +Branches	28000	420	30	78	304	23	Na 4	Ovington 1962
			Trunks	83100	220	26	50	280	16	3	
			Understory	2100	50	4	22	46	5	1	
Washington, USA	Alnus rubra (high site)	?	Tree	15600	362	47	173				West et al. 1981 (prelim. data)
			Understory	1300	24	2	23				
	Alnus rubra (poor site)	?	Tree	126000	378	27	143				
			Understory	1400	25	2	23				
Washington, USA	Alnus rubra	33	Leaves	4100	100	5	43	42	8.4	Mn 4.0	Turner et al. 1976
			Branches	19400	20	2	4	77	5.8	1.0	
			Bark	23600	165	10	18	69	38.0	6	
			Trunks	128000	128	16	27	51	45.1	6	
			Roots	35200	176	4	7	123	12.4	5	
			Overstory Total	210000	589	37	99	299	110.7	24	
			Understory	9500	103	7	132	95	16	1.4	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Washington, USA	Alnus rubra, high productivity	53	Foliage	9930	263	21	173				Bigger & Cole 1983
			Branches	9980	60	6	23				
			Bole	137000	287	41	151				
			Understory	1720	29	2.4	23				
			Forest floor	15000	327	20	30				
			Soil to 50 cm	144000	3603						
			Total	318000	4560						
Washington, USA	Alnus rubra, low productivity	53	Foliage	6060	145	9.3	64				Bigger and Cole 1983
			Branches	9270	67	4.7	21				
			Bole	111000	311	22	122				
			Understory	1900	32	2.4	23				
			Forest floor	14100	330	17	22				
			Soil to 50 cm	111900	3997						
			Total	302000	4590						
Connecticut	Alnus rugosa	16	Foliage	675	18						Voight & Steucek 1969
			Twigs	2150	20						
			Stems	14700	52						
			Coarse roots	4425	22						
			Fine roots	290	3						
			Nodules	12	.3						
Korea	Alnus sibirica	12	Leaves	3460	46	6.4	29				Mun et al. 1977
			Branches	10800	61	5.0	11				
			Stems	31180	136	7.5	20				
			Roots	11365	77	3.0	63				
			Understory	4460	59	3.6	37				
B.C., Canada	Alnus sinuata	5	Leaves	1750	44	6.9	15.0	19.7	3.3		Binkley 1982
			Stems	8910	57	13.6	21.0	20.3	3.6		
			Roots	2930	19	4.5	6.9	6.7	1.2		
Alaska, USA	Alnus tenuifolia	5	Aboveground			9.7	39.9	58.9	6.8	Mn 0.1	Van Cleve and
			Roots			3.7	13.5	88.3	28.4	0.5	Viereck, 1972
		15	Aboveground			8.4	55.1	160.6	10.7	0.8	
			Roots			6.4	33.2	188.6	28.3	1.6	
		20	Aboveground			23.0	94.0	180.2	14.0	0.3	
			Roots			22.8	72.2	181.0	30.9	1.3	
Japan	Betula platyphylla	Not Given	Leaves	2100	50.6	2.5	29.4	26.3	14.9		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	13900	58.4	5.4	16.7	82.0	15.3		
			Trunks	97800	156	11.7	38.1	293	64.5		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.S.R.	Betula	20	Foliage	1700							Cited in Rodin and
			Woody	57000							and Basilevich 1967
			Roots	30100						Ash	
			Total	89800	450					925	
U.S.S.R.	Betula	35	Foliage	5200							Cited in Rodin and
			Woody	164200							Basilevich 1967
			Roots	43900						Ash	
			Total	213300	876					1249	
Finland	Betula	40	Leaves	2900	70.2	5.6	29.0	31.2			Malkonen 1977
			Live Branches	8580	33.7	4.4	13.7	36.6			
			Dead Branches	250	0.7	<0.1	0.1	0.7			
			Bark	11400	54.0	4.7	44.8	69.7			
			Stemwood	67100	55.7	6.6	24.3	38.0			
			Below ground	24120							
			Roots>1cm		13.5	4.5	11.3	15.0			
			Roots<1cm		36.8	5.3	11.6	29.0			
			Stumps		4.8	0.6	2.4	2.5			
			Understory	2560	33.2	4.2	31.4	14.3			
U.S.S.R.	Betula	40	Foliage	3700							Smirnova and
			Woody	203400							Gorodentseva 1958
			Roots	42800						Ash	(cited in Rodin and
			Total	249900	959					1666	Basilevich 1967)
U.K.	Betula	42	Foliage	1100							Ovington and Madgwick,
			Woody	67500							1959 (cited in Rodin
			Roots	25800						Ash	and Basilevich, 1967)
			Total	94400	253					426	
Ohio, USA	Betula nigra	4	Aboveground								
			Foliage	1800	40	3	15	36	5	Mn 0.90	Wittwer & Immel 1980
			Branches	8800	53	3	21	62	5	Mn .64	
			Stem	20500	44	10	30	21	10	Mn 0.62	
			Bark	1000	9	1	2	17	1	Mn .16	
			Total tree	32100	146	17	68	136	21	Mn 2.32	
Alaska, USA	Betula papyrif.	50	Overstory:								Van Cleve in
			Foliage Total	2362.8	51.1	5.2	22.8	14.9	8.2		Cole & Rapp 1980
			Branches	11025.2	39.8	4.9	17.1	37.9	5.7		
			Boles	83954.9	130.0	9.4	64.3	110.9	24.2		
			Roots	44297	131.1	15.4	43.3	99.3	20.6		
			Understory veg.								
				95	1.0	15.5	44.8	134.2	23.5		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
England	Betula verrucosa	24	Leaves	2400	47	3	28	32	5	Na 1	Ovington and Madgwick 1959 (cited in Ovington 1962)
			Branches	11800	68	5	21	69	6	1	
			Trunks	48000	73	6	29	132	13	1	
			Roots	16900	89	5	15	79	4	1	
England	Betula verrucosa	22	Leaves +Branches	17700	178	22	45	192	17	Na 1	Ovington 1962
			Trunks	43100	62	8	17	120	7	1	
			Understory	2200	24	3	14	15	2	1	
England	Betula verrucosa	55	Leaves	2500	78	4	43	42	7	Na 1	Ovington and Madgwick 1959 (cited in Ovington 1962)
			Branches	27000	168	12	46	180	13	3	
			Trunks	134500	145	11	65	275	26	2	
			Roots	49800	152	7	46	154	14	4	
U.S.S.R.	Bogwhortleberry forest	200	Aboveground	63000	210	15	80	120	30		Rodin & Bazilevich 1967
U.S.S.R.	Carpinus, Fagus	46	Foliage	6400							After Dzens-Litorskaya 1960 (cited in Rodin Basilevich 1967)
			Woody	216300							
			Roots	57600						Ash	
			Total	280300						3844	
U.K.	Castanea sativa	39-47	Aboveground + thinning	176000	245	15	85	205	40		Ovington 1962
		47	Leaves +Branches	8200	65	6	37	41	7	Na 1	
			Trunks	108400	116	6	31	106	20	2	
			Understory	1200	15	2	9	7	3	1	
Japan	Chamaecyparis	28	Stand	143000	391	44	191	619	188		Harada et al. 1969
Kyoto, Japan	Chamaecyparis		Stem	84700	87.2	5.42	49.1	134.7	29.6		Iwatsubo 1976
			Branch	13500	40.1	2.58	17.4	62.7	6.2		
			New Fol.	2000	21.8	1.52	11.1	19.0	3.4		
			Old Fol.	8000	76.4	4.53	29.6	80.6	14.7		
			Roots	30100	45.5	2.30	17.3	49.7	10.2		
Japan	Cryptomeria japonica	24	Leaves	19900	243	25.1	99.5	175	47.8		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	7600	22	2.1	7.6	45.6	3.8		
			Trunks	117000	117	9.4	105	129	23.4		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Japan	Cryptomeria	28	Stand	158700	441	44	269	857	185		Harada et al, 1969
Japan	Cryptomeria japonica	25	Leaves	27400	282	25.2	159	189	84.9		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	10600	20	2.2	8.5	19	10.6		
			Trunks	76000	84	8.7	76.0	106	22.8		
Australia	Eucalyptus regnans	27	Leaves	8100		1.81					Ashton 1976
			Branches	71200		3.9					
			Trunks	713100		10.1					
			Understory	38700		1.7					
			Fine roots (0-12.5cm)	3500		3.3					
Stradbroke Is. Qld., Australia	Eucalyptus	7	Stemwood	51880	103	2.6	5	55	2.3	Na 69	Westman & Rogers 1977a
			Stem bark	6629	18	.4	71	75	8.4	14	
			live branches	29870	24	1.6	32	61	6.6	19	
			dead branches	5993	17	3.0	1	13	3.2	4	
			current twigs + leaves	11590	69	2.8	30	60	36.1	27	
			root crown	21740	40	1.1	2	19	.7	8	
			top root	12140	18	.5	1	15	2.0	6	
			lateral roots	28040	96	5.9	29	37	12.9	20	
			dead standing wood+bark	10470							
Australia	Eucalyptus sieberi	27	Leaves	12100		1.0					Ashton 1976
			Branches	67000		1.6					
			Trunks	804100		10.4					
			Understory	45300		0.6					
			Fine roots (0-12.5cm)	3800		3.0					
SW Australia	Eucalyptus diversicolor	36	wood	183800							Mingston, Turbon, & Dimmock 1979
			bark	20000							
			leaves	4500							
			branches	14900							
			dead wood	1800							
			fruit	-							
			total tree	225000	189	18	225	698	144	S 18 Na 61	
			understory	10300	60	2	39	39	7	S 6 Na 6	
	Eucalyptus diversicolor-E. Calophylla	A11	wood	207900							
			bark	35700							
			leaves	8900							
			branches	31100							
			dead wood	-							
			fruit	500							
			total tree	284000	333	26	389	1020	293	S 33 Na 114	
			understory	1170	11	.4	9	12	3	S 2 Na 1	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Maroondah, Victoria, Australia	Eucalyptus regnans	38	stemwood	490.6	113	9	898	157	78	Na 64	Feller 1981
			stembark	67.8	88	11	241	424	68	Na 40	
			live branches	31.3	36	3	118	83	13	Na 7	
			dead branches	8.6	10	0	4	17	3	Na 1	
			leaves	2.7	35	3	24	13	6	Na 2	
			total	601.0	282	26	1285	694	168	Na 114	
	Acacia spp.		Stemwood+bark	16.0	31	3	9	17	4	Na 3	
			branches	5.4	13	1	4	4	2	Na 1	
			leaves	.4	10	1	2	1	1	Na 0	
			shrubs-aboveground	31.6	63	7	89	133	17	Na 20	
			total	53.4	117	12	104	155	24	Na 24	
	standing dead E. regnans		stemwood	15.5	18	1	8	30	5	Na 2	
			stembark	2.5	3	0	9	16	3	Na 1	
			branches	.4	0	0	0	1	0	Na 0	
			total	18.4	19	1	16	44	7	Na 3	
			roots total	63.2	130	12	242	94	60	Na 45	
	E. obliqua		stemwood	256.6	216	6	28	79	20	Na 36	
			stembark	79.5	130	5	39	119	18	Na 48	
			branches	23.8	31	3	15	30	18	Na 10	
			leaves	3.8	26	2	16	22	10	Na 6	
			total	363.7	402	17	98	251	67	Na 100	
	E. dives		stemwood	6.4	9	0	2	2	1	Na 1	
			stembark	1.8	8	0	2	9	3	Na 1	
			live branches	.3	0	0	0	0	0	Na 0	
			dead branches	.2	0	0	0	0	0	Na 0	
			leaves	.1	1	0	0	0	0	Na 0	
			total	8.8	19	1	5	12	4	Na 2	
	Eucalypts		aboveground total	372.5	421	17	103	263	70	Na 102	
			understory aboveground	.9	4	0	7	1	1	Na 0	
			living biomass aboveground total	373.4	426	17	111	264	71	Na 103	
	E. obliqua		stemwood	12.4	19	10	4	12	12	Na 4	
			stembark	3.8	6	0	2	6	1	Na 2	
			branches	.2	0	0	0	0	0	Na 0	
	E. dives		stemwood	1.8	3	0	0	2	0	Na 0	
			stembark	.6	3	0	1	3	1	Na 0	
			branches	.1	0	0	0	0	0	Na 0	
			standing dead aboveground total	18.9	32	10	7	23	14	Na 7	
			roots over+ under story	45.4	64	9	113	25	43	Na 43	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Japan	Evergreen broad-leaved	Not Given	Leaves	5000	78.5	5.1	44.0	26.0	17.5		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	23000	87.4	16.3	66.7	87.5	25.3		
			Trunks	86000	163	30.1	138	146	51.6		
Sweden	Fagus	90	Current twigs, leaves	4000	100	6.2	23	20	6.8	Si 1.3 Na 1.6 Fe 0.6 Mn 6.6 S 4.4	Nihlgard 1972
			Branches	99000	660	55.2	228	381	40.9	Si 12.2 Na 13.4 Fe 9.4 Mn 59.8 S 34.9	
			Bark	9000	80	4.7	19	90	5.5	Si 2.9 Na 1.0 Fe 1.8 Mn 9.4 S 4.9	
			Trunks	212000	210	17.7	182	111	51.5	Si 4.7 Na 16.1 Fe 3.6 Mn 34.9 S 23.8	
			Stumps +large roots	37000	70	5.7	39	21	7.2	Si 4.1 Na 2.7 Fe 5.2 Mn 5.7 S 7.7	
			Medium roots	8000	40	5.2	21	12	2.7	Si 2.2 Na 2.3 Fe 2.0 Mn 2.9 S 3.3	
			Fine roots	6000	40	4.7	19	9	3.6	Si 5.2 Na 1.5 Fe 6.9 Mn 2.1 S 3.5	
			Total	375000	1210	100	539	645	118	Si 32.6 Na 38.7 Fe 26.9 Mn 126 S 82.7	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Central Europe	Fagus	120	Foliage	5000							After Duvigneaud 1962 (cited in Rodin and Basilevich 1967)
			Woody	270000							
			Roots	95000							
			Total	370000	1608					Ash 2588	
Sweden	Fagus sylvatica	100	Total	225000	640	62	318	478	85	S 42 Fe 5 Mn 29	Nihlgard & Lindgren 1977
England	Fagus sylvatica	39	Leaves +Branches	35500	155	22	91	72	14	Na 1	Ovington 1962
			Trunks	97900	128	16	94	79	28	2	
			Understory	200	2	<1	2	<1	<1	1	
Solling, W. Germany	Fagus sylvatica	125	Foliage	3000	90	6.0	27	12			Ulrich et al. 1974 + Pavlov 1972
			Branches	32000	96	16.0	38.4	64			
			Stem Wood	20500	246	41.0	184.5	164			
			Bark	16000	128	11.2	38.4	128			
			Stump + lge roots	35000	105	17.5	42.0	70	7		
			Fine roots	2000	6	1.0	2.4	4	.4		
Sweden	Fagus sylvatica	45-130	Overstory:								Nihlgard 1972
			Foliage Total	5000	121.0	7.0	26.7	24.5	7.5		
			Branches	99000	660.0	55.2	228.0	381.0	40.9		
			Boles		290.0	22.4	201.0	201.0	57.0		
			Roots	51000	150.0	15.6	79.0	42.0	13.5		
			Understory veg.	200	10.0	.7	8.0	.9	.1		
Germany	Fagus sylvatica	80	Overstory:								Ulrich in Cole & Rapp 1980
			Foliage Total	3294	95.5	5.7	31.4	17.5	2.5		
			Branches	25870	97.1	11.6	37.4	68.9	5.7		
			Boles	129600	211.5	18.7	133.7	216.3	17.9		
			Roots	22080	57.5	10.9	31.9	25.7	5.9		
U.K.	Fagus sylvatica	39-47	Aboveground + thinning	197000	366	49	246	202	60		Ovington 1962
Germany	Fagus sylvatica	122	Overstory:								Ulrich in Cole & Rapp 1980
			Foliage Total	3078	84.4	4.6	24.6	11.1	2.2		
			Branches	32480	128.7	9.8	42.7	76.7	8.0		
			Boles	238400	367.9	5.5	205.5	215.2	56.7		
			Roots	30040	107.0	19.0	55.5	46.0	11.6		
			Understory Veg.	13							

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Germany	Fagus sylvatica	120	Aboveground	370000	1608						Rodin & Bazilevich 1967
Sweden	Fagus sylvatica	90	Stand	375000	1060	84	460	603	105		Nihlgard 1972
Moravia Czechoslovakia	Flood-Plain Forest Stand										Klimo 1975
	Trees		aboveground parts		1.5	83	577	1.9	126	C 189.7 Ash 6.1	
	Shrubs		aboveground parts		55	8	26	31	9	C 2.2 Ash234	
	Herbs		aboveground parts		22	4	47	21	5	C 657 Ash187	
	Trees		under ground parts		189	31	68	226	48	C 10.5 Ash 1.3	
	Shrubs		under ground parts		15	2	6	8	3	C 787 Ash 63	
	Herbs		under ground parts		6	1	10	6	1	C 254 Ash 72	
Ohio, USA	Fraxinus pennsylvanica	4	Aboveground								
			Foliage	2100	30	8	36	27	4	Mn 0.08	Wittwer & Immel 1980
			Branches	4600	30	3	16	25	4	Mn .04	
			Bark	800	6	2	3	10	1	Mn .02	
			Stem	9700	24	5	20	8	4	Mn 0.10	
			Total tree	17200	90	18	75	70	13	Mn .24	
N. Carolina, USA	Hardwood		Sprouts		16.6	1.4	8.6	11.8	2.5		Boring et al, 1979
			Herbs		8.2	.7	13.0	4.4	1.5		
			Vines		3.2	.3	2.1	2.6	.6		
			Seedlings		1.2	.1	.8	.7	.2		
England	Larix decidua	46	Leaves +Branches	43600	357	31	110	100	14	Na 4	Ovington 1962
			Trunks	145800	108	13	32	72	21	3	
			Understory	4600	60	10	74	26	8	5	
U.K.	Larix decidua	39-47	Aboveground + thinning	275000	528	52	161	214	47		Ovington 1962
Japan	Larix leptolepis	28	Leaves	4500	88.6	6.5	36.5	17.2	8.0		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	13200	43.2	5.4	43.2	37.7	8.2		
			Trunks	82100	98.5	15.6	132	52.5	23.8		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	N	P	K	Ca	Mg	Other	Reference
				kg/ha							
Tennessee, USA	Liriodendron Quercus, Carya	30-80	Overstory:								Harris-Henderson in Cole & Rapp 1980
			Foliage Total	5100	78.0	6.0	45.0	75.0	21.0		
			Branches	21000	54.0	7.0	37.0	155.0	13.0		
			Boles	83000	135.0	8.0	90.0	307.0	25.0		
			Roots	31000	122.0	22.0	132.0	211.0	19.0		
Tennessee, USA	Liriodendron	50	Overstory:								Harris-Edwards in Cole & Rapp 1980
			Foliage Total	3200	53.9	6.3	52.3	35.2			
			Branches	27100	78.6	30.6	45.1	143.7			
			Boles	94400	172.0	9.7	74.8	276.8			
			Roots	36000	122.7	18.5	111.5	150.8			
			Understory veg.	8800	23.8	5.7	32.4	115.2			
Japan	Mixed hardwoods (ridgetop)	Not Given	Leaves	3000	60	3.2	26.5	33	8.4		Katagiri and Tsutsumi 1975
			Branches	19000	85	8.0	37.0	125	15.0		
			Trunks	56000	100	7.3	59.0	250	22.5		
	Mixed hardwoods (lowerslope)	Not Given	Leaves	3000	60	3.5	26	35	9		
			Branches	103000	465	43.0	200	680	80		
			Trunks	157000	280	20.0	165	700	62		
Japan	Mixed		Foliage	7310	108.2	5.9	43.2	40.2	12.3		Katagiri et al. 1978
			Branch	55300	276.4	23.2	165.8	254.2	56.9		
			Stem	325200	520.3	29.3	552.8	601.6	84.5		
			Small trees	4900	23.6	1.6	9.6	15.4	5.1		
Japan	Mixed broad -Lower slope		Foliage	4230	77	4.23	34.7	43.6	11.0		Katagiri & Tsutsumi 1978
			Branches	101990	459	42.84	198.9	673.1	79.6		
			Stem	170710	307	22.19	179.3	768.2	68.3		
	mixed broad -Upper slope		Foliage	3260	60	3.26	26.7	33.6	8.5		
			Branches	18690	84	7.86	36.5	123.9	14.6		
			Stem	56470	102	7.34	59.3	254.1	22.6		
Kyoto, Japan	Mixed broad		Stem	59600	72.3	4.78	65.9	146.1	52.6		Iwatsubo 1976
			Branch	23100	80.6	5.75	59.2	78.1	19.7		
			New Fol.	3100	45.6	2.04	37.4	19.8	9.7		
			Old Fol.	2600	31.6	1.51	16.5	18.1	5.6		
			Roots	38100	82.3	4.52	71.4	81.4	33.5		
Tennessee,	Mixed hardwood	?	Trees								West et al. 1981 (prelim. data)
			Foliage	3480	60	4	50	40			
			Branches	35950	120	11	120	390			
			Stems	132380	240	18	190	890			
			Understory								
			Foliage	930	10	1	10	10			
			Stems	14980	70	5	30	150			

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
New Brunswick, Canada	Mixed hardwoods	10	Trees	9500	50	8	35	30	7		MacLean 1978 (estimated from graphs)
			Understory		40	3	40	12	3		
		20	Trees	30000	225	29	140	140	27		
			Understory		50	5	50	22	5		
		40	Trees	30000	160	22	80	115	15		
			Understory		18	3	18	10	3		
New Hampshire, USA	Mixed Hardwoods	90	Leaves +twigs	3620	80.5			24.9			Hornbeck, 1977
			Branches	53930	195.4			229.0			
			Bark	14040	81.3			193.4			
			Trunk	131050	125.5			99.3			
			Total	202640	482.7			546.6			
New Hampshire, USA	Mixed Hardwoods	55	Aboveground	132810	351	34	155	383	36	S 42 Na 1.6	Likens et al, 1977 Whittaker et al, 1974
			Belowground	28260	181	53	63	101	13	S 17 Na 3.8	
England	Nothofagus obligua	22	Leaves +Branches	32000	404	23	141	167	25	Na 16	Ovington 1962
			Trunks	48700	105	10	76	105	12	2	
			Understory	800	11	1	13	5	2	2	
New Zealand	Nothofagus truncata	110	Leaves	2700	32	2	13	20	4	Na 4	Miller, cited in Ovington 1962
			Branches	42000	137	19	119	281	40	7	
			Trunks	224800	172	32	250	647	58	9	
			Roots	39200	65	21	67	172	21	3	
U.S.S.R.	Picea	72	Foliage	11500							Remezov et al, 1959 (cited in Rodin and Basilevich, 1967)
			Woody	214700							
			Total aboveground		320	70	270	420	50		
			Roots	64600						Ash	
			Total	290800	564					1633	
U.S.S.R.	Picea	83	Foliage	19400							Remezov et al, 1959 (cited in Rodin and Basilevich, 1967)
			Woody	260900							
			Total aboveground		590	95	395	700	80		
			Roots	77600						Ash	
			Total	357900	847					2308	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.S.R.	Picea	110	Foliage	14900							Parshevrikov, 1957, 1962 (cited in Rodin and Basilevich, 1967)
			Woody	182300							
			Total aboveground		820	50	270	860	180		
			Roots	76600						Ash	
			Total	273800	1327					2494	
U.S.S.R.	Picea	120	Foliage	4500							Ebermayer 1876 (cited in Rodin and Basilevich 1967)
			Woody	35500							
			Roots	11300						Ash	
			Total	51300	174					293	
U.S.S.R.	Picea	125	Foliage	11500							Cited in Rodin and Basilevich 1967
			Woody	121300							
			Roots	40700						Ash	
			Total	173500	447					1013	
U.S.S.R.	Picea	130	Foliage	12300							Parshevrikov, 1957, 1962 (cited in Rodin and Basilevich, 1967)
			Woody	118900							
			Total aboveground		470	30	160	595	80		
			Roots	65700						Ash	
			Total	196900	882					1776	
U.S.S.R.	Picea	200	Foliage	21100							Marchenko and Karlov 1961, 1962 (cited in Rodin and Basilevich 1967)
			Woody	234600							
			Roots	85100						Ash	
			Total	340800	1977					1988	
U.S.S.R.	Picea	45-55	Foliage	6100							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	191900							
			Roots	32900						Ash	
			Total	230900	819					1994	
Sweden	Picea abies on sphagnum	60-70	Wood	117700	77.7	9.4	29.4	78.8	11.8		Holmen 1964
			Bark	10000	53.9	7.0	20.7	128.2	8.3		
			Live branches	29300	170.2	19.1	49.9	161.4	18.2		
			Needles	15900	210.1	33.6	65.3	128.9	22.3		
			Dead branches	4700	22.0	1.3	2.3	23.9	6		
New York, USA	Picea abies	33	Stand	61411	399	59	44	376	19		Fornes et al, 1970

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Sweden	Picea abies	55	Aboveground	308000	770	87	437	459			
		120		308000	586	68	328				Nykvist 1974
		53		138000	330	44	152	211			
		59		114000	226	32	142	282			
		100		181000	369	35	160	454			
		139		149000	295	35	159	374			
		65		178000	534	70	167	521			
England	Picea abies	47	Leaves +Branches	31900	226	26	117	105	20	Na 3	Ovington 1962
			Trunks	107900	105	11	44	107	19	2	
Solling, W. Germany	Picea abies	85	Foliage	18000	270	28.8	126	72	9		Ulrich et al. 1974
			Branches	28000	168	33.6	168	56	19.6		
			Stem wood	194000	175	27.2	175	194	38.8		
			bark	18000	180	23.4	72	162	16.2		
			Stump + lge roots	70000	420	84	420	140	49		
			fine roots	2000	12	2.4	12	4	1.4		
Sweden	Picea abies	55	Leaves	18000	220	21.8	122	84	9.6	Si 12.3 Na 4.9 Fe 2.0 Mn 40.5 S 20.7	Nihlgard 1972
			Current Twigs	3300	50	6.5	31	6	2.5	Si 0.1 Na 0.3 Fe 0.2 Mn 2.1 S 2.6	
			Branches	25000	230	30.2	112	86	18.2	Si 3.8 Na 8.4 Fe 7.0 Mn 17.3 S 20.0	
			Bark	22000	100	13.6	69	168	21.4	Si 3.1 Na 3.5 Fe 3.1 Mn 29.0 S 11.3	
			Trunks	240000	170	14.9	103	115	17.5	Si 7.4 Na 20.4 Fe 2.7 Mn 54.0 S 57.6	
			Stumps+ large roots	52000	50	2.4	51	23	7.0	Si 1.3 Na 1.8 Fe 3.5 Mn 10.0 S 10.0	
			Medium roots	4500	20	1.7	8	14	1.9	Si 0.1 Na 0.5 Fe 0.7 Mn 2.7 S 2.6	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
			Fine roots	2000	20	1.6	6	8	1.6	Si 0.4 Na 1.4 Fe 1.2 Mn 2.3 S 1.9	
			Total	367000	860	92.7	502	504	79.7	Si 28.5 Na 41.2 Fe 20.4 Mn 158 S 127	
Sweden	Picea abies	55	Needles	18000	220	22	122	84	10		Nihlgard 1972
			Branches	28000	280	38	143	92	21		
			Wood	24000	170	15	103	115	18		
			Bark	22000	100	14	69	168	21		
			Roots	59000	90	6	65	45	10		
England	Picea abies	20	Leaves	61100	599	65	301	167	48	Na 12	Ovington 1962
			*Branches								
			Trunks	157200	260	34	136	190	34	2	
Sweden	Picea abies	13	Stem wood	8520							Tamm 1975
			bark	1720							
			Branches	7510							
			Needles	8620							
		23	Stem wood	40060							
			bark	6400							
			Branches	12860							
			Needles	13400							
			Roots >5mm	11070							
			Roots <5mm	4740							
Finland	Picea abies	70	Aboveground	160000	343		136	368			Malkonen, 1973
U.K.	Picea abies	47	Stand, litter & understory	165000	691	56	191	277			Ovington 1962
Sweden	Picea abies	52	Leaves	10800	128	20	49	50	9		Tamm and Carbonnier 1961 (cited in Ovington 1962)
			Branches	15600	74	9	27	44	8		
			Trunks	105800	109	12	65	108	18		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Germany	Picea abies	34	Overstory:								Ulrich in Cole & Rapp 1980
			Foliage Total	18870	247.8	29.6	132.2	60.5	17.9		
			Branches	18730	99.4	22.8	111.9	35.3	21.2		
			Boles	105100	102.2	6.3	105.1	195.4	22.5		
			Roots	34560							
England	Picea abies	47	Leaves +Branches	80300	573	64	166	309	50	Na 9	Ovington 1962
			Trunks	182400	132	18	60	198	35	3	
Sweden	Picea abies	59	Total	114800	226	32	142	282			Tamm 1969
	no thinning	50	Total	283500	842	80	442	463			
	no thinning	85	Total	381700	722	78	330	541			
Sweden	Picea abies	58	Leaves	9100	91	15	56	76			Tamm and Carbonnier 1961 (cited in Ovington 1962)
			Branches	14300	60	8	29	63			
			Trunks	85200	63	8	52	120			
Sweden	Picea abies	60	Overstory:								Nihlgard 1972
			Foliage Total	18000	220.0	21.8	122.0	84.0	9.6		
			Branches	25000	230.0	30.2	112.0	86.0	18.2		
			Boles	262000	270.0	28.5	172.0	283.0	38.9		
			Roots	59000	90.0	5.7	65.0	45.0	10.5		
			Understory veg.		.001	.01	.02	.1	.02	10	
Sweden	Picea abies	65-132	Stem wood	127300	74	5.2	37.1	93	10.2	Na 1.27	Nykvist
										Mn 22.5	
			bark	11100	38	4.7	20.8	119	6.6	Na 1.33	
										Mn 12.5	
			Needles	14900	155	14.4	64.6	119	14.9	Na 1.20	
										Mn 35.7	
			Shoots	500	5	.8	3.8	2	.7	Na .02	
										Mn .3	
			Branches <5mm	7800	50	5.3	16.9	33	7.0	Na .86	
										Mn 5.0	
			Branches 5-20	9600	28	3.0	10.8	43	5.1	Na .57	
										Mn 6.2	
			Branches >20mm	8300	14	1.3	5.4	43	2.9	Na .42	
										Mn 5.0	
			Dead Br.<5	300	1	.1	.1	1	.1	Na .01	
										Mn .03	
			5-20	1400	3	.2	.1	3	.1	Na .04	
										Mn .3	
			>20mm	100	.2	.01	.01	.3	.01	Na .003	
										Mn .02	
			Roots L layer	3100	6	.8	4.1	9	1.1	Na .18	
										Mn .8	
			F 5-20	100	.3	.03	.1	.2	.03	Na .003	
										Mn .03	
			2-5	300	2	.2	.6	1	.2	Na .01	
										Mn .3	
			>2mm	500	4	.4	1.2	1	.3	Na .02	
										Mn .5	
			H >20mm	1400	4	.4	1.8	4	.5	Na .08	
										Mn .5	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other		Reference
			5-20	2000	9	.9	3.8	6	.9	Na	.18	
										Mn	1.0	
			2-5	1100	6	.6	2.1	3	.7	Na	.11	
										Mn	.7	
			<2	800	6	.5	1.5	2	.5	Na	.16	
										Mn	.6	
			Min. Soil	1900	5	.6	2.5	5	.6	Na	.14	
										Mn	.5	
			Vacc. myrt.	185	1.95	.17	.92	.96	.17	Na	tr	
										Mn	.57	
			Vacc. vitis	4	.04	.003	.02	.02	.01	Na	tr	
										Mn	.01	
			Deschampsia	60	1.05	.11	1.43	.13	.06	Na	tr	
										Mn	.05	
			Luzola pil.	3	.06	.01	.11	.02	.01	Na	tr	
										Mn	.01	
			Field layer	270	3.4	.33	2.94	1.31	.29	Na	.01	
										Mn	.68	
			Ground layer	520	7.8	1.15	6.65	1.39	.54	Na	.08	
										Mn	.39	
U.S.S.R.	Picea abies	72	Total	291000	564							Rodin & Bazilevich 1967
		83	Total	358000	847							
		110	Total	274000	1327							
U.S.S.R.	Picea abies	45	Overstory:									Kazimirov & Morozova 1973
			Foliage Total	9800	101.9	11.8	50.0	95.1	13.7			
			Branches	12100	55.7	4.8	15.7	44.8	6.0			
			Boles	56300	123.9	11.2	39.4	101.3	11.2			
			Roots	15800	63.2	7.9	23.7	44.2	6.3			
			Understory veg.	1606	22.1	3.1	12.0	10.5	2.0			
Germany	Picea abies	87	Overstory:									Ulrich in Cole & Rapp 1980
			Foliage Total	17880	228.0	13.8	118.8	70.3	5.6			
			Branches	28210	242.7	17.3	183.1	74.8	19.7			
			Boles	198400	258.4	7.9	99.3	267.6	30.7			
			Roots	71720								
U.K.	Picea abies	39-47	Aboveground + thinning	350000	536	59	246	421	76			Ovington 1962

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Germany	Picea abies	115	Overstory:								Ulrich in Cole & Rapp 1980
			Foliage Total	12660	161.4	13.3	84.1	49.7	40.0		
			Branches	246300	212.0	15.1	160.0	65.3	17.2		
			Boles	195700	255.0	36.9	98.0	264.1	30.3		
			Roots	74930							
Czechoslovakia	Picea abies	100	Aboveground		830	109	317	455	30		Rodin & Bazilevich 1967
U.S.S.R.	Picea abies	120	Total	51000	174						Rodin & Bazilevich 1967
		125	Total	174000	447						
		130	Total	197000	882						
U.S.S.R.	Picea abies	200	Total	336000	1915	67	449	732	142	S 91 Fe 76 Mn 28	Marchenko & Karlov 1962
	Picea, Betula	80-200	Total	129000	619	33	133	243	74	S 24 Fe 16 Mn 27	
Sweden	Picea abies		Total, above ground	10660	52	7	32	65	6	Mn 13	Tamm 1974
U.S.S.R.	Picea forest	93	Aboveground		468	85	278	552	90		Rodin & Bazilevich 1967
Minnesota, USA	Picea glauca	40	Stand	184800	449	64	204	809	46		Alban et al. 1978
Minnesota, USA	Picea glauca	41	Overstory								Perala & Alban, 1979
			Foliage	11700	130	18.3	64	140	11.0		
			Live branch	17000	70	12.6	52	115	12.1		
			Dead branch	14200	31	3.0	7	93	4.2		
			Bark	12400	45	7.5	26	188	8.9		
			Bolewood	92000	56	4.3	27	115	6.8		
			Root+stump	32000	43	7.0	25	96	6.0		
			Understory								
			Herbs	10	.2	.04	.3	.1	.03		
			Shrub leaves	0	0	0	0	0	0		
			Shrub stems	0	0	0	0	0	0		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	N	P	K	Ca	Mg	Other	Reference
				kg/ha							
Prince George, B.C., Canada	Picea glauca	110-350	Total		316.4	47.8	135.3	531.7	211.7		Kimmins 1974
			Wood	115897	59.8	3.6	57.3	86.2	9.3		
			Bark	22929	57.4	8.3	27.3	206.3	5.3		
			Lge. branches	12369	21.7	2.1	6.1	59.9	.8		
			Sm. branches	7231	18.1	2.3	5.9	38.0	.5		
			Twigs	4016	25.1	3.9	2.0	14.8	.3		
			Foliage	6894	61.5	9.5	3.5	25.5	.6		
			Twigs & foliage	10909	86.6	13.4	5.5	40.3	.9		
			Crown	30511	126.4	17.8	17.5	138.2	2.2		
			Bole	138827	117.2	11.9	84.6	292.5	14.6		
			Roots		72.8	18.1	33.2	101.0	7.9		
			Total aboveground		243.7	29.5	99.7	430.7	25.0		
Quebec, Canada	Picea mariana	65	Foliage	8280	65	16	30	73	9		Weetman & Webber 1972
			Branches	10300	31		13	41			
			Wood	76900	45	26	20	112	18		
			Bark	11600	26		21	51			
Alaska, USA	Picea mariana	51	Overstory:								Van Cleve in Cole & Rapp 1980
			Foliage Total	5012	21.0	2.8	9.8	3.5	2.9		
			Branches	3590	7.4	1.1	3.9	1.8	1.8		
			Boles	7995	11.5	1.6	10.3	24.2	2.2		
			Roots	12457	18.5	2.9	13.7	21.4	3.1		
			Understory veg.	8639	66.7	7.6	20.0	31.7	11.3		
	Picea mariana	55	Overstory:								
			Foliage Total	5310	26.4	3.6	13.7	53.3	2.6		
			Branches	4691	19.2	1.7	5.4	17.9	3.1		
			Boles	14017	49.0	8.9	12.2	48.7	4.8		
			Roots	10401	39.5	5.1	41.2	88.7	10.4		
			Understory veg.	6283	50.8	5.2	15.3	22.0	6.4		
	Picea mariana	130	Overstory:								
			Foliage Total	14196	70.8	8.5	17.6	163.3	15.9		
			Branches	12947	49.0	6.1	6.2	71.0	10.7		
			Boles	86046	95.1	14.3	51.8	390.7	33.4		
			Roots	51697	70.8	7.6	24.5	97.5	11.4		
			Understory veg.	7598	46.7	6.9	24.4	28.4	7.4		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
B.C. Canada	Picea/Pinus forest	up to 350	Aboveground	213000	324	42	150	537	31		Kimmins 1974
N. Carolina, USA	Picea, Abies	50	Aboveground	180000		37	177	354	72		Weaver 1973, 1975
U.K.	Pinus (plantation)	20	Aboveground	52000	290	30	130	110	25		Ovington 1962
Sweden	Pinus abies	55	Stand	367000	770	87	437	459	69		Nihlgard 1972
E. Canada	Pinus banksiana	20	Total	13207	32.9	3.0	15.5	19.4	3.1		Morrison, 1973
		20	Total	7354	18.9	1.7	8.9	11.1	1.8		
		20	Total	16002	38.8	3.5	18.3	23.1	3.7		
		20	Total	6865	15.8	1.4	7.5	9.6	1.5		
		30	Total	99213	195.0	16.3	94.7	126.4	19.8		
		30	Total	63434	113.2	9.2	55.7	76.3	11.8		
		30	Total	88498	184.8	15.8	89.0	116.9	18.4		
		30	Total	61000	119.0	9.9	57.9	77.4	12.1		
		65	Total	105783	161.1	12.5	81.0	115.6	17.5		
		65	Total	53989	84.9	6.6	42.5	60.2	9.2		
		65	Total	76046	121.2	9.5	60.6	85.5	13.0		
		65	Total	43637	71.3	5.6	35.5	49.8	7.6		
Ontario	Pinus banksiana	45	Stand	124482	182	22	140	150	26		Morrison & Foster 1977
Minnesota, USA	Pinus banksiana	40	Stand	175300	296	30	119	241	46		Alban et al, 1978
Ontario, Canada	Pinus banksiana	65	Foliage	4345	50	6	14	12	3		Morrison & Foster, 1979
			Cones	2910	5	1	1	1	<1		
			Branches	16267	43	3	24	27	4		
			Stemwood	83451	65	3	43	57	10		
			Stembark	6696	17	1	7	30	2		
			Roots	23256	24	3	15	28	6		
			Ground veg.	310	4	<1	2	1	<1		
Minnesota, USA	Pinus banksiana		Trees-shallow		198	12	55	138	27		Green and Grigal 1979(in White and Harvey, 1979)
			-deep		310	26	127	258	48		
			Understory								
			-shallow		54	4	12	28	5		
			-deep		36	3	19	36	4		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Ontario, Canada	Pinus banksiana	30	Leaves		55.8	5.5	17.3	16.0	3.1		Foster and Morrison 1976
			Live branches		29.7	2.3	19.9	24.0	3.7		
			Dead branches		18.1	0.5	2.9	7.7	0.7		
			Bark		14.5	1.3	7.4	20.9	2.0		
			Trunks		34.3	3.2	26.6	30.5	6.1		
			Cones		0.6	0.1	0.2	0.1	0.1		
			Roots		12.3	1.6	7.4	13.0	2.9		
			Total	90700	165.3	14.5	81.7	112.2	18.4		
Minnesota, USA	Pinus banksiana	41	Overstory								Perala & Alban, 1979
			Foliage	4900	64	6.0	26	15	5.0		
			Live branch	9000	32	4.2	19	20	5.0		
			Dead branch	3600	8	.4	1	8	.9		
			Bark	11800	34	3.5	14	51	6.0		
			Bolewood	103000	61	5.5	41	78	16.9		
			Root+stump	18000	21	3.0	15	39	6.0		
			Understory								
			Herbs	280	5.2	.9	9.4	3.1	.8		
			Shrub leaf	430	11.6	1.3	5.0	9.9	2.0		
			Shrub twig	3800	19.2	2.4	9.5	29.8	2.2		
New Brunswick, Canada	Pinus banksiana	30	Trees	51000	130	20	65	50	20		MacLean 1978 (estimated from graphs which are adjusted to normal stocking)
			Understory		18	2	10	5	2		
		40	Trees	65000	150	23	75	65	22		
			Understory		14	2	10	6	2		
		60	Trees	67000	160	23	75	65	22		
			Understory		20	2	40	6	2		
Prince George, B.C Canada	Pinus contorta	110-125	Total		201.2	31.9	147.9	305.2	55.9		Kimmins 1974
			Wood	153640	56.0	6.1	78.1	72.4	20.7		
			Bark		53.3	8.1	26.0	151.2	20.0		
			Sm. branches	8560	12.6	1.6	4.3	15.3	1.1		
			Twigs	1860	8.8	1.4	0.9	3.2	.2		
			Foliage	3026	24.3	2.6	1.6	5.1	.5		
			Twigs & foliage	4880	33.1	4.0	1.5	8.3	.7		
			Crown	13437	45.7	5.6	6.8	23.6	1.8		
			Bole	181100	109.3	14.2	104.1	223.6	40.7		
			Roots (est.)		46.2	12.1	37.0	58.0	13.4		
			Total aboveground	194540	155.0	19.8	110.9	247.2	47.5		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Japan	Pinus densiflora	Not Given	Leaves	8500	86.1	8.0	42.9	46.8	21.6		Tsutsumi 1971 and Kawahara and Tsutsumi 1972
			Branches	15500	46.8	6.8	71.9	90.7	21.2		
			Trunks	93700	65.6	9.4	93.7	244	169		
Tennessee, USA	Pinus echinata	30	Overstory:								Harris in Cole & Rapp 1980
			Foliage Total	4600	51.0	4.0	36.0	43.0	12.0		
			Branches	27000	64.0	7.0	29.0	100.0	11.0		
			Boles	89000	100.0	7.0	60.0	164.0	17.0		
			Roots	34000	117.0	21.0	128.0	187.0	17.0		
Florida, USA	Pinus elliottii		Bole	90140	99.1	9.0	18.0	153.0	18.0		West et al. 1981 (prelim. data)
			Branches	7390	17.0	1.5	4.4	21.4	3.0		
			Foliage	4530	36.2	1.4	10.9	10.9	5.4		
			Understory	5300	23.6	1.7	5.2	22.4	5.1		
Florida, USA	Pinus elliottii		Bole	93,030	102.0	9.3	18.6	158.0	18.6		West et al. 1981 (prelim. data)
			Branches	7540	17.3	1.5	4.5	21.9	3.0		
			Foliage	5230	41.8	1.6	12.5	12.6	6.3		
			Understory	5700	25.0	1.7	5.1	19.3	5.8		
England	Pinus nigra	46	Leaves +Branches	30200	207	17	93	75	14	Na 2	Ovington 1962
			Trunks	212000	229	14	102	115	39	3	
			Understory	6800	87	7	156	55	10		
Scotland	Pinus nigra	40	Foliage	11300	175	15	77	38	12	Na 6	Miller & Miller 1976
			Live Branch	16700	57	5	30	51	10	Na 3	Miller, Miller, and Pauline 1976
			Dead Branch	5300	9	1	2	16	3	Na 2	
			Stem Wood	85000	61	4	32	42	12	Na 4	
			Bark	15000	53	5	18	32	8	Na 5	
			Roots	33300	83	13	42	20	13	Na 5	
Scotland	Pinus nigra	35	Total	149600	256	51	180	153	68		Craig and Miller 1967 (cited in Foster and Morrison 1976)
England	Pinus nigra	64	Aboveground	119000	205	23	100	202	35		Ovington 1962
U.K.	Pinus nigra	18	Needles	3000	30.0	4.9	18.2	18.2	3.1		Wright and Will 1958 Note: some totals do not add up precisely due to conversion of pound/acre to kg/ha.
			Branches	6100	20.9	3.1	15.0	26.8	5.0		
			Bark	4700	17.1	2.5	8.0	15.0	3.8		
			Wood	10800	9.1	1.0	5.9	9.6	2.0		
			Total	24650	77.1	11.5	47.2	69.7	13.9		
		28	Needles	4600	31.1	4.9	24.7	22.5	3.8		
			Branches	10400	22.5	3.0	18.8	48.2	6.9		
			Bark	12300	22.5	3.5	17.7	25.7	5.1		
			Wood	38000	21.4	1.6	15.0	21.4	4.0		
			Total	65400	97.6	3.1	76.1	117.9	19.7		
		48	Needles	5360	49.3	6.8	34.3	25.7	6.5		
			Branches	10720	33.8	4.3	27.8	48.2	9.1		
			Bark	20000	44.5	6.2	29.5	30.0	9.5		
			Wood	70000	49.3	4.1	35.9	46.1	11.3		
			Total	107200	176.9	21.3	127.6	50.1	36.5		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Scotland	Pinus nigra	48	Aboveground	112085	185	22	133	157	38		Wright & Will 1958
U.K.	Pinus nigra	47	Stand, litter + understory	176000	556	43	325	229			Ovington 1962
England	Pinus nigra	35	Aboveground	200000	586	75	207	230	93		Ovington 1962
U.K.	Pinus nigra	39-47	Aboveground + thinning	426000	635	43	284	290	87		Ovington 1962
Arizona, USA	Pinus ponderosa	49	Leaves	10620	111						Klemmedson, 1975
			Branches	20150	65						
			Trunks	121000	145						
			Roots	38000	93						
			Understory	100	1						
Arizona, USA	Pinus ponderosa	50	Leaves	10000	109	Basalt Parent Material					Welch and Klemmedson 1975
			Branches	38000	95						
			Trunks	183000	194						
			Roots	15000	37						
		50	Leaves	21000	224	Andesite Parent Material					
			Branches	43000	112						
			Trunks	214000	220						
			Roots	25000	51						
		50	Leaves	18000	181	Rhyolite Parent Material					
			Branches	53000	134						
			Trunks	261000	240						
			Roots	16000	37						
		50	Leaves	8000	83	Limestone Parent Material					
			Branches	44000	103						
			Trunks	168000	156						
			Roots	63000	38						
Japan	Pinus pumila		New fol.	6810	89.2	12	39.4	7.2	7.3		Tsutsumi et al. 1968
			Old fol.	14800	194	18.4	48.5	35.8	15.2		
			Branches	24100	123	18.1	50.1	46.3	25.3		
			Stems	39100	102	13.3	53.6	44.2	32.8		
New Zealand	Pinus radiata	26	Total	252200	258	41	252	157			
			Slash	20175	93	10	66	25			Will 1968 (cited in Foster & Morrison 1976)
			Logs	201753	173	18	158	105			
			Roots	28021	34	13	28	28			

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
New Zealand	Pinus radiata	35	Aboveground	362000	230	32	283	188			
New Zealand	Pinus radiata	26	Aboveground	222500	221	28	225	130			Orman & Will 1960 (cited in Foster and Morrison, 1976)
New Zealand	Pinus radiata	10	Stem wood	49590							Madgwick et al. 1977
			bark	4780							
			Live branches	11380							
			Dead branches	50							
			Cones	210							
			1 yr.needles	4730							
			2 yr.needles	1070							
			3 yr.needles	50							
			4 yr.needles	0							
			5 yr.needles	0							
		22	Stem wood	243500							
			bark	27360							
			live branches	27360							
			Dead branches	4600							
			Cones	3210							
			1 yr needles	4020							
			2 yr needles	3070							
			3 yr needles	1910							
			4 yr needles	260							
			5 yr needles	10							
New Zealand	Pinus radiata	35	Aboveground	305600	320	40	325	188			Will 1964 (cited in Foster & Morrison 1976)
New Zealand	Pinus radiata (-lupins)	4	Foliage	3570	42.8						Madgwick et al. 1977
			Branches	2470	7.3						
			Stem wood	5240	5.8						
			bark	820	4.6						
			Dead twigs	110	1.0						
	Pinus radiata (+lupins)	4	Foliage	2100	32.4						
			Branches	1490	6.3						
			Stem wood	2090	3.2						
			bark	370	2.8						
			Dead twigs	60	.4						
			Lupins	9200	83.1						

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
N. Carolina, USA	Betula lutea	100+		60600		49.2	139.4	407.8	161.8		Weaver & De Selm 1973
	Betula lutea	60		39700		74.8	143.6	381.0	130.4		
Japan	Betula papyrif.			14000	168	8.6	30	165	28		Tsutsumi, 1971
Alaska, USA	Betula papyrif.	50	L	68772.0	548.0	79.0	99.0	489.0	139.0		Van Cleve in Cole & Rapp, 1980
Washington,USA	Conifer -duff mull	old	L	13657	171	15	15				Gessel & Balci, 1965
			F	17971	266	22	21				
			H	71722	957	77	67				
Washington USA	Conifer mix (on Basalt)		L	1920	200	26	28				Wooldridge, 1968
			F	2080	252	33	50				
			H	4580	336	60	235				
	Conifer mix		L	1710	154	17	37				
			F	2290	267	26	63				
			H	2500	249	19	176				
Japan	Cryptomeria		Total	8000-30000	56-282	2.4-12.4	5.6-44.3	48.2-58.8	17.6-20.2		Kawana et al. 1979
Japan	Cryptomeria			12000	80	8.4	14	157	44		Tsutsumi, 1971
Japan	Cryptomeria			24000	184	8.2	18	304	86		Tsutsumi, 1971
California, USA	Cupresaus	30		30640							Kittredge, 1940
Maroondah, Victoria Australia	E. regnans	38	Total	47500	394	11	32	126	39	Na 5	Feller, 1981
	E. obliqua-E. dives	38	Total	13100	132	3	9	40	14	4	
Stradbroke Is. Qld.,Australia	Eucalyptus	?	Total	27000	195	6.8	23	142	34	Na 8	Westman and Rogers 1977a
SW Western Australia	Eucalyptus diversicolor	36	Total	27300	224	7	32	396	60	S 28 Na 16	Mingston et al., 1979
	E. diversicolor-E. calophylla	all	Total	19500	105	5	26	234	48	S 14 Na 10	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass (kg/ha)	N	P	K	Ca	Mg	Other	Reference
			Whole tree crop	24980							
		45	Stemwood	55570	37.23	2.22	18.34	34.45			
			Bark	5320	19.68	2.93	12.29	26.07			
			Dead Br.	3230	7.53	.42	.94	3.94			
			Live Br.	7360	30.40	3.61	15.75	19.06			
			Needles	4430							
			1st Yr.		18.39	2.21	10.62	2.69			
			2nd Yr.		20.35	1.98	8.56	6.11			
			3rd Yr.		10.21	.95	4.00	4.11			
			4th Yr.		6.46	.62	2.35	3.08			
			Cones	10	.04	.01	.03				
			Aboveground Parts	75920	150.3	14.95	72.88	99.5			
			Below ground Parts	19280	35.97	6.17	23.37	23.22			
			Stumps	4120	4.53	.58	3.25	2.68			
			Roots >1cm	11080	11.86	1.55	8.86	7.20			
			Roots <1cm	4080	19.58	4.04	11.26	13.34			
			Whole tree crop	95200							
		47	Stemwood	27100	19.51	1.36	8.94	13.55			
			Bark	3330	12.72	1.93	7.33	10.76			
			Dead Br.	1170	3.70	.20	.44	1.98			
			Live Br.	6780	29.22	3.32	12.00	15.93			
			Needles	3540							
			1st Yr.		14.32	1.74	6.57	1.82			
			2nd Yr.		14.18	1.50	5.41	3.12			
			3rd Yr.		10.30	.99	3.27	2.76			
			4th Yr.		4.68	.47	1.55	1.46			
			Cones	20	.07	.01	.04				
			Aboveground Parts	41940	108.7	11.52	45.55	51.38			
			Below ground Parts	11010	21.18	3.22	14.39	9.02			
			Stumps	2360	2.12	.31	1.68	1.39			
			Roots >1cm	5910	5.44	.83	4.49	3.55			
			Roots <1cm	2740	13.62	2.08	18.22	4.08			
			Whole tree crop	52950							
		28	Lichens		.04		.01				
			Mosses		19.52	1.78	9.16	5.76			
			Grasses		.07	.01	.11	.01			
			Herbs		.15	.03	.20	.12			
			Dwarf shrubs		8.59	.85	3.76	4.73			
			Shrubs		.18	.02	.08	.14			
			Aboveground parts		28.55	2.69	13.32	10.76			
			Below ground parts		9.91	1.04	3.18	4.49			
		45	Mosses		33.21	3.46	15.74	10.42			
			Grasses		2.11	.15	2.41	.30			
			Herbs		1.82	.22	2.40	.60			
			Dwarf shrubs		5.86	.60	4.03	3.03			
			Shrubs		.44	.05	.31	.89			
			Aboveground parts		43.44	4.48	24.89	15.24			
			Below ground parts		15.95	2.76	4.45	7.10			
		47	Lichens		.64	.06	.17	.07			
			Mosses		12.26	1.35	6.50	4.08			
			Grasses		0	0	0	0			

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Kyoto, Japan	Fagus cren.		Total	11600	105.4	6.8	8.8	111.6	10.0		Kawahara, 1971
Shiga, Japan	Chamaecyparus		Total	17100	99.5	4.1	7.2	92.9	9.7		
Kyoto, Japan	Pinus dens.		Total	19200	126.7	21.5	40.3	316.8	23.0		
Solling, W. Germany	Fagus sylvatica		Total	29700	810	52	83	91	34	Na 14 Al340	Ulrich et al. 1974 and Ulrich et al 1979
	Picea abies		Total	49000	960	53	41	83	20	Na 20 Al197	
Sweden	Fagus sylvatica	45-130	L	5200	86.0	5.8	104.0	34.2	4.8		Nihlgard, 1972
Germany	Fagus sylvatica	122	L	29700	810.0	52.0	83.0	91.0	34.0		Ulrich in Cole & Rapp, 1980
Japan	Larix leptolepis			13000	200	10.5	13	102	21		Tsutsumi, 1971
Tennessee,USA	Liriodendron	50	L	6000	77.9	5.3	9.2	99.6			Harris in Cole & Rapp, 1980
	Liriodendron, Carya, Quercus	30-80	L	1500	187.0	11.0	14.0	294.0	22.0		
Japan	Mix, broad			5000	62	3.3	8	27	9		
	Mix, broad			4000	52	2.9	12	116	17		Tsutsumi, 1971
Japan	Mixed		Total	6200	76	3.8	6.6	79.9	7.6		Katagiri et al. 1978
Japan	Mixed broad -lower slope		Total	4800	111	6.4	9.6	134.6	12.9		Katagiri & Isutsumi, 1978
	Mixed broad -upper slope		Total	15460	260	12	36.8	151.2	25.7		
Kyoto, Japan	Mixed broad		Total	15000	287.1	10.3	19.4	78.8	26.1		Iwatsuba, 1976
	Chamaecyparis		Total	12300	112.9	5.1	11.8	37.0	5.8		
Meathop Wood, 1980	Mixed decid.	80	L	6120	74.4	3.3	12.0	101.0	8.1		Satchell in Cole & Rapp,
Tennessee, USA	Mixed hardwoods		Total	13310	150	12	25	200			West et al. 1981 (preliminary data)

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
New York, USA	Pinus resinosa	32	Stand	142777	307	33	83	295	28		Fornes et al, 1970
Minnesota, USA	Pinus resinosa	40	Stand	243400	421	50	205	335	72		Alban et al, 1978
Minnesota, USA	Pinus resinosa	41	Overstory								Perala & Alban, 1979
			Foliage	10600	110	12.5	59	33	11.5		
			Live branch	9800	22	3.9	18	30	5.1		
			Dead branch	6900	15	.6	2	24	2.3		
			Bark	13600	44	5.9	21	73	9.9		
			Bolewood	134000	111	8.7	47	124	25.0		
			Root+stump	25000	35	6.0	20	29	8.0		
			Understory								
			Herbs	170	2.8	.6	5.7	1.9	.5		
			Shrub leaf	140	3.6	.4	1.7	3.1	.6		
			Shrub twig	900	4.5	.5	2.2	7.5	.6		
U.S.S.R.	Pinus sp.	71	Aboveground	216000	510	40	230	360	50		Rodin & Bazilevich 1967
N. Carolina, USA	Pinus strobus	15	Overstory:								Swank in Cole & Rapp 1980
			Foliage Total	4664	72.8		22.7	17.6		4664	
			Branches	22825	78.8		45.4	47.5			
			Boles	42110	72.4		40.9	32.6			
			Roots	60300	422.1		163.2	203.6			
U.S.S.R.	Pinus sylvestris	100	Foliage	15100							P'yavchenko 1960a, 1960b (cited in Rodin and Basilevich 1967)
			Woody	17900							
			Roots	4000							
			Total	37000	229					Ash 280	
Central Sweden	Pinus sylvestris	120-150	Current needles	1260	15	1.5	6.7	1.8	1.0	Na 0.06	Bringmark 1977
										S 0.67	
			Older needles	2675	36	3.3	12.1	8.3	1.6	Na 0.16	
										S 1.55	
			Current shoots	260	2.6	0.36	1.3	0.38	0.21	Na 0.01	
										S 0.12	
			Older shoots	560	3.9	0.48	2.7	1.6	0.44	Na 0.03	
										S 0.25	
			Branches	8100	22	2.1	10.1	16	3.2	Na 0.24	
										S 2.4	
			Stemwood	45200	24	1.8	14.0	24.4	6.3	Na 0.45	
										S 4.5	
			Stembark	3050	10	1.0	2.9	10.6	1.3	Na 0.15	
										S 0.67	
			Stump & big roots	14240	11	1.3	9.3	5.6	1.7	Na 0.10	
										S 1.28	
			Roots 1-5 cm	2900	3.5	0.6	3.3	1.9	0.7	Na 0.06	
										S 0.64	
			Roots <1 cm	2950	5.3	1.1	4.9	3.1	1.7	Na 0.21	
										S 1.18	
			Dead branches	570	2.2	0.15	0.55	1.5	0.19	Na 0.03	
										S 0.22	

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Washington, USA	Abies, Tsuga	200	Total	145000	1600						Vitousek et al. 1982
Oregon, USA	Abies, Tsuga -46 sites	Old	Total	60840							Williams & Dyrness, 1967
N.B., Canada	Acer	7	Total	36680	304	29.3	22.0	223.7	18.3		MacLean, 1978
		17	Total	102930	720	61.8	41.2	422.0	41.2		
		20	Total	51410	447	41.1	25.7	359.9	36.0		
		29	Total	50230	487	45.2	20.1	512.3	45.2		
New England, USA	Acer, Fagus, Betula	66	Total	58850	1180						Vitousek et al. 1982
Indiana, USA	Acer, Fagus, Quercus	95	Total	9750	104						Vitousek et al. 1982
N.H., USA	Acer,Betula, Fagus	110	L	48016	125.6	7.8	66.0	372.0	38.0		Whittaker Cole & Rapp, 1980
England,UK	Alnus inc.	21	L	560							Ovington, 1954
			F+H	4830							
			Total	5390							
	Betula alba	21	L	420							
			F+H	4300							
			Total	4720							
Washington, USA	Alnus rubra (high site)	7	Total	16000	370	20	30				West et al. 1981 (preliminary data)
	Alnus rubra (low site)	7	Total	14000	340	17	22				
Washington, USA	Alnus rubra	40	Total	15000	225						Vitousek et al. 1982
Washington, USA	Alnus rubra	53	Total								Bigger & Cole, 1983
	high productivity			15000	327	20.3	30.3				
	low productivity			141000	330	16.5	21.7				
Washington, USA	Alnus rubra	9	Total		189	10	15	59	18	S 16 Fe 101 Mn 7 Cu 0.3 Zn 0.5	Radwan et al. in prep.
		18			347	23	32	188	84	S 39 Fe 944 Mn 31 Cu 2.0 Zn 2.5	
		28			218	16	21	96	23	S 21 Fe 174 Mn 11 Cu 0.3 Zn 1.1	
		31			222	18	29	100	28	S 25	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.S.R.	Pinus sylvestris	71	Total	28000	664						Rodin & Bazilevich 1967
N. Carolina, USA	Pinus taeda										Wells and Jorgensen 1975
		11	Aboveground	77000			56	138	29		Nemeth 1972
			Roots	14000			24	36	11		and Wheeler 1972
		12	Aboveground	91000			59	158	33		(cited in Wells and
			Roots	16000			28	41	13		Jorgensen 1975)
U.S.A.	Pinus taeda	30	Aboveground	176400	212	31	132	127	41		Switzer et al 1966, 1968 (adapted by Foster and Morrison 1976)
Mississippi, USA	Pinus taeda	5	Aboveground	6000	38						Smith et al. 1971
		4	Aboveground	16000	72						(cited in Wells and Jorgensen 1975)
N. Carolina, USA	Pinus taeda	16	Leaves	8000	82	10	48				Jorgensen, Wells and Metz, 1975
			Branches	23200	60	6	28				
			Trunks	109600	79	11	65				
			Bark	15200	36	4	24				
			Roots	36300	64	17	61				
			Total	192300	321	48	226				
Japan	Pinus taeda	7	Aboveground	46000	235	21	51	100	44		Akai et al. 1968 & 1972
		34	Aboveground	197000	422	142	238	445	75		(cited in Wells and Jorgensen 1975)
N. Carolina, USA	Pinus taeda	4	Leaves		20.5	2.9	12.5	9.6	2.3		Haines and Sanderford 1975
			Bark		0.9	0.1	0.9	0.7	0.1		
			Wood		6.2	0.5	4.5	2.9	1.1		
			Total		27.6	3.5	17.9	13.2	3.5		
		4	Leaves		25.0	3.0	16.1	8.5	2.1		
		(N,P,K	Bark		2.7	0.3	1.8	1.5	0.4		
		fert.)	Wood		7.1	1.0	5.4	3.2	1.1		
			Total		34.8	4.3	23.3	13.2	3.6		
S.E. USA	Pinus taeda	10	Aboveground	28000	80	7	40	25	8	S 7	Switzer, Nelson and Smith 1968 (estimated from graph)
		20	Aboveground	90000	165	12	95	70	22	13	
		30	Aboveground		210	20	125	125	40	20	
		40	Aboveground		235	25	145	165	50	25	
		50	Aboveground		250	25	150	180	65	25	
		60	Aboveground		250	25	155	185	65	25	

Table 5 Forest Floor Biomass and Nutrient Content

Location	Dom. Veg.	Age	Component/ Horizon	Biomass (kg/ha)	N	P	K	Ca	Mg	Other	Reference
										Fe 419 Mn 19 Cu 1.7 Zn 1.4	
		38			248	16	22	118	36	S 25 Fe 326 Mn 18 Cu 0.7 Zn 1.1	
		42			258	21	24	128	24	S 23 Fe 306 Mn 18 Cu 0.6 Zn 1.0	
		45			405	24	26	120	42	S 43 Fe 517 Mn 30 Cu 1.1 Zn 1.5	
Washington, USA	Alnus rubra	30	L	66350	877.0	45.0	91.0	391.0	57.0		Turner, 1975
Washington, USA	Alnus rubra	34	Total		1156						Turner et al, 1976
Washington,USA	Alnus rubra	5-41	Total	13000-29000	250-730						Bormann & DeBell, 1981
Washington, USA	Alnus rubra, Pseudotsuga	23	Total	23040	280						Binkley, 1982
Korea	Alnus sibirica	12	L	5120	22	13	9				Mun et al. 1977
B.C., Canada	Alnus sinuata	5	Total	2450	47	6	2	25	10		Binkley, 1983
B.C., Canada	Alnus/Pseudo.	18	L + F	19900	340	29	19	144	40		Binkley et al., 1982
California, USA	Arbutus	30		23969							Kittredge, 1940
Alaska, USA	Betula (7 stands)	25-120	L	3097	24.8	3.7	5.6	43.7	7.7	Mn 3.8	van Cleve and Noonan, 1971
			F	7710	121.0	9.2	12.3	106.4	19.3	10.8	
			H	29707	487.2	38.6	53.5	279.2	62.4	48.7	
			Total	40515	633.0	51.6	71.4	429.3	89.4	63.3	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
			Shrubs								
			aboveground	1970	14.4	1.2	5.4	6.8	1.7	Na 0.34 S 2.14	
			belowground	3470	17.9	2.1	4.5	4.5	1.3	Na 0.30 S 3.18	
			Moss & lichens	2510	19.7	1.7	7.8	3.9	1.1	Na 0.32 S 1.34	
Sweden	Pinus sylvestris on sphagnum	44	Wood	24200	18.4	1.9	8.2	12.1	4.6		Holmen 1964
			Bark	3000	10.2	1.3	4.7	18.6	2.0		
			Live branches	7100	31.8	4.0	13.4	21.2	4.5		
			Needles	3500	47.2	4.8	17.0	11.8	4.5		
			Dead branches	1600	4.9	.3	.7	5.4	.4		
Finland	Pinus sylvestris		Stemwood		4455	622	1382	3361	730		Lehtonen 1978
			Bark		1247	423	1027	1282	307		
			Live branches		7615	1476	4369	8364	1315		
			Dead branches		857	70	164	984	110		
			1st Yr. Needles		541	183	462	231	84		
			2nd Yr. Needles		610	175	606	462	91		
			3rd Yr. Needles		720	130	316	392	77		
			Buds		29	11	18	11	5		
			Stump wood & roots		2931	578	1883	1373	618		
			Total		19005	3648	10227	16460	3337		
U.S.S.R.	Pinus sylvestris	71	Foliage	13900							Remezov et al. (cited in Rodin and Basilevich 1967)
			Woody	202400							
			Roots	63600						Ash	
			Total	279900	664					1214	
Sweden	Pinus sylvestris		Stem wood		17	1.4	12	19			Popovic & Burgtorf 1964
			Bark		9	7.5	6	13			
			Live Branch		18	2.1	10	16			
			Foliage		25	2.5	8	12			
			Dead Branch		2	.1	.4	3			
			Total		71	8	36	63			
Finland	Pinus sylvestris	70	Aboveground	97000	137		72	108			Malkonen, 1973
Finland	Pinus sylvestris	28	Stemwood	9630	5.78	.58	3.66	5.68			Malkonen 1975
			Bark	1940	6.54	.99	3.72	10.67			
			Dead Br.	780	2.68	.14	.34	2.43			
			Live Br.	3270	12.75	1.73	7.29	11.28			
			Needles	2320							
			1st Yr.		8.91	1.13	5.34	1.50			
			2nd Yr.		10.06	.95	3.74	3.83			
			3rd Yr.		5.33	.52	1.95	2.95			
			4th Yr.		1.25	.13	.49	.89			
			Aboveground parts	17940	53.3	6.17	26.53	39.23			
			Below ground parts	7040	21.1	4.16	12.03	9.96			
			Stumps.	1440	1.41	.24	1.08	.96			
			Roots >1cm	2110	2.83	.36	1.67	1.46			
			Roots <1cm	3490	16.86	3.56	9.28	7.54			

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
B.C., Canada	Tsuga mertensiana, Abies amabilis	420	Leaves +twigs	5200	172	24	76	102	16		Krumlik and Kimmins 1976 (figures may not be additive due to rounding errors)
			Branches small	2200	21	4	12	28	3		
			large	7600	52	8	32	103	9		
			Bark	16700	158	37	85	306	18		
			Trunks	68200	154	29	194	203	42		
			Total	467300	557	101	399	741	87		
Japan	Tsuga sieboldii	120-443	Overstory:								Ando in Cole & Rapp 1980
			Foliage Total	7846	84.7	5.3	46.7	39.7	11.7		
			Branches	92345	205.7	13.4	105.4	430.7	5.1		
			Boles	348410	291.8	6.0	289.1	463.4	45.8		
			Roots	165565							
			Understory veg.	118318	281.1	14.7	220.5	283.1	46.6		

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
New Hampshire,	Abies balsamea		Forest floor								Lang et al., 1981
			01 horizon	75000	1800	130	60	150	52	Na 5	
			02 horizon	17200	500	67	36	17	47	Na 3	
			Total	92200	2300	217	96	167	99	Na 8	
			Branches								
			Slight-mod. decay	3300	10	<1	<1	2	<1	Na <1	
			Adv. decay	1400	4	<1	<1	2	<1	Na <1	
			Total	4700	14	1	1	7	1	Na <1	
			Bole wood								
			Slight decay	300	1	<1	<1	1	<1	Na <1	
			Mod. decay	4800	10	4	<1	8	<1	Na <1	
			Adv. decay	3700	11	3	<1	7	<1	Na <1	
			Total	8800	22	7	1	16	2	Na <1	
			Buried wood	3900	22	2	1	7	<1	Na <1	
Oregon, USA	Abies concolor	23	Forest floor		666.0	55.0	219.0	170.6	219.0		Grier (unpubl.) cited in Cole et al.
		180	Forest floor		2090.0	137.0	700.0	4805.0	343.0		
New Mexico	Abies concolor		Total	80800	883	85	235	2674	339	S 173 Mn 46.0 Zn 7.9	Wollum, 1973
Japan	Abies firma	97-145	L	4279	484.0	32.0	113.0	182.0	67.0		Ando in Cole & Rapp, 1980
	Tsuga sieboldii	120-443		50780	506.8	34.1	76.3	159.0	30.0		
Colorado, USA	Abies lasiocarpa		Non-woody	55506	498	55	182	724	170		Snell et al, 1979
			Woody	47433	100	12	40	103	11		
Japan	Abies may.		Total	10500	1218	236	242	642	390		Tsutsumi, 1971
Oregon, USA	Abies nobilis	130	Forest floor		884.0	213.0	75.0	515.0	205.0		Grier (unpubl.) cited in Cole et al.
New England, USA	Abies, Betula	75	Total	117000	1815						Vitousek et al. 1982

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
			Herbs		0	0	0	0			
			Dwarf shrubs		14.04	1.20	5.58	7.38			
			Shrubs		.30	.04	.14	.10			
			Aboveground parts		27.24	2.65	12.39	11.63			
			Below ground parts		15.41	2.20	3.22	5.71			
U.K.	Pinus sylvestris	20	Foliage	12500							Ovington 1957 (cited in Rodin and Basilevich, 1967)
			Woody	39100							
			Roots	14000						Ash	
			Total	65600	373					372	
England	Pinus sylvestris	55	Stand	150720	453	41	150	272	64		Ovington 1957, 1959
Sweden	Pinus sylvestris	39	Total	16300	46	5	19	17			Tamm 1969
		72	Total	47500	85	9	47	43			
U.S.S.R.	Pinus sylvestris	100	Total	81000	287						Rodin & Bazilevich 1967
	Pinus sylvestris	100	Total	37000	229						
England	Pinus sylvestris	23	Leaves	5100	115	10	52	36	8	Na 1	Ovington, 1959a,b (cited in Ovington, 1962)
			Branches	13800	60	5	28	34	10	1	
			Trunks	44300	59	5	34	56	8	1	
			Roots	28100	189	11	35	48	16	6	
			Understory	200	2	<1	2	1	<1		
Scotland	Pinus sylvestris	33	Foliage	7300	89	9	43	36	6		Ovington & Madgwick 1959
			Branches	23700	79	9	43	43	9		
			Boles	118800	97	12	84	115	24		
			Roots	36100	81	11	54	33	13		
U.S.S.R.	Pinus sylvestris	100	Foliage	6200							Manakov 1961, 1962a, 1962b (cited in Rodin and Basilevich 1967)
			Woody	56700							
			Roots	17800						Ash	
			Total	80700	287					458	
U.K.	Pinus sylvestris	39-	Aboveground + thinning	370000	417	38	237	359	72		Ovington 1962
U.K.	Pinus sylvestris	18	Needles	5900	56.8	6.0	35.4	15.0	5.5		Wright and Will 1958 Note: some totals do not add up precisely due to conversion of pound/acre to kg/ha.
			Branches	12500	37.5	4.7	34.3	22.5	6.5		
			Bark	6700	28.9	3.2	19.8	16.1	4.2		
			Wood	27100	21.4	1.9	20.9	12.9	5.7		
			Total	52500	144.7	15.9	110.4	66.5	21.9		
		28	Needles	4500	64.3	6.9	24.7	13.9	4.1		
			Branches	13400	58.0	7.4	35.9	23.6	8.6		
			Bark	8000	36.5	4.8	22.0	19.3	6.2		
			Wood	64100	55.7	4.8	40.7	25.7	15.4		
			Total	90000	214.4	23.9	123.3	82.5	34.3		
		64	Needles	4500	48.8	5.3	18.2	21.4	3.6		
			Branches	16000	50.9	6.3	27.9	34.3	7.6		
			Bark	13600	35.4	5.5	18.2	79.3	6.0		
			Wood	79500	61.1	4.7	31.1	57.9	16.0		
			Total	113600	196.2	21.8	95.4	193.0	33.23		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Meathop Wood, G.B.	Quercus, Betula, Mixed decid.	80	Overstory:								Satchell in Cole & Rapp 1980
			Foliage Total	3505	85.7	4.6	38.9	41.9	9.5		
			Branches	33640	58.8	3.7	61.1	137.4	8.0		
			Boles	75920	133.6	8.4	113.1	301.0	8.5		
			Roots	24218	223.0	11.9	112.8	235.3	30.8		
			Understory veg.	15529	8.1	5.4	42.9	66.9	9.7		
N. Carolina, USA	Quercus, Carya Acer		Stand	190000	995		400	830			Henderson et al. 1978
Tennessee, USA	Quercus, Carya	30-80	Overstory:								Harris in Cole & Rapp 1980
			Foliage Total	5600	67.0	6.0	53.0	70.0	17.0		
			Branches	26000	131.0	9.0	53.0	288.0	19.0		
			Boles	90000	171.0	9.0	114.0	498.0	31.0		
			Roots	33000	128.0	22.0	136.0	244.0	19.0		
Tennessee, USA	Quercus, Carya		Stand	156000	470		340	980			Henderson et al. 1978
N. Carolina, USA	Quercus, Carya	60-200	Overstory:								Swank in Cole & Rapp 1980
			Foliage Total	5584	95.0		46.0	49.0			
			Branches	25599	116.0		46.0	133.0			
			Boles	106313	194.0		135.0	361.0			
			Roots	52525	434.0		167.0	278.0			
Illinois,	Quercus, Carya	150	Total:xeric	237300							Rolfe et al. 1978
			mesic	243700							
			Foliage:xeric	5200							
			mesic	5600							
			Twigs:xeric	6200							
			Twigs:mesic	6800							
			Limbs:xeric	45700							
			Limbs:mesic	46800							
			Boles:xeric	127300							
			Boles:mesic	130600							
			Above-ground xeric	190500							
			mesic	194900							
			Aerial parts		478	29	310	1603	105		
			Foliage		63	4.9	59.6	64.4	17.9		
			Twigs		35	1.5	21.3	107.3	9.6		
			Limbs		126	7.8	110.7	601.2	33.1		
			Boles		252	14.7	115	837.3	44.2		
			Roots		153	12	109	426	26		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Ohio, USA	Populus sp.	4	Aboveground								Wittwer & Immel 1980
			Foliage	1900	38	4	27	40	7	Mn 0.26	
			Branches	750	64	10	50	64	9	Mn 0.36	
			Stem	27600	44	14	53	42	12	Mn 0.28	
			Bark	7600	75	8	48	117	10	Mn 0.81	
			Total tree	44600	221	36	178	263	38	Mn 1.71	
New Hampshire, USA	Prunus, Betula	4	Leaves	18	15.7	1.0	5.5	3.5	0.7		Safford and Filip 1974
			Branches +stem		18.9	2.0	10.1	8.4	0.5		
		4 (fert.)	Leaves		34.7	3.3	11.4	9.1	2.4		
			Branches +stem		74.9	11.7	47.2	32.6	3.5		
Washington, USA	Pseudotsuga	23	Douglas-fir								Binkley 1983
			Foliage	15480	240						
			Branches	24600	31						
			Stems	218200	170						
	Pseudotsuga/ Alnus rubra	23	Douglas-fir								
			Foliage	11000	171						
			Branches	15430	20						
			Stems	140890	109						
			Alder								
			Foliage	2300	54						
			Branches	10090	65						
			Stems	38300	79						
B.C., Canada	Pseudotsuga	23	Douglas-fir								Binkley 1982, 1983
			Foliage	9600	89	20	57	47	9	S 35.4	Binkley et al. 1984
			Branches	13300	13	2	7	6	<1		
			Stems	35000	27	3	12	14	2	S 5.3	
			Understory								
			Conifers	9500	16	3	7	11	2		
			Shrubs & herbs	2500	27	3	23	18	5		
	Pseudotsuga, Alnus sinuata	23	Douglas-fir								
			Foliage	9900	110	11	54	42	7	S 20.9	
			Branches	13900	17	3	11	6	<1		
			Stems	45900	28	5	31	18	2	S 11.5	
			Alder								
			Foliage	1800	56	5	16	10	5	S 5.2	
			Stems	23800	50	3	13	12	4	S 5.5	
			Understory								
			Conifers	1700	3	1	1	2	1		
			Shrubs & herbs	1100	12	2	10	8	2		
	Pseudotsuga, Alnus rubra	23	Douglas-fir								
			Foliage	3390	55	3.1	17.3	17.6	3.1	S 8.1	
			Branches	5500	7	1.1	4.4	2.4	<1		
			Stems	41240	32	3.3	14	17	2	S 5.8	
			Alder								
			Foliage	2900	89	6.6	7	15	7	S 8.1	
			Branches	7490	48	1.8	20	15	7		
			Stems	53520	110	4.6	52	43	11	S 12.8	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Belgium	Quercus, Fagus	75	Stand	156000	533	44	342	1248	102		Duvigneaud & Denaeyer-de Smet, 1970
Belgium	Quercus, Fagus, Carpinus	70-75	Total	147000	474	36	286	1165	93	Mn 70	Duvigneaud & Denaeyer De Smet 1970
Belgium	Quercus, Fraxinus	100+	Aboveground	380000	947	63	493	1338	126		Duvigneaud & Denaeyer-de Smet, 1970
U.S.S.R.	Tilia	40	Foliage	2800							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	116800							
			Roots	38900						Ash	
			Total	158500	784					1937	
U.S.S.R.	Tilia	74	Foliage	4500							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	165100							
			Roots	55400						Ash	
			Total	22500	1085					2686	
Oregon, USA	Tsuga heterophylla Picea sitchensis	30	Foliage		231.9	29.2	83.1	49.5	21.7		Grier unpublished cited in Cole et al.
			Branches		63.5	10.2	25.9	32.0	6.8		
			Stems		170.1	43.6	42.1	135.3	15.3		
			understory		t	t	t	t	t		
			Roots		98.8	22.2	36.2	59.6	14.4		
	Tsuga heterophylla Picea sitchensis	121	Foliage		85.2	10.9	31.1	19.3	7.5		
			Branches		76.1	10.8	30.8	52.5	8.8		
			Stems		584.6	148.9	138.3	432.8	46.9		
			Understory		15.7	3.4	9.7	7.7	2.2		
			Roots		178.7	43.5	61.0	152.6	33.5		
B.C., Canada	Tsuga heterophylla Chamaecyparis nootkatensis	250	Leaves +twigs	3800	27	4	12	24	3		Krumlik and Kimmins 1976
			Branches								
			small	5700	8	1	5	12	1		(Figures may not be additive due to rounding errors)
			large	5300	6	1	4	12	1		
			Bark	7200	12	2	8	37	1		
			Trunks	34300	16	5	24	22	4		
			Total	56300	70	13	53	107	11		
Oregon, USA	Tsuga mertensiana & Abies concolor	130	Foliage		140.0	39.0	100.0	130.0	20.0		Grier unpublished in Cole et al.
			Branches		68.0	14.0	47.0	130.0	13.0		
			Stems		186.0	14.0	39.0	236.0	36.0		
			Understory		15.0	1.0	9.0	11.0	1.0		
			Roots		108.0	9.0	36.0	167.0	30.0		

Table

Location	Dom. Veg.	Age	Componer
U.S.A.	Pinus virginiana	27-31	Abovegro
Ohio, USA	Platanus occidentalis	4	Abovegro Foliag Branch Stem Bark Total tr
innesota, USA	Populus tremuloides	40	Foliage Branches Wood Bark Roots
sconsin, USA	Populus tremuloides	45	Stand
S.S.R.	Populus	25	Foliage Woody Roots Total
nesota, USA	Populus tremuloides	49	Overstory Foliage Live bra Dead bra Bark Bolewood Root+stu Understory Herbs Shrub lea Shrub ste
S.R.	Populus	50	Foliage Woody Roots Total

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga, high productivity	53	Foliage	12300	148	27	64				Bigger & Cole 1983
			Branches	24800	102	12	37				
			Boles	281000	478	56	225				
			Understory	592	6.5	0.8	5.5				
			Forest floor	17600	214	21	26				
			Soil to 50 cm	121400	2066						
			Total	458000	3011						
Korea	Quercus acutissima	12	Leaves	5275	41	6.5	40				Mun et al. 1977
			Branches	12000	40	3.0	14				
			Stems	52150	127	8.5	34				
			Roots	17360	72	7.5	72				
			Understory	3200	66	3.5	57				
Oklahoma, USA	Quercus	80	Total	219370	1157	101	1258	4549	311	Mn 124	Johnson & Risser 1974
U.S.S.R.	Quercus	12	Foliage	3300							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	43000							
			Roots	22700						Ash	
			Total	69000	278					1127	
U.S.S.R.	Quercus	40	Foliage	4100							After Ozens-Litorskaya 1960 (cited in Rodin Basilevich 1967)
			Woody	118900							
			Roots	31800						Ash	
			Total	154800						2187	
U.S.S.R.	Quercus	43	Foliage	3800							Mira, 1955 (cited in Rodin and Basilevich 1967)
			Woody	104900							
			Roots	45900						Ash	
			Total	154600	628					2012	
U.K.	Quercus	47	Stand, litter & understory	134000	464	40	254	292			Ovington 1962
U.S.S.R.	Quercus	48	Foliage	3600							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	187000							
			Roots	70200						Ash	
			Total	260800	952					2570	
Belgium	Quercus	80	Overstory:								Duvigneud, Denaeyer 1970
			Foliage Total	3458	73.0	4.7	36.0	54.0	4.6		
			Branches	36425	295.0	23.0	164.0	776.0	72.0		
			Boles	75202							
			Roots	34600	121.0	10.0	92.0	372.0	19.0		
			Understory veg.	4700	46.0	4.6	46.0	70.0	6.0		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	N	P	K	Ca	Mg	Other	Reference
				kg/ha							
		Fert.	Dead branches		14.2	2.4	1.6				
		Unfert.	Bark		53.3	10.1	49.5				
		Fert.	Bark		66.7	12.0	38.9				
		Unfert.	Wood		55.3	6.9	4.0				
		Fert.	Wood		45.0	5.4	3.2				
		Unfert.	Total		260.0	50.0	138.0				
		Fert.	Total		430.6	57.9	130.0				
Whidbey		Unfert.	Needles		125.5	43.2	74.1				
		Fert.	Needles		170.9	32.3	105.9				
		Unfert.	Live branches		54.6	9.5	37.3				
		Fert.	Live branches		83.2	10.9	49.7				
		Unfert.	Dead branches		24.6	2.1	3.8				
		Fert.	Dead branches		24.2	3.7	7.7				
		Unfert.	Bark		82.0	11.0	52.6				
		Fert.	Bark		103.8	13.5	64.1				
		Unfert.	Wood		73.7	5.8	5.1				
		Fert.	Wood		72.6	5.7	5.0				
		Unfert.	Total		360.5	71.7	173.0				
		Fert.	Total		454.7	66.1	232.5				
Washington, USA	Pseudotsuga menziesii (plantation)	9	Foliage		12.8	2.5	7.9	6.3	1.2		Turner 1975
			Branches		7.1	2.0	9.3	11.3	2.0		
			Stems		13.5	1.0	42.3	25.6	7.6		
			Understory		46.1	11.3	51.9	48.0	15.3		
			Roots		2.3	.9	1.5	2.1	.3		
	Pseudotsuga menziesii	22	Foliage		65.1	12.5	42.6	27.0	5.8		
			Branches		17.6	7.1	40.3	34.7	7.9		
			Stems		144.6	92.6	48.0	140.6	15.3		
			Understory		66.6	8.7	59.4	68.7	18.5		
	Pseudotsuga menziesii	30	Foliage		54.2	13.5	42.4	39.8	6.7		
			Branches		23.8	5.4	19.6	54.2	5.1		
			Stems		142.8	19.8	126.0	153.8	26.0		
			Understory		47.8	5.8	26.7	52.0	11.1		
	Pseudotsuga menziesii (plantation)	30	Foliage		98.0	21.1	66.7	73.1	14.6		
			Branches		49.0	9.3	28.7	70.5	7.4		
			Stems		169.0	24.1	107.0	214.6	31.1		
			Understory		29.0	4.6	24.1	25.1	5.7		
			Roots		2.3	0.9	1.5	2.1	0.3		
	Pseudotsuga menziesii	42	Foliage		105.5	22.3	73.4	68.1	9.9		
			Branches		24.2	10.5	39.2	45.8	11.8		
			Stems		225.8	25.2	109.8	159.3	22.9		
			Understory		38.6	4.1	14.7	41.5	9.8		
	Pseudotsuga menziesii	49	Foliage		108.0	25.0	66.0	69.0	15.0		
			Branches		55.0	9.0	32.0	45.0	9.0		
			Stems		168.0	25.0	100.0	192.0	28.0		
			Understory		28.0	4.0	23.0	23.0	5.0		
	Pseudotsuga menziesii	73	Foliage		113.7	24.2	75.7	114.9	14.0		
			Branches		62.2	5.8	60.7	71.9	7.4		
			Stems		174.4	24.5	216.9	246.5	36.8		
			Understory		17.8	4.7	15.1	14.7	4.1		
	Pseudotsuga menziesii	95	Foliage		108.6	28.4	66.3	100.7	14.9		
			Branches		59.0	12.1	32.2	92.8	8.4		
			Stems		277.7	39.4	155.1	239.8	34.3		
			Understory		8.6	1.9	6.8	4.5	1.7		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.S.R.	Quercus	220	Foliage	3700							Mira, 1955 (cited in Rodin and Basilevich 1967)
			Woody	402800							
			Roots	97300							
			Total	503800	1258					Ash 6396	
Missouri, USA	Quercus	35-92	Trees	94780	121.6	10.4	67.1	463.4	23.4		Rochow 1975
			Shrublayer	5120	16.5	1.8	9.8	37.3	2.7		
			Herb	175	2.1	0.3	2.8	2.6	0.4		
Roquet, France	Quercus ilex	150	Overstory:								Loissant, Rapp in Cole & Rapp 1980
			Foliage Total	7000	93.0	10.0	43.0	70.0	9.0		
			Branches	27000	135.0	40.0	90.0	493.0	25.0		
			Boles	235000	517.0	174.0	493.0	3290.0	117.0		
			Roots	45000	153.0	81.0	85.0	1147.0	7.2		
			Understory veg.	340	2.3	.1	17.0	4.1	1.1		
England	Quercus petraea	21	Leaves +Branches	14100	214	13	61	61	17	Na 3	Ovington 1962
			Trunks	28300	70	6	41	58	11	1	
			Understory	600	11	1	14	4	2	1	
Tennessee, USA	Quercus prinus	30-80	Overstory:								Harris in Cole & Rapp 1980
			Foliage Total	5300	75.0	5.0	52.0	58.0	12.0		
			Branches	30000	139.0	10.0	61.0	294.0	13.0		
			Boles	102000	183.0	11.0	129.0	500.0	20.0		
			Roots	36000	132.0	22.0	140.0	249.0	18.0		
England	Quercus robur	47	Leaves +Branches	21700	218	21	105	73	18	Na 1	Ovington 1962
			Trunks	106600	151	11	118	173	23	3	
			Understory	1600	24	3	23	11	4	1	
U.S.S.R.	Quercus robur	220	Total	504000	1258						Rodin & Bazilevich 1967
U.K.	Quercus robur	39-47	Aboveground + thinning	185000	449	38	286	338	53		Ovington 1962
Belgium	Quercus robur, mixed	115-160	Overstory:								Duvigneud, Denaeyer 1970
			Foliage Total	3500	83.0	6.0	40.0	34.0	7.0		
			Branches	78300	259.0	23.0	139.0	339.0	27.0		
			Boles	210050	386.0	17.0	219.0	769.0	58.0		
			Roots	35300	297.0	29.3	112.0	301.7	27.7		
			Understory veg.	30580	166.0	14.0	112.0	172.0	32.0		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga (high site)	?	Tree	292000	727	95	326				West et al. 1981 (prelim. data)
			Understory	575	7	1	6				
	Pseudotsuga (low site)	?	Tree	162000	328	56	140				
			Understory	2700	16	3	13				
U.S.A.	Pseudotsuga	52	Aboveground-trees	204700	360	72	172				Heilman 1961 (cited in Ovington 1962)
			Roots	12300	49	11	21				
U.K.	Pseudotsuga	47	Stand, litter & understory	264000	636	62	257	388			Ovington 1962
Washington, USA	Pseudotsuga menziesii	28-52									Heilman & Gessel 1963
Upper pack			Unfert. Needles		71.5	22.9	67.0				
			Fert. Needles		140.6	16.5	105.1				
			Unfert. Live branches		17.0	3.2	15.9				
			Fert. Live branches		36.8	5.8	29.8				
			Unfert. Dead branches		2.6	.6	1.0				
			Fert. Dead branches		2.1	.3	1.1				
			Unfert. Bark		10.9	1.9	10.0				
			Fert. Bark		18.1	3.0	17.0				
			Unfert. Wood		9.7	1.3	.8				
			Fert. Wood		16.0	1.8	1.2				
			Unfert. Total		111.9	30.0	94.6				
			Fert. Total		213.7	27.6	154.1				
Darrington			Unfert. Needles		49.1	19.0	26.3				
			Fert. Needles		96.3	20.3	38.2				
			Unfert. Live branches		11.9	2.7	8.7				
			Fert. Live branches		24.7	5.0	14.7				
			Unfert. Dead branches		4.4	.7	1.1				
			Fert. Dead branches		5.8	.9	1.6				
			Unfert. Bark		9.7	2.5	9.4				
			Fert. Bark		17.5	3.9	12.5				
			Unfert. Wood		8.2	1.1	8.1				
			Fert. Wood		14.8	1.7	13.4				
			Unfert. Total		83.4	26.0	53.6				
			Fert. Total		159.2	31.8	80.4				
Lower Pack			Unfert. Needles		78.4	27.7	72.6				
			Fert. Needles		148.2	27.1	94.0				
			Unfert. Live branches		21.7	4.7	19.6				
			Fert. Live branches		51.3	8.7	42.3				
			Unfert. Dead branches		24.5	2.0	3.4				
			Fert. Dead branches		39.4	4.2	9.2				
			Unfert. Bark		45.6	7.6	33.6				
			Fert. Bark		62.9	11.1	51.1				
			Unfert. Wood		25.9	2.6	1.8				
			Fert. Wood		34.5	3.0	2.2				
			Unfert. Total		196.6	44.6	130.9				
			Fert. Total		336.4	54.2	198.8				
Matlock			Unfert. Needles		87.4	24.2	44.8				
			Fert. Needles		232.3	26.6	57.0				
			Unfert. Live branches		50.5	6.5	35.6				
			Fert. Live branches		72.4	11.5	29.2				
			Unfert. Dead branches		13.4	2.2	4.0				

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.A.	Pseudotsuga	38	Aboveground-trees	152900	260	50	138				Heilman 1961 (cited in Ovington 1962)
			Roots	16900	67	12	43				
			Understory		10		8				
Oregon, USA	Pseudotsuga menziesii	95	Foliage		154.0	40.0	95.0	88.0	16.0		
			Branches		87.0	20.0	60.0	195.0	17.0		Grier unpublished
			Stems		276.0	30.0	55.0	385.0	60.0		cited in Cole et al., 1967
			understory		14.0	6.0	14.0	38.0	4.0		
	Pseudotsuga menziesii	130	Foliage		135.0	32.0	67.0	98.0	13.0		
			Branches		65.0	16.0	50.0	153.0	15.0		
			Stems		186.0	20.0	36.0	260.0	40.0		
			Understory		5.0	1.0	4.0	5.0	1.0		
Washington, USA	Pseudotsuga	36	Leaves								Cole, Gessel and Dice 1967
			current	1990	24	5	16	7			
			older	7107	78	24	46	66			
			Branches								
			current	513	4	1	3	2			
			older	13373	40	9	32	65			
			dead	8145	17	2	3	39			
			Wood								
			current	7485	10	2	10	4			
			older	114202	67	7	42	43			
			Bark	18728	48	10	44	70			
			Roots	32896	32	6	24	37			
			Understory	1010	6	1	7	9			
U.S.A.	Pseudotsuga	32	Aboveground-trees	34200	84	26	54				Heilman 1961 (cited in Ovington 1962)
			Roots	20700	68	13	55				
			Understory	3200	21	3	22				
England	Pseudotsuga	21	Leaves +Branches	24500	213	13	68	98	18	Na 8	Ovington 1962
			Trunks	90300	99		63	54	11	2	
			Understory	200	4	<1	5	1	1		
England	Pseudotsuga	47	Leaves +Branches	49700	311	34	136	246	38	Na 6	Ovington 1962
			Trunks	202700	157	15	73	92	24	4	
			Understory	3600	49	6	39	23	5	2	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
England	Pseudotsuga	22	Leaves +Branches	82700	704	94	241	557	39	Na 3	Ovington 1962
			Trunks	92100	109		45	117	10	2	
U.S.A.	Pseudotsuga	38	Aboveground-trees	86300	196	45	131				Heilman 1961 (cited in Ovington 1962)
			Roots	1000	35	7	28				
			Understory	1300	10	1	10				
U.S.A.	Pseudotsuga	29	Aboveground-trees	37200	112	30	94				Heilman 1961 (cited in Ovington 1962)
			Roots	25100	90	18	86				
			Understory	1100	59		8	66			
U.K.	Pseudotsuga menziesii	39-	Aboveground + thinning	459000	628	65	284	432	86		Ovington 1962
B.C., Canada	Pseudotsuga	15-20	Leaves								
			current	2044	19.62	2.96	12.6	8.0	1.73		Webber 1977
			older	7337	81.11	13.34	38.7	71.4	7.66		
			Branches	12572	37.11	6.94	23.0	67.3	7.08		
			Wood	35958	24.67	2.71	5.1	15.3	3.35		
			Bark	6931	22.77	5.09	22.9	33.8	3.42		
			Total tree	64842	185.28	31.04	102.3	195.8	23.24		
			Understory	3913	13.8	1.3	8.3	18.1	3.0		
Oregon, USA	Pseudotsuga	450	Overstory								Grier et al. 1974
			Leaves	8906	75	20	70	93			
			Branches	48543	49	10	49	243			
			Trunks	472593	189	12	123	284			
			Understory								
			Leaves	3595	34	4	14	21			
			Stems	5104	9	3	8	22			
			Herbs	65	1		1	1			
			Epiphytes	1100	14	ND	ND	ND			
			Roots	74328	62	5	21	97			
Washington, USA	Pseudotsuga, low productivity	53	Foliage	11100	113	22	48				Bigger & Cole 1983
			Branches	19700	51	6.8	12				
			Boles	134000	161	27	81				
			Understory	2240	14	3	13				
			Forest floor	13900	187	19	27				
			Soil to 50 cm	38200	483						
			Total	219000	1000						

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga, high productivity	53	Foliage	12300	148	27	64				Bigger & Cole 1983
			Branches	24800	102	12	37				
			Boles	281000	478	56	225				
			Understory	592	6.5	0.8	5.5				
			Forest floor	17600	214	21	26				
			Soil to 50 cm	121400	2066						
			Total	458000	3011						
Korea	Quercus acutissima	12	Leaves	5275	41	6.5	40				Mun et al. 1977
			Branches	12000	40	3.0	14				
			Stems	52150	127	8.5	34				
			Roots	17360	72	7.5	72				
			Understory	3200	66	3.5	57				
Oklahoma, USA	Quercus	80	Total	219370	1157	101	1258	4549	311	Mn 124	Johnson & Risser 1974
U.S.S.R.	Quercus	12	Foliage	3300							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	43000							
			Roots	22700						Ash	
			Total	69000	278					1127	
U.S.S.R.	Quercus	40	Foliage	4100							After Dzens-Litorskaya 1960 (cited in Rodin Basilevich 1967)
			Woody	118900							
			Roots	31800						Ash	
			Total	154800						2187	
U.S.S.R.	Quercus	43	Foliage	3800							Mira, 1955 (cited in Rodin and Basilevich 1967)
			Woody	104900							
			Roots	45900						Ash	
			Total	154600	628					2012	
U.K.	Quercus	47	Stand, litter & understory	134000	464	40	254	292			Ovington 1962
U.S.S.R.	Quercus	48	Foliage	3600							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	187000							
			Roots	70200						Ash	
			Total	260800	952					2570	
Belgium	Quercus	80	Overstory:								Duvigneud, Denaeyer 1970
			Foliage Total	3458	73.0	4.7	36.0	54.0	4.6		
			Branches	36425	295.0	23.0	164.0	776.0	72.0		
			Boles	75202							
			Roots	34600	121.0	10.0	92.0	372.0	19.0		
			Understory veg.	4700	46.0	4.6	46.0	70.0	6.0		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.S.R.	Quercus	220	Foliage	3700							Mira, 1955 (cited in Rodin and Basilevich 1967)
			Woody	402800							
			Roots	97300						Ash	
			Total	503800	1258					6396	
Missouri, USA	Quercus	35-92	Trees	94780	121.6	10.4	67.1	463.4	23.4		Rochow 1975
			Shrublayer	5120	16.5	1.8	9.8	37.3	2.7		
			Herb	175	2.1	0.3	2.8	2.6	0.4		
Roquet, France	Quercus ilex	150	Overstory:								Loissant, Rapp in Cole & Rapp 1980
			Foliage Total	7000	93.0	10.0	43.0	70.0	9.0		
			Branches	27000	135.0	40.0	90.0	493.0	25.0		
			Boles	235000	517.0	174.0	493.0	3290.0	117.0		
			Roots	45000	153.0	81.0	85.0	1147.0	7.2		
			Understory veg.	340	2.3	.1	17.0	4.1	1.1		
England	Quercus petraea	21	Leaves +Branches	14100	214	13	61	61	17	Na 3	Ovington 1962
			Trunks	28300	70	6	41	58	11	1	
			Understory	600	11	1	14	4	2	1	
Tennessee, USA	Quercus prinus	30-80	Overstory:								Harris in Cole & Rapp 1980
			Foliage Total	5300	75.0	5.0	52.0	58.0	12.0		
			Branches	30000	139.0	10.0	61.0	294.0	13.0		
			Boles	102000	183.0	11.0	129.0	500.0	20.0		
			Roots	36000	132.0	22.0	140.0	249.0	18.0		
England	Quercus robur	47	Leaves +Branches	21700	218	21	105	73	18	Na 1	Ovington 1962
			Trunks	106600	151	11	118	173	23	3	
			Understory	1600	24	3	23	11	4	1	
U.S.S.R.	Quercus robur	220	Total	504000	1258						Rodin & Bazilevich 1967
U.K.	Quercus robur	39-47	Aboveground + thinning	185000	449	38	286	338	53		Ovington 1962
Belgium	Quercus robur, mixed	115-160	Overstory:								Duvigneud, Denaeyer 1970
			Foliage Total	3500	83.0	6.0	40.0	34.0	7.0		
			Branches	78300	259.0	23.0	139.0	339.0	27.0		
			Boles	210050	386.0	17.0	219.0	769.0	58.0		
			Roots	35300	297.0	29.3	112.0	301.7	27.7		
			Understory veg.	30580	166.0	14.0	112.0	172.0	32.0		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Meathop Wood, G.B.	Quercus, Betula, Mixed decid.	80	Overstory:								Satchell in Cole & Rapp 1980
			Foliage Total	3505	85.7	4.6	38.9	41.9	9.5		
			Branches	33640	58.8	3.7	61.1	137.4	8.0		
			Boles	75920	133.6	8.4	113.1	301.0	8.5		
			Roots	24218	223.0	11.9	112.8	235.3	30.8		
			Understory veg.	15529	8.1	5.4	42.9	66.9	9.7		
N. Carolina, USA	Quercus, Carya Acer		Stand	190000	995		400	830			Henderson et al, 1978
Tennessee, USA	Quercus, Carya	30-80	Overstory:								Harris in Cole & Rapp 1980
			Foliage Total	5600	67.0	6.0	53.0	70.0	17.0		
			Branches	26000	131.0	9.0	53.0	288.0	19.0		
			Boles	90000	171.0	9.0	114.0	498.0	31.0		
			Roots	33000	128.0	22.0	136.0	244.0	19.0		
Tennessee, USA	Quercus, Carya		Stand	156000	470		340	980			Henderson et al, 1978
N. Carolina, USA	Quercus, Carya	60-200	Overstory:								Swank in Cole & Rapp 1980
			Foliage Total	5584	95.0		46.0	49.0			
			Branches	25599	116.0		46.0	133.0			
			Boles	106313	194.0		135.0	361.0			
			Roots	52525	434.0		167.0	278.0			
Illinois,	Quercus, Carya	150	Total:xeric	237300							Rolfe et al. 1978
			mesic	243700							
			Foliage:xeric	5200							
			mesic	5600							
			Twigs:xeric	6200							
			Twigs:mesic	6800							
			Limbs:xeric	45700							
			Limbs:mesic	46800							
			Boles:xeric	127300							
			Boles:mesic	130600							
			Above-ground xeric	190500							
			mesic	194900							
			Aerial parts		478	29	310	1603	105		
			Foliage		63	4.9	59.6	64.4	17.9		
			Twigs		35	1.5	21.3	107.3	9.6		
			Limbs		126	7.8	110.7	601.2	33.1		
			Boles		252	14.7	115	837.3	44.2		
			Roots		153	12	109	426	26		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
Belgium	Quercus, Fagus	75	Stand	156000	533	44	342	1248	102		Duvigneaud & Denaeyer-de Smet, 1970
Belgium	Quercus, Fagus, Carpinus	70-75	Total	147000	474	36	286	1165	93	Mn 70	Duvigneaud & Denaeyer De Smet 1970
Belgium	Quercus, Fraxinus	100+	Aboveground	380000	947	63	493	1338	126		Duvigneaud & Denaeyer-de Smet, 1970
U.S.S.R.	Tilia	40	Foliage	2800							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	116800							
			Roots	38900						Ash	
			Total	158500	784					1937	
U.S.S.R.	Tilia	74	Foliage	4500							Remezov et al, 1959 (cited in Rodin and Basilevich 1967)
			Woody	165100							
			Roots	55400						Ash	
			Total	22500	1085					2686	
Oregon, USA	Tsuga heterophylla Picea sitchensis	30	Foliage		231.9	29.2	83.1	49.5	21.7		Grier unpublished cited in Cole et al.
			Branches		63.5	10.2	25.9	32.0	6.8		
			Stems		170.1	43.6	42.1	135.3	15.3		
			understory		t	t	t	t	t		
			Roots		98.8	22.2	36.2	59.6	14.4		
	Tsuga heterophylla Picea sitchensis	121	Foliage		85.2	10.9	31.1	19.3	7.5		
			Branches		76.1	10.8	30.8	52.5	8.8		
			Stems		584.6	148.9	138.3	432.8	46.9		
			Understory		15.7	3.4	9.7	7.7	2.2		
			Roots		178.7	43.5	61.0	152.6	33.5		
B.C., Canada	Tsuga heterophylla Chamaeoyparis nootkatensis	250	Leaves +twigs	3800	27	4	12	24	3		Krumlik and Kimmins 1976
			Branches								
			small	5700	8	1	5	12	1		(Figures may not be additive due to rounding errors)
			large	5300	6	1	4	12	1		
			Bark	7200	12	2	8	37	1		
			Trunks	34300	16	5	24	22	4		
			Total	56300	70	13	53	107	11		
Oregon, USA	Tsuga mertensiana & Abies concolor	130	Foliage		140.0	39.0	100.0	130.0	20.0		Grier unpublished in Cole et al.
			Branches		68.0	14.0	47.0	130.0	13.0		
			Stems		186.0	14.0	39.0	236.0	36.0		
			Understory		15.0	1.0	9.0	11.0	1.0		
			Roots		108.0	9.0	36.0	167.0	30.0		

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
B.C., Canada	Tsuga mertensiana, Abies amabilis	420	Leaves +twigs	5200	172	24	76	102	16		Krumlik and Kimmins 1976 (figures may not be additive due to rounding errors)
			Branches small	2200	21	4	12	28	3		
			large	7600	52	8	32	103	9		
			Bark	16700	158	37	85	306	18		
			Trunks	68200	154	29	194	203	42		
			Total	467300	557	101	399	741	87		
Japan	Tsuga sieboldii	120-443	Overstory:								Ando in Cole & Rapp 1980
			Foliage Total	7846	84.7	5.3	46.7	39.7	11.7		
			Branches	92345	205.7	13.4	105.4	430.7	5.1		
			Boles	348410	291.8	6.0	289.1	463.4	45.8		
			Roots	165565							
			Understory veg.	118318	281.1	14.7	220.5	283.1	46.6		

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
New Hampshire,	Abies balsamea		Forest floor								Lang et al., 1981
			01 horizon	75000	1800	150	60	150	52	Na 5	
			02 horizon	17200	500	67	36	17	47	Na 3	
			Total	92200	2300	217	96	167	99	Na 8	
			Branches								
			Slight-mod. decay	3300	10	<1	<1	2	<1	Na <1	
			Adv. decay	1400	4	<1	<1	2	<1	Na <1	
			Total	4700	14	1	1	7	1	Na <1	
			Bole wood								
			Slight decay	300	1	<1	<1	1	<1	Na <1	
			Mod. decay	4800	10	4	<1	8	<1	Na <1	
			Adv. decay	3700	11	3	<1	7	<1	Na <1	
			Total	8800	22	7	1	16	2	Na <1	
			Buried wood	3900	22	2	1	7	<1	Na <1	
Oregon, USA	Abies concolor	23	Forest floor		666.0	55.0	219.0	170.6	219.0		Grier (unpubl.) cited in Cole et al.
		180	Forest floor		2090.0	137.0	700.0	4805.0	343.0		
New Mexico	Abies concolor		Total	80800	883	85	235	2674	339	S 173 Mn 46.0 Zn 7.9	Wollum, 1973
Japan	Abies firma	97-145	L	4279	484.0	32.0	113.0	182.0	67.0		Ando in Cole & Rapp, 1980
	Tsuga sieboldii	120-443		50780	506.8	34.1	76.3	159.0	30.0		
Colorado, USA	Abies lasiocarpa		Non-woody	55506	498	55	182	724	170		Snell et al, 1979
			Woody	47433	100	12	40	103	11		
Japan	Abies may.		Total	10500	1218	236	242	642	390		Tsutsumi, 1971
Oregon, USA	Abies nobilis	130	Forest floor		884.0	213.0	75.0	515.0	205.0		Grier (unpubl.) cited in Cole et al.
New England, USA	Abies, Betula	75	Total	117000	1815						Vitousek et al. 1982

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
N. Carolina, USA	Betula lutea	100+		60600		49.2	139.4	407.8	161.8		Weaver & De Selm 1973
	Betula lutea	60		39700		74.8	143.6	381.0	130.4		
Japan	Betula papyrif.			14000	168	8.6	30	165	28		Tsutsumi, 1971
Alaska, USA	Betula papyrif.	50	L	68772.0	548.0	79.0	99.0	489.0	139.0		Van Cleve in Cole & Rapp, 1980
Washington,USA	Conifer -duff mull	old	L	13657	171	15	15				Gessel & Balci, 1965
			F	17971	266	22	21				
			H	71722	957	77	67				
Washington USA	Conifer mix (on Basalt)		L	1920	200	26	28				Wooldridge, 1968
			F	2080	252	33	50				
			H	4580	336	60	235				
	Conifer mix		L	1710	154	17	37				
			F	2290	267	26	63				
			H	2500	249	19	176				
Japan	Cryptomeria		Total	8000-30000	56-282	2.4-12.4	5.6-44.3	48.2-58.8	17.6-20.2		Kawana et al, 1979
Japan	Cryptomeria			12000	80	8.4	14	157	44		Tsutsumi, 1971
Japan	Cryptomeria			24000	184	8.2	18	304	86		Tsutsumi, 1971
California, USA	Cupresaus	30		30640							Kittredge, 1940
Maroondah, Victoria Australia	E. regnans	38	Total	47500	394	11	32	126	39	Na 5	Feller, 1981
	E. obliqua-E. dives	38	Total	13100	132	3	9	40	14	4	
Stradbroke Is. Qld.,Australia	Eucalyptus	?	Total	27000	195	6.8	23	142	34	Na 8	Westman and Rogers 1977a
SW Western Australia	Eucalyptus diversicolor	36	Total	27300	224	7	32	396	60	S 28 Na 16	Mingston et al., 1979
	E. diversicolor-E. calophylla	all	Total	19500	105	5	26	234	48	S 14 Na 10	

Table 5 Forest Floor Biomass and Nutrient Content

Location	Dom. Veg.	Age	Component/ Horizon	Biomass (kg/ha)	N	P	K	Ca	Mg	Other	Reference
Washington, USA	Abies, Tsuga	200	Total	145000	1600						Vitousek et al. 1982
Oregon, USA	Abies, Tsuga -46 sites	Old	Total	60840							Williams & Dyrness, 1967
N.B., Canada	Acer	7	Total	36680	304	29.3	22.0	223.7	18.3		MacLean, 1978
		17	Total	102930	720	61.8	41.2	422.0	41.2		
		20	Total	51410	447	41.1	25.7	359.9	36.0		
		29	Total	50230	487	45.2	20.1	512.3	45.2		
New England, USA	Acer, Fagus, Betula	66	Total	58850	1180						Vitousek et al. 1982
Indiana, USA	Acer, Fagus, Quercus	95	Total	9750	104						Vitousek et al. 1982
N.H., USA	Acer, Betula, Fagus	110	L	48016	125.6	7.8	66.0	372.0	38.0		Whittaker Cole & Rapp, 1980
England, UK	Alnus inc.	21	L	560							Ovington, 1954
			F+H	4830							
			Total	5390							
	Betula alba	21	L	420							
			F+H	4300							
			Total	4720							
Washington, USA	Alnus rubra (high site)	?	Total	16000	370	20	30				West et al. 1981 (preliminary data)
	Alnus rubra (low site)	?	Total	14000	340	17	22				
Washington, USA	Alnus rubra	40	Total	15000	225						Vitousek et al. 1982
Washington, USA	Alnus rubra	53	Total								Bigger & Cole, 1983
	high productivity			15000	327	20.3	30.3				
	low productivity			141000	330	16.5	21.7				
Washington, USA	Alnus rubra	9	Total		189	10	15	59	18	S 16 Fe 101 Mn 7 Cu 0.3 Zn 0.5	Radwan et al. in prep.
		18			347	23	32	188	84	S 39 Fe 944 Mn 31 Cu 2.0 Zn 2.5	
		28			218	16	21	96	23	S 21 Fe 174 Mn 11 Cu 0.3 Zn 1.1	
		31			222	18	29	100	28	S 25	

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
										Fe 419 Mn 19 Cu 1.7 Zn 1.4	
		38			248	16	22	118	36	S 25 Fe 326 Mn 18 Cu 0.7 Zn 1.1	
		42			258	21	24	128	24	S 23 Fe 306 Mn 18 Cu 0.6 Zn 1.0	
		45			405	24	26	120	42	S 43 Fe 517 Mn 30 Cu 1.1 Zn 1.5	
Washington, USA	Alnus rubra	30	L	66350	877.0	45.0	91.0	391.0	57.0		Turner, 1975
Washington, USA	Alnus rubra	34	Total		1156						Turner et al, 1976
Washington,USA	Alnus rubra	5-41	Total	13000- 29000	250- 730						Bormann & DeBell, 1981
Washington, USA	Alnus rubra, Pseudotsuga	23	Total	23040	280						Binkley, 1982
Korea	Alnus sibirica	12	L	5120	22	13	9				Mun et al. 1977
B.C., Canada	Alnus sinuata	5	Total	2450	47	6	2	25	10		Binkley, 1983
B.C., Canada	Alnus/Pseudo.	18	L + F	19900	340	29	19	144	40		Binkley et al., 1982
California, USA	Arbutus	30		23969							Kittredge, 1940
Alaska, USA	Betula (7 stands)	25-120	L	3097	24.8	3.7	5.6	43.7	7.7	Mn 3.8	van Cleve and Noonan, 1971
			F	7710	121.0	9.2	12.3	106.4	19.3	10.8	
			H	29707	487.2	38.6	53.5	279.2	62.4	48.7	
			Total	40515	633.0	51.6	71.4	429.3	89.4	63.3	

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
			Herbs		0	0	0	0			
			Dwarf shrubs		14.04	1.20	5.58	7.38			
			Shrubs		.30	.04	.14	.10			
			Aboveground parts		27.24	2.65	12.39	11.63			
			Below ground parts		15.41	2.20	3.22	5.71			
U.K.	Pinus sylvestris	20	Foliage	12500							Ovington 1957 (cited in Rodin and Basilevich, 1967)
			Woody	39100							
			Roots	14000						Ash	
			Total	65600	373					372	
England	Pinus sylvestris	55	Stand	150720	453	41	150	272	64		Ovington 1957, 1959
Sweden	Pinus sylvestris	39	Total	16300	46	5	19	17			Tamm 1969
		72	Total	47500	85	9	47	43			
U.S.S.R.	Pinus sylvestris	100	Total	81000	287						Rodin & Bazilevich 1967
	Pinus sylvestris	100	Total	37000	229						
England	Pinus sylvestris	23	Leaves	5100	115	10	52	36	8	Na 1	Ovington, 1959a,b (cited in Ovington, 1962)
			Branches	13800	60	5	28	34	10	1	
			Trunks	44300	59	5	34	56	8	1	
			Roots	28100	189	11	35	48	16	6	
			Understory	200	2	<1	2	1	<1		
Scotland	Pinus sylvestris	33	Foliage	7300	89	9	43	36	6		Ovington & Madgwick 1959
			Branches	23700	79	9	43	43	9		
			Boles	118800	97	12	84	115	24		
			Roots	36100	81	11	54	33	13		
U.S.S.R.	Pinus sylvestris	100	Foliage	6200							Manakov 1961, 1962a, 1962b (cited in Rodin and Basilevich 1967)
			Woody	56700							
			Roots	17800						Ash	
			Total	80700	287					458	
U.K.	Pinus sylvestris	39-	Aboveground + thinning	370000	417	38	237	359	72		Ovington 1962
U.K.	Pinus sylvestris	18	Needles	5900	56.8	6.0	35.4	15.0	5.5		Wright and Will 1958 Note: some totals do not add up precisely due to conversion of pound/acre to kg/ha.
			Branches	12500	37.5	4.7	34.3	22.5	6.5		
			Bark	6700	28.9	3.2	19.8	16.1	4.2		
			Wood	27100	21.4	1.9	20.9	12.9	5.7		
			Total	52500	144.7	15.9	110.4	66.5	21.9		
		28	Needles	4500	64.3	6.9	24.7	13.9	4.1		
			Branches	13400	58.0	7.4	35.9	23.6	8.6		
			Bark	8000	36.5	4.8	22.0	19.3	6.2		
			Wood	64100	55.7	4.8	40.7	25.7	15.4		
			Total	90000	214.4	23.9	123.3	82.5	34.3		
		64	Needles	4500	48.8	5.3	18.2	21.4	3.6		
			Branches	16000	50.9	6.3	27.9	34.3	7.6		
			Bark	13600	35.4	5.5	18.2	79.3	6.0		
			Wood	79500	61.1	4.7	31.1	57.9	16.0		
			Total	113600	196.2	21.8	95.4	193.0	33.23		

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Kyoto, Japan	Fagus cren.		Total	11600	105.4	6.8	8.8	111.6	10.0		Kawahara, 1971
Shiga, Japan	Chamaecyparus		Total	17100	99.5	4.1	7.2	92.9	9.7		
Kyoto, Japan	Pinus dens.		Total	19200	126.7	21.5	40.3	316.8	23.0		
Solling, W. Germany	Fagus sylvatica		Total	29700	810	52	83	91	34	Na 14 Al340	Ulrich et al. 1974 and Ulrich et al 1979
	Picea abies		Total	49000	960	53	41	83	20	Na 20 Al197	
Sweden	Fagus sylvatica	45-130	L	5200	86.0	5.8	104.0	34.2	4.8		Nihlgard, 1972
Germany	Fagus sylvatica	122	L	29700	810.0	52.0	83.0	91.0	34.0		Ulrich in Cole & Rapp, 1980
Japan	Larix leptolepis			13000	200	10.5	13	102	21		Tsutsumi, 1971
Tennessee,USA	Liriodendron	50	L	6000	77.9	5.3	9.2	99.6			Harris in Cole & Rapp, 1980
	Liriodendron, Carya, Quercus	30-80	L	1500	187.0	11.0	14.0	294.0	22.0		
Japan	Mix, broad			5000	62	3.3	8	27	9		
	Mix, broad			4000	52	2.9	12	116	17		Tsutsumi, 1971
Japan	Mixed		Total	6200	76	3.8	6.6	79.9	7.6		Katagiri et al. 1978
Japan	Mixed broad -lower slope		Total	4800	111	6.4	9.6	134.6	12.9		Katagiri & Isutsumi, 1978
	Mixed broad -upper slope		Total	15460	260	12	36.8	151.2	25.7		
Kyoto, Japan	Mixed broad		Total	15000	287.1	10.3	19.4	78.8	26.1		Iwatsuba, 1976
	Chamaecyparis		Total	12300	112.9	5.1	11.8	37.0	5.8		
Meathop Wood, 1980	Mixed decid.	80	L	6120	74.4	3.3	12.0	101.0	8.1		Satchell in Cole & Rapp,
Tennessee, USA	Mixed hardwoods		Total	13310	150	12	25	200			West et al. 1981 (preliminary data)

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
New Zealand	Nothofagus	110	Total		125	7	15	215	23	Na 8	Miller (in Ovington, 1962)
California, USA	Photinia	30		11861							Kittredge, 1940
Minnesota, USA	Picea	40	Total		752		76	1398			Alban et al., 1978
Minnesota, USA	Picea	41	Total	26000	509	40	43	753	46		Perala & Alban, 1979
Sweden	Picea	100	F	25800	435						Nykvist, 1977
			L + F + H		1181	66.8	95	289	77		
	Picea	139	L + F + H		574	50.9	80	260	29		
Sweden	Picea	59	Total		770	28					Tamm, 1969
	Picea	53	Total		290	15					
	Pinus	76	Total		740	27					
Germany	Picea abies	34	L	52000	1430.0	199.0	105.0	72.0	44.0		Ulrich in Cole & Rapp, 1980
		87	L	49000	960.0	53.0	41.0	83.0	20.0		
		115	L	111000	2260.0	98.0	115.0	258.0	46.0		
USSR	Picea abies	45	L	19200							Kazimirov & Morozova, 1973
Sweden	Picea abies	60	L	18500	245.0	15.4	15.0	47 9	7.5		Nihlgard, 1972
England, UK	Picea abies	20	Total		294	20	31	73	23	3	Ovington, 1962 (summary)
	Picea abies	47			360	19	30	65	27	4	
	Picea abies	47			436	24	21	117	19	5	
Alaska, USA	Picea mariana	51	L	88664	486.0	105.6	59.7	395.6	95.7		Van Cleve in Cole & Rapp, 1980
		55	L	133260	656.5	152.1	145.4	231.3	224.5		
		130	L	119235	709.7	87.4	122.2	452.2	99.3		
Quebec, Canada	Picea mariana	65	Total		1214						Weetman and Webber 1972
	Picea rubra		Total		1465						
New Mexico, USA	Picea, Abies	300	Total	65100	980						Vitousek et al. 1982
Nova Scotia Canada	Picea, Abies	All	Total		900	62	110	290	32		Freedman et al. 1981

Table 4 Standing Crop Biomass & Nutrient Content

Location	Dom. Veg.	Age	Component	Biomass	kg/ha N	P	K	Ca	Mg	Other	Reference
U.S.S.R.	Pinus sylvestris	71	Total	28000	664						Rodin & Bazilevich 1967
N. Carolina, USA	Pinus taeda										Wells and Jorgensen 1975
		11	Aboveground	77000			56	138	29		Nemeth 1972
			Roots	14000			24	36	11		and Wheeler 1972
		12	Aboveground	91000			59	158	33		(cited in Wells and
			Roots	16000			28	41	13		Jorgensen 1975)
U.S.A.	Pinus taeda	30	Aboveground	176400	212	31	132	127	41		Switzer et al 1966, 1968 (adapted by Foster and Morrison 1976)
Mississippi, USA	Pinus taeda	5	Aboveground	6000	38						Smith et al. 1971
		4	Aboveground	16000	72						(cited in Wells and Jorgensen 1975)
N. Carolina, USA	Pinus taeda	16	Leaves	8000	82	10	48				Jorgensen, Wells and Metz, 1975
			Branches	23200	60	6	28				
			Trunks	109600	79	11	65				
			Bark	15200	36	4	24				
			Roots	36300	64	17	61				
			Total	192300	321	48	226				
Japan	Pinus taeda	7	Aboveground	46000	235	21	51	100	44		Akai et al. 1968 & 1972
		34	Aboveground	197000	422	142	238	445	75		(cited in Wells and Jorgensen 1975)
N. Carolina, USA	Pinus taeda	4	Leaves		20.5	2.9	12.5	9.6	2.3		Haines and Sanderford 1975
			Bark		0.9	0.1	0.9	0.7	0.1		
			Wood		6.2	0.5	4.5	2.9	1.1		
			Total		27.6	3.5	17.9	13.2	3.5		
		4 (N,P,K fert.)	Leaves		25.0	3.0	16.1	8.5	2.1		
			Bark		2.7	0.3	1.8	1.5	0.4		
			Wood		7.1	1.0	5.4	3.2	1.1		
			Total		34.8	4.3	23.3	13.2	3.6		
S.E. USA	Pinus taeda	10	Aboveground	28000	80	7	40	25	8	S 7	Switzer, Nelson and Smith 1968 (estimated from graph)
		20	Aboveground	90000	165	12	95	70	22	13	
		30	Aboveground		210	20	125	125	40	20	
		40	Aboveground		235	25	145	165	50	25	
		50	Aboveground		250	25	150	180	65	25	
		60	Aboveground		250	25	155	185	65	25	

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
										Na .001	
										Mn .01	
			moss	1075	16.1	1.38	1.31	4.1	.74	Na .093	
										Mn 1.38	
			Unid'd	38688	560.1	34.11	29.52	121.7	20.92	Na 4.327	
										Mn 24.28	
			H	45740	372.6	8.86	25.07	74.1	41.98	Na 15.962	
										Mn 31.28	
N.B., Canada	Pinus	16	Total	99280	715	49.6	59.6	188.6	29.8		MacLean, 1978
		19	Total	104490	951	73.1	104.5	501.5	52.2		
		49	Total	129250	1176	103.4	180.9	439.4	90.5		
		57	Total	74140	823	51.9	81.6	96.4	37.1		
Washington USA	Pinus (on Basalt)		L	2490	168	22	37				Wooldridge, 1968
			F	3190	322	34	95				
			H	7330	115	33	97				
	Pinus		L	2000	149	21	36				
			F	2240	208	21	104				
			H	1660	141	20	100				
Minnesota, USA	Pinus banksiana		Total-shallow		335	24	22	160	23		Green & Grigal 1979
			-deep		544	40	37	254	33		(in White & Harvey 1979)
Ontario, Canada	Pinus banksiana	20	Total	15971	234	17	19	91	18		Foster & Morrison, 1976
		30		19967	328	26	43	88	88		
		65		25624	430	34	48	98	98		
Minnesota, USA	Pinus banksiana	41	Total	25000	468	32	37	375	50		Perala & Alban, 1979
Ontario, Canada	Pinus banksiana	65	Total	25600	283	13	680	396	157		Morrison & Foster, 1979
Minnesota, USA	Pinus banksiana	40	Total		689		68	770			Alban et al., 1978
Colorado, USA	Pinus contorta		L	4910			2.7	25.1	16.4	Na .6	Stottlemyer & Ralston, 1968
			F	6870			3.8	35.0	27.8	.9	
			H	16810			16.5	85.8	91.5	2.0	
			Total	28590			23.0	145.9	135.7	3.5	

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Colorado, USA	Picea, Abies		L	2810			1.6	22.0	9.3 Na	0.3	Stottlemyer & Ralston, 1968
			F	3680			2.0	28.8	14.9	0.5	
			H	11210			11.0	87.8	61.0	1.3	
			Total	17700			14.6	138.6	85.2	2.1	
N. Carolina, USA	Picea, Abies	40-	Total	91000		93.6	287.9	328.0	210.7		Weaver, 1975
Sweden	Picea, Pinus	65-132	L Spr. needles	2298	27.2	2.07	2.07	20.5	.92Na	.23	Nykvist
									Mn	3.53	
			Pine needles	152	1.3	.11	.15	.8	.05Na	.015	
									Mn	.14	
			Branches <2	596	5.7	.48	.48	2.0	.18Na	.042	
									Mn	.54	
			Branches 2-5	921	6.9	.55	.46	2.3	.18Na	.055	
									Mn	.37	
			Branches >5mm	58	.4	.04	.03	.2	.01Na	.003	
									Mn	.02	
			Bark	120	.8	.07	.16	.2	.05Na	.008	
									Mn	.04	
			Cones	822	5.7	.49	1.07	1.6	.33Na	.057	
									Mn	.25	
			Deschampsia	246	2.9	.30	2.95	.5	.12Na	.017	
									Mn	.26	
			Vacc. myrt.	23	.3	.03	.08	.2	.03Na	.027	
									Mn	.04	
			Herbs	54	.9	.08	.12	.5	.07Na	.008	
									Mn	.18	
			Pleurozium	602	7.8	.96	3.01	2.5	.42Na	.084	
									Mn	.60	
			Dicranumum	270	3.4	.41	2.16	1.1	.24Na	.043	
									Mn	.34	
			Phlium	59	.7	.09	.47	.2	.05Na	.009	
									Mn	.08	
			Hylocum	107	1.3	.16	.86	.4	.10Na	.017	
									Mn	.14	
			Unid'd	1840	22.7	1.66	1.84	7.0	1.10Na	.387	
									Mn	1.50	
			F Needles	810	11.2	.73	.58	4.1	.32Na	.057	
									Mn	1.04	
			Branches <20	1894	18.4	1.25	1.25	5.5	.76Na	.141	
									Mn	1.24	
			Branches >20mm	269	2.5	.16	.16	.8	.11Na	.022	
									Mn	.14	
			Bark	390	4.1	.23	.20	1.4	.17Na	.019	
									Mn	.27	
			Cones	2631	27.9	1.49	1.05	9.3	1.05Na	.176	
									Mn	1.23	
			Resin	13							
			Dead roots	2851	27.2	1.85	3.14	6.1	1.35Na	.242	
									Mn	1.87	
			herbs	11	.1	.01	.004	.04	.004		

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Arizona, USA	Pinus ponderosa	60	Basalt,								Binkley (unpub. data)
			med. site L.	11400							
			med. site F.	13800							
			Limestone L.	12100							
			good site F.	19500							
			Sandstone L.	8000							
			poor site F.	12300							
New Mexico	Pinus ponderosa		Total	27700	250	15	141	139	38	S 31 Mn 7.6 Zn 2.1	Wollum, 1973
	Pinus ponderosa		Total	32300	314	24	281	219	29	S 38 Mn 14.9 Zn 2.2	
Arizona, USA	Pinus ponderosa	43	unthinned	33000	306	27	80	160	135	Mn 146 S 36 Zn 36	Wollum & Schubert, 1975
			med. thinned	25000	225	19	57	125	90	Mn 94 S 24 Zn 26	
			heavy thinned	20000	180	15	43	100	62	Mn 62 S 17 Zn 20	
NWS, Australia	Pinus radiata	?	L	5813	68	6	14	26	5	B 0.06 Zn 0.37 Cu 0.40 Mn 4.6	Ballard and Will, 1981
			L+F Fine	38000	414	28	15	124	24	B 0.22 Zn 1.82 Cu 2.01 Mn 18.2	
			L+F Woody	11670	41	3	21	5		B 0.03 Zn 0.33 Cu 0.11 Mn 1.33	
NSW, Australia	Pinus radiata	3	Leaves	400							Forrest & Ovington, 1970
			Branches	0							
			F+H	0							
			Total	400							
		5	Leaves	1800							
			Branches	0							
			F+H	0							
			Total	1800							
		7	Leaves	4700							
			Branches	0							
			F+H	0							
			Total	4700							
		9	Leaves	2600							
			Branches	2600							
			F+H	8900							

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Japan	Pinus dens.		Total		121.8	4.44	23	80.1	12.3	Na 2.6	Nishimura, 1973
Japan	Pinus dens.			8000	96	5.5	11	61	12		Tsutsumi, 1971
Indiana, USA	Pinus echinata	33	Total	17250	134						Vitousek et al. 1982
Tennessee,USA	Pinus echinata	30	L	27000	290.0	18.0	21.0	256.0	23.0		Harris in Cole & Rapp, 1980
New Mexico	Pinus edu.		Total	9400	80	12	21	216	41	S 18 Mn 4.1 Zn 1.0	Wollum, 1973
	Pinus ponderosa		Total	25100	191	15	80	432	83	S 37 Mn 3.7 Zn 1.4	
	Pinus, Pseudo.		Total	25500	234	14	178	929	62	S 29 Mn 3.8 Zn 2.0	
Scotland	Pinus nigra	40	L	10800							Miller & Miller 1976
			H	13100							Miller, Miller and Pauline
			Total	23900	304	57	39	87	26	Na 13	1976
England,UK	Pinus nigra	21	L	3907							Ovington, 1954
			F+H	14251							
			Total	18158							
	Larix leptolepis	21	L	1825							
			F+H	12282							
			Total	14107							
New Mexico, USA	Pinus ponderosa	200	Total	113000	1240						Vitousek et al. 1982
Arizona, USA	Pinus ponderosa	30-150	<2mm								Covington, 1978
			Before burn	19800	410	46	53	286	127		
			After burn	15850	380	56	76	645	235		
			After burn + 7 months	11840	257	47	75	583	158		
Arizona, USA	Pinus ponderosa	49	Needles	1304	8						Klemmedson, 1975
			Branches	12488	48						
			Wood	1500	3						
			Humus	18570	170						
			F+H	12890	62						
			Other OM	74	-						

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Central Sweden	Pinus sylvestris	120-140	L+F	6950	72	5.4	11.1	24.5	3.5	Na 9.57 S 6.78	Bringmark, 1977
			H	19900	160	10.7	18.5	45.7	11.2	Na 2.0 S 15.4	
Finland	Pinus sylvestris	28	H		1	3	20	45			Malkonen, 1975
		45	H		1	5	31	91			
		48	H		1	4	28	48			
Scotland, UK	Pinus sylvestris	33	Total		1622	78	165	322	31	Na 34	Ovington & Madgwick, 1959a
England, UK	Pinus sylvestris	23	Total		163	22	24	139	171	Na 3	Ovington, 1959
		55			409	28	34	141	31	6	
England, UK	Pinus sylvestris	7	Total	15982	158.9	9.0	10.0	26.2	8.6	Na .84	Ovington, 1959
		11		12144	116.6	7.1	11.0	47.5	7.0	1.08	
		14		9875	90.7	6.8	11.7	63.3	5.8	1.22	
		17		17381	193.9	13.5	15.5	77.1	7.9	1.57	
		20		26370	336.0	21.0	23.3	127.5	11.4	2.57	
		23		29790	162.9	21.9	24.3	138.9	16.9	2.89	
		31		31527	285.2	19.1	31.5	122.5	16.3	3.79	
		35		36694	345.8	22.0	31.2	128.0	26.8	4.53	
		55		45011	408.7	27.6	34.4	141.4	30.7	6.47	
England, UK	Pinus sylvestris	47	Total		409	9	11	25	9	Na 2	Ovington, 1962 (summary)
	Pinus nigra	46			274	15	24	67	15	3	
S. Carolina, USA	Pinus taeda	17	L		26.4	4.0	2.7	16.6	3.1		Van Lear, 1980
			F		132.5	16.9	9.9	42.3	8.5		
N. Carolina, USA	Pinus taeda	14	Total	15512	182	11.4	10.3	77.0	11.4		Wells et al, 1975
				15002	176	11.8	11.1	53.3	10.9		
Mississippi, USA	Pinus taeda	15-30	Total	17900	170	12	13	53	18		Switzer et al, 1979
		30-45		19000	180	11	15	85	20		
		45-100		20900	200	14	17	130	22		
		100-150		17800	210	13	18	180	23		
		150-240		14000	190	12	17	300	28		

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
			Total	14300							
		12	Leaves	4900							
			Branches	1300							
			F+H	1080							
			Total	17000							
New Zealand	Pinus radiata + Lupin	4	L	13000	113.4						Gadgil, 1976
	Pinus rad. +Lupin	4	L	10000	107.9						
California,USA	Pinus radiata	30	Total	60045							Kittredge, 1940
	Pinus pin.	30		35088							
	Pinus can.	30		31134							
New England, USA	Pinus resinosa	55	Total	61900	755						Vitousek et al. 1982
New York,USA	Pinus resinosa -good	37	L	5845							Stutzbach et al., 1972
			F	17071							
			H	13692							
			Total	36608							
	Pinus resinosa -poor	37	L	7319							
			F	8374							
			H	6674							
			Total	22367							
Minnesota, USA	Pinus resinosa	40	Total		538		62	660			Alban et al., 1978
Minnesota, USA	Pinus resinosa	41	Total	26000	350	24	30	278	39		Perala & Alban, 1979
N.Carolina, USA	Pinus strobus	60-200		9500	110.0		29.0	130.0			Swank in Cole & Rapp, 1980
Mass, USA	Pinus strobus	34-96	L	3966							Mader & Lull, 1968
			F	21976							
			H	18117							
			Total	43952							

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
N.Carolina, USA	Pinus taeda	16	Total		307	30	28	93	20		Wells & Jorgensen, 1975
N.Carolina, USA	Pinus taeda	50	L	3715	34.2			46.4			Wells & Davey, 1966
			F+H	19639	265.1			286.7			
	Pinus virg.	40	L	2488	24.4			15.9			
			F+H	8722	99.4			56.7			
S. USA	Pinus taeda	20	Total		124	9	16	81	16	S 11	Switzer & Nelson, 1972
N.Carolina, USA	Pinus taeda	20	L	4721	36.8			16.5			Wells & Davey, 1966
			F	19392	306.4			77.6			
New Mexico, USA	Populus tremuloides	60	Total	28900	520						Vitousek et al. 1982
Alberta, USA	Populus tremuloides		L	11000	200	15	40	375	25		Lousier & Parkinson 1979
			F	21700	550	30	40	700	45		
			H	39900	900	50	130	1100	65		
			Ah	42200	475	30	350	300	60		
Minnesota, USA	Populus	40	Total		667		78	1081			Alban et al., 1978
Minnesota, USA	Populus	49	Total	20000	442	32	34	536	57		Perala & Alban, 1979
Alaska, USA	Populus (7 stands)	20-120	L	2829	38.2	4.0	5.4	60.0	6.8	.7	van Cleve & Noonan, 1971
			F	8677	136.2	11.3	14.8	178.7	21.7	2.7	
			H	30517	476.1	45.8	64.1	402.8	79.3	30.2	
			Total	42023	650.5	61.0	84.2	641.5	107.8	33.6	
New Hampshire, USA	Prunus, Acer	3	Total	63900							Covington, 1976
	Prunus, Acer	4		56700	1480		71.4	347	74.8		
	Acer, Betula	7		59900							
	Acer, Prunus	11		52600							
	Acer, Betula	22		35300	950		45.5	317	43.8		
	Acer, Betula	30		60300							
	Acer, Fagus	35		58400							
	Acer, Fagus	40	Total	66800	1837		71.5	136	299		
	Acer, Sorbus	49		83100							
	Acer, Fagus	57		72500	1870		125	350	70.3		
	Acer, Fagus	200		89300	2402		86.6	446	50.0		

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga (high site)	?	Total	17670	226	21	26				West et al. 1981 (preliminary data)
	Pseudotsuga (low site)	?	Total	13870	203	19	27				
Washington, USA	Pseudotsuga	300	Total	12000	110						Vitousek et al. 1982
Washington, USA	Pseudotsuga	53	Total								Bigger & Cole, 1983
	high productivity			17600	214	20.9	25.9				
	low productivity			1390	187	18.8	27.1				
Washington, USA	Pseudotsuga	45	Total	18000	175						Vitousek et al. 1982
Washington, USA	Pseudotsuga	23	Total	21150	280						Binkley, 1982
Washington, USA	Pseudotsuga	25-41	Total	14000	150-						Bormann and DeBell 1981
				25000	260						
Oregon, USA	Pseudotsuga										
	+Holodiscus		Total	22881	162	20	30	240	63	5 25	Youngberg, 1966
	+Gaultheria			28108	199	39	65	244	58	32	
	+Acer cir.			23348	173	32	31	205	74	24	
				21949	191	46	60	192	73	18	
	+Gaultheria			21703	287	40	32	236	70	29	
	+Acer cir.			32549	348	47	60	293	134	36	
	+Polystichum			29419	258	43	34	184	46	26	
	+Rubus			82185	1249	115	163	339	194	134	
	+Polystichum			63974	479	479	74	208	126	48	
Oregon, USA	Pseudotsuga menziesii	95	Forest Floor		274	76.0	34.0	92.0	36.0		Grier (unpubl.) cited in Cole et al.,
		130			384	109.0	32.0	160.0	47.0		
		450			445	62.0	80.0	619.0	160.0		
B.C., Canada	Pseudotsuga	120									de Catanzaro, 1979
	dry		L	5690							
			Total	45040							
	mesic		L	7100							
			Total	45680							
	moist		L	4670							
			Total	25200							

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga menziesii (plantation)	9	Forest Floor		28	6.2	10.8	30.9	6.6		Turner, 1975
	Pseudotsuga menziesii (plantation)	30	Forest floor		223	30.3	44.1	129.5	53.6		
	Pseudotsuga menziesii	49	Forest floor		272	38.0	51.0	203.0	46.0		
California, USA	Pseudotsuga	30		30887							Kittredge, 1940
Washington	Pseudotsuga menziesii	45	Total								Turner, 1977
			Control	28700							
			Low fert.	31100							
			High fert.	19600							
England, UK	Pseudotsuga	21	Total		156	11	25	68	9	Na 3	Ovington, 1962 (summary)
		22			188	22	18	230	9	6	
		47			119	7	9	27	7	1	
	Larix dec.	46			594	25	23	104	27	4	
	Betula	22			47	6	8	72	4	1	
	Alnus	22			65	5	5	72	2	1	
	Quercus	21			121	6	11	36	7	1	
	Quercus	47			71	5	8	35	5	1	
	Fagus	39			180	11	20	31	14	1	
	Nothofagus	22			71	5	7	39	5	1	
	Castanea	47			80	6	10	32	7	1	
Oregon	Pseudotsuga menziesii	450	Fallen logs	215000	215	7	24	163	16	Na 5'	Sollins et al 1980
			Fine Litter	51200	256	50	56	445	133	Na 7'	
			Soil org. matter	13300	3724	8	33	102	27	Na 2'	
Washington, USA	Pseudotsuga	22	Wood	613	4	.4	.5	2.9	.7		Turner, 1975
			L	11406	73	14.4	21.3	50.6	30.5		
			H	8520	100	10.8	15.9	60.5	22.8		
		30	Wood	1396	11	.9	1.4	7.0	1.1		
			L	5850	46	7.2	9.6	47.1	10.2		
			H	9437	97	11.6	15.5	75.9	16.4		
		42	Wood								
			L	2410	20	2.9	3.8	15.1	3.5		
			H	14726	142	20.9	27.0	104.5	25.6		
		73	Wood	56372	219	21.7	35.0	233.1	19.2		
			L	10991	43	13.2	6.8	45.4	3.7		
			H	28372	312	34.2	34.8	185.1	43.8		
		95	Wood	37262	124	14.9	12.7	107.3			
			L	9210	87	9.3	12.8	65.3			
			H	34216	324	34.4	47.5	242.8			

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Washington,USA	Pseudotsuga	450	L needles		14.4	3.2	4.8	34	2.3		Abee, 1973
			cones		3.6	.4	.8	1.4	.5		
			twigs		3.2	.4	.8	7	.4		
			branches		1.2	.1	.3	1.7	.2		
			bark		2	.2	.3	2.4	.1		
			hardwoods		.7	.1	.3	2.7	.2		
			moss, lichens		1.5	.2	.3	.6	.1		
			L + F + H	50874	414	51	100	404	58	S 33	
New Mexico	Pseudotsuga		Total	38200	269	28	338	800	119	S 59 Mn 16.2 Zn 3.6	Wollum, 1973
	Pseudotsuga		Total	44500	286	27	232	804	171	S 54 Mn 18.9 Zn 3.9	
Washington USA	Pseudotsuga		Branches	1423	5	1	4	8			Cole et al, 1968
			Needles	3005	35	4	5	27			
			Wood	6345	14	2	8	17			
			H	11999	121	19	15	85			
New Mexico, USA	Pseudotsuga, Abies	200	Total	82000	900						Vitousek et al. 1982
B.C., Canada	Pseudotsuga, Tsuga	100+	L + F	27250	376	26	28	242	71		Binkley et al., 1982
B.C., Canada	Pseudotsuga, Alnus rubra	23	Total	33600	502	61	18	238	50		Binkley, 1983, Binkley et al. 1984
	Pseudotsuga, Alnus sinuta	23	Total	22100	282	72	16	160	51		
	Pseudotsuga,	23	Total	7000	36	45	6	31	17		
Korea	Quercus acutissima	12	L	6300	91	10	10				Mun et al. 1977
New England, USA	Quercus	65	Total	58200	660						Vitousek et al. 1982

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Indiana, USA	Quercus	81	Total	19400	310						Vitousek et al. 1982
Minnesota,USA	Quercus		Total	4574	43.8	5.4		49.6	10.0		Reiners & Reiners, 1970
			Total	4687							
Tennessee,USA	Quercus alba	30-80	L	27000	334.0	22.0	26.0	517.0	32.0		Harris in Cole & Rapp, 1980
	Quercus prinus	30-80	L	25000	298.0	18.0	26.0	318.0	22.0		
N.Carolina, USA	Quercus alba		L	1912	26.8			27.9			Wells & Davey, 1966
			F+H	6809	116.4			147.1			
France	Quercus ilex	150	L	11400	124.7	4.0	10.2	361.2	19.7		Loissant, Rapp in Cole & Rapp, 1980
Belgium	Quercus mixed	115-160	L	5600							Duvigneud, Denaeyer in Cole & Rapp, 1980
	Mixed decid.	80	L	4762	44.0	2.0	17.0	107.0	5.0		
Illinois, USA	Quercus-Carya	150	Xeric Total	5900	69	8	7	118	7		Rolfe, Akhtar & Arnold, 1978
		150	Mesic Total	6100							
Illinois, USA	Quercus-Carya-Liriodendron	70-100	Total[1]	35762[1]		1.8	4		3.2		Luvall, 1976
Mississippi, USA	Quercus, Carya, Pinus	early success	Total		175	11	14	70	19	C-10000	Switzer et al. 1979
		middle success	Total		200	14	17	130	22	C-11300	
		late success	Total		200	13	17	240	25	C-8600	
New England, USA	Quercus, Acer	50	Total	59600	845						Vitousek et al. 1982
California, USA	Sequoia	30		27675							Kittredge, 1940
Minnesota,USA	Thuja, Fraxinus		Total	4115	45.0	6.5		87.0	11.5		Reiners & Reiners, 1970
			Total	4438							
	Thuja, Betula		Total	4881	42.0	6.2		90.6	12.0		
			Total	5634							

Table 5 Forest Floor Biomass and Nutrient Content

kg/ha

Location	Dom. Veg.	Age	Component/ Horizon	Biomass	N	P	K	Ca	Mg	Other	Reference
Oregon, USA	Tsuga heteropylla, Picea sitchensis	30	Forest floor		316.5	58.9	29.5	201.5	56.8		Grier (unpubl.) cited in Cole et al.
Oregon, USA	Tsuga heteropylla, Picea sitchensis	121	Forest floor		474.3	98.4	118.5	347.5	82.9		Grier (unpubl.) cited in Cole et al.
Oregon, USA	Tsuga mertensiana,	130	Forest floor		812.0	233.0	104.0	294.0	12.0		Grier (unpubl.) cited in Cole et al.
Washington,USA	Tsuga het. -mor	old	L	14431	162	15	14				Gessel & Balci, 1965
			F	22449	313	25	24				
			H	121004	1565	102	89				
Washington, USA	Tsuga, Picea	120	Total	21000	165						Vitousek et al. 1982
Japan	Varied										
	lower slope		Total		100	6	10.8	87.4	13.9		Tsutsumi et al. 1978
	mid slope		Total		120	6.9	14.4	77.8	13.6		
	upper slope		Total		200	10.6	21.9	107	19.6		
USA (22 states avg)	Varied		Mull	5371	58.5			59.1			Mader, 1953
			Mor	6164	78.9			29.6			

' Mean values from two watersheds, based on 0.04ha. plots per watershed.
' Mean as in ' & includes large woody components eg down tree & branches as well as other O1 and O2 components.

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
California, USA											
Granitic			0-100		5490						Colwell, 1976
Volcanic			0-100		5760						
Sedimentary			0-100		6580						
Acid			0-100		4840						
Basic			0-100		6340						
Ultrabasic			0-100		7330						
Washington, USA	Abies amab.	200	0-15	Total	878	2.2	72	44	26		Calculated from Vitousek et al. 1982
				NH4	3.9						
				NO3	0.1						
			15-30	Total	1170	3.2	23	12	7		
			30-70	Total	4200	5.4	43	22	13		
B.C., Canada 1500m	Abies amab.		0-30		3976	400	105	102	32		Phiri, 1973
New England, USA	Abies balsamea	75	0-15	Total	6791	4.4	123	126	57		Calculated from Vitousek et al. 1982
				NO4	15						
				NO3	2.2						
			15-30	Total	1028	1.7	22	112	8		
				NO4	5.2						
				NO3	0						
New Hampshire,	Abies balsamea		0-30	Total		2165					
						222	2130	123	4190	Na Na 930	Lang et al., 1981
				Exch.	NH4-24	-	87	110	26		
						NO3-7					
			30-60	Total	1220	204	2350	243	6565	Na 121	
				Exch.	NH4-14	-	81	59	9		
						NO3-3					
			60-90	Total	490	285	11840	1593	18750	Na 415	
				Exch.	NH4-13	-	313	23	8		
					NO3-3						
Oregon, USA	Abies con.	23	Soil	Total N	1980	3212	240	90	240		Grier (unpubl.) cited Cole et al.
				Extract.P							
				Exch.Ca Mg K							
		130	Soil	Total N	2320	3212	240	240	90		
				Extract.P							
				Exch.Ca Mg K							
Japan	Abies firma	97-145	Root-zone		3389.0	5.0	368.0	278.0	143		Ando in Cole & Rapp, 1980

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
England, U.K.	Abies grand	45	0-70			92	216	423	296	Na 89	Ovington, 1958
Colorado, USA	Abies lasio.		0-50	Total	3390	7	577	2690	592		Snell et al, 1979
Prince George, B.C. Canada	Abies lasio.	110-350	Org. Layer								Kimmins, 1974
				Total	842	74	96	344	55		
				Exch.			106	263	47		
			Min.Horizons -To sampled depth								
				Total	4395	6243	6373	6713	22846		
				Exch.			330	893	142		
			-In root zone								
				Total	3605	4492	4378	3829	13463		
				Exch.			224	653	117		
			-In top 30cm								
				Total	2546	2979	2410	1906	5824		
				Exch.			144	479	89		
			Total to 1m.								
				Total	5237	6317	6469	7057	22901		
				Exch.			436	1156	189		
			Total rooting zone								
				Total	4451	4566	4474	4173	13518		
				Exch.			350	916	164		
			Total in zone of max. rooting								
				Total	3388	3053	2506	2250	5879		
				Exch.			250	742	139		
Oregon, USA	Abies nobilis	130	Soil	Total N	14000	23	1000	800	178		Grier (unpubl.) cited in Cole et al.
				Extract.P Exch.Ca Mg K							
Indiana, USA	Acer, Fagus, Quercus	95	0-15	Total N	1837	51	107	1194	88		Calculated from Vitousek et al. 1982
				NH4F-P NH4	4.1						
				Extr. cations NO3	2.2						
			15-30	Total	1210	31	129	352	53		
				NO4	5.8						
				NO3	1.5						
			30-70	Total	2852	2.9	417	1996	299		
				NH4	14.6						
				NO3	5.3						
New England, USA	Acer, Fagus, Betula	66	0-15	Total	3348	0.8	46	39	14		Calculated from Vitousek et al. 1982
				NH4	4.9						
				NO3	1.1						
			15-30	Total	2280	1.1	52	67	16		
				NH4	3.8						
				NO3	0.9						
			30-70	Total	2346	9.7	80	117	18		
				NH4	no value						
				NO3	no value						

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
N.Hampshire, USA	Acer,Betula, Fagus	110	Root-zone							Org.Mat 174900	Whittaker in Cole & Rapp, 1980
Korea	Alnus sibirica	12	0-35	Total N Exch. P+K	7230	36	1520				Mun et al. 1977
Oregon, USA	Alnus	40	0-30	Avail.	8662	4.3	413	190	49		Franklin et al. 1968
	Pseudotsuga	40			5682	2.5	416	648	354		
	Mixed	40			7147	2.9	318	183	106		
	Alnus	30			7886	3.4	250	141	63		
	Pseudotsuga	30			6901	3.3	472	336	360		
England, U.K.	Alnus inc.	21	0-70			194	119	8260	213	Na 87	Ovington, 1958
Washington, USA	Alnus rubra	0	0-20	Total N,S Bray-Curtis #2P Exch. SO4 and cations	3030	239	468	1570	296	S 295 SO4S 50 Fe 121 Mn 82 Cu 2.4 Zn 6.0	Radwan et al. in prep.
			20-50		2550	165	357	1060	251	S 441 SO4S 214 Fe 112 Mn 69 Cu 2.2 Zn 3.9	
		9	0-20		3390	240	324	564	74	S 370 SO4S 76 Fe 126 Mn 49 Cu 1.5 Zn 9.2	
			20-50		4000	262	373	429	67	S 611 SO4S 240 Fe 116 Mn 116 Cu 1.8 Zn 13.3	
		18	0-20		2890	58	355	1230	329	S 270 SO4S 18 Fe 95 Mn 37 Cu 2.8 Zn 7.9	
			20-50		3390	48	359	1580	543	S 424 SO4S 133 Fe 121 Mn 39 Cu 2.4 Zn 14.5	
		28	0-20		3110	342	432	1310	228	S 240 SO4S 0 Fe 113 Mn 57 Cu 2.1	

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
			20-50		3590	323	483	1380	290	Zn 12.7 S 428 SO4S 174 Fe 127 Mn 50 Cu 2.5	
		31	0-20		3330	73	293	568	110	Zn 24.8 S 311 SO4S 27 Fe 89 Mn 54 Cu 1.6	
			20-50		2330	76	277	443	91	Zn 4.4 S 402 SO4S 140 Fe 54 Mn 35 Cu 0.8	
		38	0-20		3590	200	442	1140	236	Zn 2.6 S 336 SO4S 0 Fe 117 Mn 75 Cu 2.7	
			20-50		3800	192	459	1130	235	Zn 9.0 S 464 SO4S 164 Fe 124 Mn 78 Cu 2.9	
		42	0-20		3170	266	436	1050	197	Zn 14.3 S 270 SO4S 0 Fe 120 Mn 67 Cu 2.5	
			20-50		3740	283	470	1270	299	Zn 9.5 S 481 SO4S 134 Fe 144 Mn 72 Cu 2.7	
		45	0-20		4000	187	294	400	58	Zn 16.0 S 386 SO4S 50 Fe 108 Mn 44 Cu 2.3	
			20-50		3850	154	435	674	133	Zn 24.3 S 784 SO4S 337 Fe 112 Mn 59 Cu 2.4 Zn 11.8	

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
Washington, USA	Alnus rubra	40	0-15	Total	1920	6.8	112	787	104		Calculated from Vitousek et al. 1982
				NH4	3.4						
				NO3	0.8						
			15-30	Total	765	7.8	60	444	55		
			30-70	Total	2376	6.5	232	891	178		
Washington, USA	Alnus rubra	23	0-50	Total N	5565		114	176	20	C 98,100	Calculated from Binkley, 1982
				Exch. cations							
				Walkley-Black C							
Washington, USA	Alnus rubra	34	Root-zone	Total	5454						Turner et al., 1976
Alaska,USA	Betula papyrif.		Root-zone		2879.0	26.2	186.0	7547.7	2317.1	Org.Mat. 280100	Van Cleve in Cole & Rapp, 1980
England, U.K.	Betula alb.	21	0-70			230	125	7105	156	Na 88	Ovington, 1958
N. Carolina, USA	Betula lut.	40-60	A1-B1	Avail.		23	229	148	64		Weaver, 1975
	Betula lut.	>100				24	112	57	26		
England, U.K.	Castania sat.	45	0-70			39	239	424	266	Na 59	Ovington, 1958
B.C., Canada	Ceanothus, Pseudotsuga	14	0-15	Total N	1130	54	1510	110			Binkley & Husted, in review
				Exch. cations							
England, U.K.	Chamaecyparis	20	0-60			4	152	292	215	Na 111	Ovington, 1958
Shiga, Japan	Chamaecyparis				10640	21.4	884	305	42.3		Kawahara, 1971
England, U.K.	Coppice	20	0-60			4	208	326	211	Na 93	Ovington, 1958
Japan	Cryptomeria	1	0-20	Total			12921	4318	13183		Kawana et al, 1979
				Exch.			559	2000	151		
		3	0-20	Total			3719	6489	6229		
				Exch.			209	1018	132		
		5	0-20	Total			5506	3320	8025		
				Exch.			262	656	88		
		7	0-20	Total			5794	3239	8257		
				Exch.			187	331	38		
		9	0-20	Total			2200	1933	3731		
				Exch.			127	211	31		
		12	0-20	Total			4915	3057	5772		
				Exch.			263	610	65		
		22	0-20	Total			5004	3112	5901		
				Exch.			155	690	40		

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
S.W. Western Australia	E. diversicolor	36	0-90	Total	7439	1718	6214	10224	5346	S 2906	Mingston et al, 1979
				extract.		842	471	3827	1027	S 260	
										Na 179	
	E. diversicolor	all	0-90	Total	4442	5351	58314	11754	10680	S 2826	
	E. calophylla			extract.		4195	382	3783	1224	S 377	
										Na 275	
Maroondah, Victoria, Australia	Eucalyptus regnans	38	0-100	Total	17278	3295					Feller, 1980
				extract.		260	825	1031	347	Na 536	unpublished data
	Eucalyptus-obliqua E. dives	38	0-100	Total extract.	13443	1704 855	1541	1582	2104	Na 685	
Stradbroke Is. Queensland, Australia	Eucalyptus	7	0-14	Total N Others	3038	3	24	99	43	Na 74	Westman & Rogers 1977
			14-110	extract.	14865	15	141	214	262	828	
			110-191		14854	46	103	193	226	1170	
Kyoto, Japan	Fagus cren.				11472	31.6	399	275	22.1		Kawahara, 1971
England, U.K.	Fagus sylv.	45	0-70			42	254	365	249	Na 47	Ovington, 1958
Germany	Fagus sylv.									Org.Mat.	Ulrich in Cole &
		80	root-zone		9452	2310	550	280	45	212000	& Rapp, 1980
		122			7340	2870	387	268	40	190000	
Solling, W. Germany	Fagus sylv.	125	0-10	Total	2530	645	17300	2200	1700		Ulrich et al. 1974
			10-20		1450	535	20200	1600	2300		Ulrich et al. 1979
			20-30		1310	580	n.d.	n.d.	n.d.		
			30-40		1200	590	23400	2500	4000		
			40-50		840	520	23700	2200	4300		
			0-10	Exch.			87	109	10.3		
			10-20				69	51	5.2		
			20-30				88	48	4.9		
			30-40				91	43	4.7		
			40-50				118	36	5.1		
Sweden	Fagus sylv.	45-130	Root-zone		7800	38	56	175	84	Org.Mat. 207000	Nihlgard in Cole & Rapp, 1980
New Hamp. USA	Hardwood			Total	3600						Bormann et al, 1977
England, U.K.	Larix dec.	45	0-70			463	223	404	254	Na 64	Ovington, 1958
England, U.K.	Larix eur.	20	0-60			4	154	360	204	Na 77	Ovington, 1958

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
England, U.K.	Larix lep.	21	0-70			329	115	17720	296	Na 158	Ovington, 1958
Montana, USA	Larix, Pseudotsuga		0-50	Total	11420	16210	200000	52400	53300	Cu 280 Fe 300000 Mn 11500 Na 66800 Zn 2630	Stark 1979
				Exch.		11440	1700	8570	890	Cu 28 Fe 300 Mn 440 Na 150 Zn 9	
Tennessee, USA	Liriodendron	50	Root-zone		7650.0	2840.0	38960.0	8130.0		Org.Mat 159000	Harris in Cole & Rapp, 1980
Tennessee, USA	Liriodendron, Carya, Quercus	30-80	Root-zone		7300.0	1400.0	36000.0	6300.0	8700	Org Mat 189000	Harris in Cole & Rapp, 1980
Japan	Lower slope Upper slope			Total Total	8560 2720		430 116	1140 34	391 11		Katagiri & Tsutsumi, 1976
Japan	Mixed		0-70		6762	13.5	203	30.3	57.2		Katagiri et al. 1978
Kyoto, Japan	Mixed broad Chamaecyparis		0-70 0-70	Total Total	3701 2143	531 300	5779 2640	258 194	3842 2165		Iwatsubo, 1976
Great Britain	Mixed decid.	80	Root-zone			1512.0	1543.0	1766.4	81.5	Org.Mat. 138000	Satchell in Cole & Rapp, 1980
Tennessee, USA	Mixed hardwood		0-45	Total Exch.	3380 4	1340 33	52000 260	8800 960			West et al. 1981 (prelimin. data)
England, U.K.	Nothofagus	20	0-60			3	156	344	278	Na 106	Ovington, 1958
England, U.K.	Open (3)		0-60			3	200	420	214	Na 66	Ovington, 1958
Minnesota, USA	Picea	40	0-10 10-36	Total N Exch. K Total Ca	1608 934 3744		104 195 630	1451 1357 5016			Alban et al., 1978
Minnesota, USA	Picea	41	0-10 10-25	Total N Exch. cations	1257 640	20 50	68 72	1014 598	109 101		Perala & Alban 1979
			25-36 36-61		236 497	26 43	48 131	300 1145	51 200		

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
Sweden	Picea	59	A	Total	800	41					Tamm, 1969
			B		1200+	250+					
		53	A		470	63					
			B		5700	1300					
Sweden	Pinus	76	A		530	2					Tamm, 1969
			B		520	500					
Nova Scotia,	Picea abies	All	0-30	Total	3860	1220	13300	5460	1740		Freedman et al. 1981
				Exch.	NH4-35	105	61	77	30		
					NO3-10						
England, U.K.	Picea abies	20	0-60			5	147	293	227	Na 68	Ovington, 1958
England, U.K.	Picea abies	45	0-70			210	236	466	314	Na 78	Ovington, 1958
Sweden	Picea abies	60	Root-zone		6900.0	146.0	65.0	150.0	31.0	Org.Mat. 207000	Nihlgard, 1972
Solling, W. Germany	Picea abies	85	0-10	N,P Total	2400	560	103	100	11.5		Ulrich et al., 1974, 1979
			10-20	K,Ca,Mg	1570	500	96	51	6.6		
			20-30	Exch.	1100	495	46	35	3.8		
			30-40		940	530	60	24	3.3		
			40-50		860	505	67	45	5.1		
Sweden	Picea abies	65-132	0-5		491	270	5800	3300	900	Na 3600 Mn 99	Nykvist 1977
			5-10		382	305	5700	4300	1000	Na 3500 Mn 104	
			10-15		354	303	4900	3300	800	Na 2000 Mn 102	
			15-20		325	353	5700	3600	900	Na 3400 Mn 93	
			20-25		360	412	5700	2900	900	Na 2700 Mn 99	
			25-30		389	393	7700	4800	1500	Na 4300 Mn 127	
			30-40		504	778	13900	8300	2400	Na 7900 Mn 228	
			40-50		424	750	14500	9800	3100	Na 9800 Mn 235	
Germany	Picea abies		Root-zone							Org.Mat.	Ulrich in Cole & Rapp, 1980
		34			6650.0	2660.0	340.0	170.0	36.0	190000	
		87			7100.0	2630.0	546.0	283.0	35.0	190000	
		115			7060.0	1530.0	342.0	160.0	38.0	251000	

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
Alaska, USA	Picea mariana									Org. Mat.	Van Cleve in
		51	Root-zone		2689.0	2.0	124.0	1691.0	853.8	3951.0	Cole & Rapp, 1980
		55			2198.0	5.4	169.0	609.0	121.0	35350.0	
		130			2362.0	4.4	286.0	5052.0	912.0	47490.0	
Quebec, Canada	Picea mariana	65	0-35	Total	296						Weetman & Webber 1972
	Picea rub.		0-35		559						
England, U.K.	Picea omo.	20	0-60			3	144	282	216	109	Ovington, 1958
Sweden	Picea on sphagnum	60	root depth		8600	220	140	5800			Holmen, 1964
New Mexico, USA	Picea, Abies	300	0-20	Total	4060	1.4	106	407	33		Calculated from
			20-40	Total	2058	0.6	57	118	7		Vitousek et al. 1982
				NH4	4.1						
				NO3	0.1						
N. Carolina, USA	Picea, Abies	40-60	A1-B2	Avail.		9	80	81	30		Weaver, 1975
Minnesota, USA	Pinus banks.	41	0-10	Total N	1382	26	99	1497	138		Perala & Alban 1979
			10-25	Exch.cations	666	46	107	977	131		
			25-36		270	20	70	459	69		
			36-61		558	39	161	1195	192		
Minnesota, USA	Pinus banks.	40	0-10	Total N	1502		94	2080			Alban et al., 1978
			10-36	Exch. K	810		187	1722			
				Total Ca	3314		477	4840			
Minnesota, USA	Pinus banks.		Shallow	Total	3194	23	126	317	56		Green & Grigal, 1979
			Deep		5554	495	500	1727	289		(From White & Harvey 1979)
Ontario, Canada	Pinus banks.	65	to Bf2	Avail	2920	2152	80637	34406	21075		Morrison &
			Total		15	6	539	172	37		Foster, 1979
Prince George, B.C. Canada	Pinus con.	110-125	Org.Horizons	Total	352	39	42	76	18		Kimmins, 1974
				Exch.			42	57	12		
			Min.Horizons								
			-To sampled depth								
				Total	2073	4418	3532	3068	12387		
				Exch.			179	525	56		
			-In root zone								
				Total	1299	2309	1867	1235	4997		
				Exch.			81	222	22		
			-In top 30cm (zone of max. rooting)								
				Total	917	1498	955	496	43		
				Exch.			43	104	10		
			Total sampled depth								
				Total	2424	4457	3574	3144	12405	1t4	Exch.
							221	582	68		
			Total in rooting zone								
				Total	1651	2348	1909	1311	5015		
				Exch.			123	279	34		

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
			Total in zone of max. rooting								
				Total	1269	1498	997	572	1977		
				Exch.			85	161	22		
Kyoto, Japan	Pinus densi.				5056	8.4	206	180	13.8		Kawahara, 1971
Japan	Pinus densi.			N Total Others HCL	588	16.1	126	205	82.1	Na 47.1	Nishimura, 1973
Indiana, USA	Pinus echin.	33	0-15	Total	1112	14	95	953	133		Calculated from Vitousek et al. 1982
				NH4	1.6						
				NO3	0.5						
			15-30	Total	684						
				NH4	2.7						
				NO3							
			0.3								
			30-70	Total	1359	4	706	3442	1087		
				NH4	6.3						
				NO3	0.2						
Tennessee, USA	Pinus echinata	30	Root-zone		4100.0	1200.0	38000.0	3600.0	10900.0	Org.Mat. 116000	Harris in Cole & Rapp, 1980
England, U.K.	Pinus nigra	20	0-60			3	242	770	437	Na 120	Ovington, 1958
England, U.K.	Pinus nigra	45	0-70			59	359	473	269	Na 79	Ovington, 1958
England, UK	Pinus nigra	21	0-70			314	66	22865	182	Na 127	Ovington, 1958
Scotland	Pinus nigra	40	105	Total	701						Miller, Miller & Pauline 1976
New Zealand	Pinus on Pumice soil		0-15	Truog P		22.4	291	259	50		Knight & Will 1970
			15-45	Exch.others		4.5	725	167	17		
			47-75			7.8	933	131	19		
			75-135			10.1	1236	306	9		
			135-165			5.6	781	613	62		
			165-200			3.4	202	1584	192		
			Total			53.8	4169	3060	348		
Sweden	Pinus on sphagnum	44	root depth		1000	60	60	300			Holmen, 1964
New Mexico, USA	Pinus pond.	200	0-10	Total	790	2.1	231	1028	95		Calculated from Vitousek et al. 1982
				NH4	2.1						
				NO3	0.1						
			10-20	Total	568	1.1	133	841	95		
				NH4	1.1						
				NO3	<.1						
			20-40	Total	394	0.8	77	947	166		
				NH4	0.8						
				NO3	0.2						

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
New Zealand	Pinus rad.	10	100	Total(HCl)		1042	2240	2016			Will, 1966
				Avail.		414	1232	549			
New Zealand	Pinus rad. -lupins	4	0-100	Total	1143						Gadgil, 1976
	Pinus rad. +lupins	4	0-100	Total	1197						
New England, USA	Pinus res.	50	0-15	Total	2488	1.1	37	57	11		Calculated from Vitousek et al. 1982
				NH4	1.3						
				NO3	0.2						
			15-30	Total	1074	0.6	47	24	14		
				NH4	3.8						
				NO3	0.1						
			30-70	Total	1487	0.7	145	74	45		
				NH4	3.0						
				NO3	0.4						
Minnesota, USA	Pinus res.	40	0-10	Total N	1894		112	2187			Alban et al. 1978
			10-36	Exch. K	856		191	1716			
				Total Ca	3736		600	4942			
Minnesota, USA	Pinus res.	41	0-10	Total N	1117	23	87	1387	112		Perala & Alban 1979
			10-25	Exch.cations	611	50	80	830	91		
			25-36		242	25	51	350	53		
			36-61		471	48	114	867	139		
N. Carolina, USA	Pinus strob.	14	30	Total			153-260	627-1231	160-505		Yount, 1975
	Mixed dec.		30				135-241	170- 499	130-273		
England, U.K.	Pinus sylv.	45	0-70			107	249	473	299	Na 57	Ovington, 1958
Central Sweden	Pinus sylv.	120-150	0-20	Total N	780	-	46	91	18	Na 8.3	Bringmark, 1977
Finland	Pinus sylv.	28	Humus		1.0	3.0	20.0	45.0			Malkonen, 1974
			0-10		3.0	9.0	32.0	42.0			
			10-20		3.0	6.0	18.0	44.0			
			20-30		4.0	6.0	16.0	36.0			
			Total		11.0	24.0	86.0	167.0			
		45	Humus		1.0	5.0	31.0	91.0			
			0-10		5.0	9.0	37.0	113.0			
			10-20		5.0	3.0	26.0	60.0			
			20-30		7.0	2.0	17.0	44.0			
			Total		18.0	19.0	111.0	308.0			
		48	Humus		1.0	4.0	28.0	48.0			
			0-10		5.0	7.0	30.0	33.0			
			10-20		4.0	7.0	14.0	19.0			
			20-30		5.0	3.0	12.0	19.0			
			Total		15.0	21.0	84.0	119.0			

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
N. Carolina, USA	Pinus taeda	16	0-70		1753	371	404				Wells et al., 1975
New Mexico, USA	Populus tremuloides	60	0-10	Total	1414	1.3	207	365	28		Calculated from Vitousek et al. 1982
				NH4	7.3						
				NO3	0.1						
			10-20	Total	977	1.1	289	423	49		
				NH4	3.2						
				NO3	0.1						
			20-60	Total	5491	11.5	584	1187	240		
				NH4	12.0						
				NO3	0.5						
Minnesota, USA	Populus	40	0-10	Total N	1313		102	1195			Alban et al., 1978
			10-36	Exch. K, Total Ca	745 3197		192 748	1448 4821			
Minnesota, USA	Populus	49	0-10	Total N	1093	24	87	854	100		Perala & Alban 1979
			10-25	Exch.cations	600	42	78	693	95		
			25-36		247	23	49	387	51		
			36-61		529	51	116	1014	148		
Oregon, USA	Pseudostuga menziesii	450	Root-zone		4560.0	34.0	660.0	2040.0	560.0	Org.Mat. 120000	Grier in Cole & Rapp, 1980
Washington, USA	Pseudostuga menziesii	42	Root-zone		2476.0		209.5	661.0	97.8		Turner in Cole & Rapp, 1980
Washington, USA	Pseudostuga menziesii (plantation)	9	Soil Extract. Exch.	Total N P Ca Mg K	2907	141	286	837	100		Turner 1975
	Pseudostuga menziesii	22	Soil Extract. Exch.	Total N P Ca Mg K	2809	141	741	109	234		
	Pseudostuga menziesii	30	Soil Extract. Exch.	Total N P Ca Mg K	2809	141	234	741	109		
	Pseudostuga menziesii (plantation)	30	Soil Extract. Exch.	Total N P Ca Mg K	2907	141	286	837	100		
	Pseudostuga menziesii	42	Soil Extract. Exch.	Total N P Ca Mg K	2809	141	234	741	109		
	Pseudostuga menziesii	49	Soil Extract. Exch.	Total N P Ca Mg K	2907	141	286	837	100		
	Pseudostuga menziesii	73	Soil Extract. Exch.	Total N P Ca Mg K	2809	141	234	741	109		
	Pseudostuga menziesii	95	Soil Extract. Exch.	Total N P Ca Mg K	2809	141	234	741	109		

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
Oregon, USA	Pseudostuga menziesii	95	Soil	Total N Extract.P Exch.Ca Mg K	10000	160	1500	6000	900		Grier (unpubl.) cited in Cole et al.
	Pseudostuga menziesii	130	Soil	Total N Extract.P Exch.Ca Mg K	8000	20	1000	2400	420		
Washington, USA	Pseudotsuga	23	0-50	Total N Exch. cations Walkley-Black C	4650		103	241	40	C 77,140	Calculated from Binkley, 1982
England, U.K.	Pseudotsuga	20	0-60			4	199	475	270	101	Ovington, 1958
Washington, USA	Pseudotsuga	36	0-15		809	1167	79	313			Cole et al, 1967
			15-30		868	1195	66	196			
			30-45		761	980	52	152			
			45-60		371	536	37	80			
				Total	2809	3878	234	741			
		42	0-15		860	1230	83	400	32		Grier & Cole, 1972
			15-30		820	1110	66	210	33		
			30-45		710	1040	53	100	27		
			45-60		400	520	42	110	15		
				Total	2790	3900	244	820	107		
Oregon, USA	Pseudotsuga	450	0-15	Total	780					C 23600	Binkley et al. 1982
			15-30		600					C 12000	
	Ceanothus,	4	0-15		710					C 18800	
	Pseudotsuga		15-30		540					C 10800	
	Ceanothus,	12	0-15		1060					C 28100	
	Pseudotsuga		15-30		820					C 21800	
	Pseudotsuga	450	0-15		790					C 20800	
			15-30		700					C 13900	
	Ceanothus,	12	0-15		1230					C 38600	
	Pseudotsuga		15-30		830					C 17800	
	Pseudotsuga	31	0-15		1330					C 41600	
			15-30		990					C 23300	
B.C., Canada	Pseudotsuga	23	0-50	Total N Bray P Exch. K Walkley-Black C	1560	24	140	465	63	C 34,050	Calculated from Binkley, 1982
B.C., Canada	Pseudotsuga	14	0-15	Total N Exch. cations	630	38	430	38			Binkley & Husted, 1983
England, U.K.	Pseudotsuga	45	0-70			50	253	534	285	107	Ovington, 1958

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga	300	0-15	Total	2411	7.7	99	787	168		Calculated from Vitousek et al. 1982
				NH4	2.8						
				NO3	0.1						
			15-30	Total	1999	4.8	46	517	113		
			30-70	Total	2376	6.5	6.0	891	178		
Washington, USA	Pseudotsuga	45	0-15	Total	973	2.7	34	212	8		Calculated from Vitousek et al. 1982
				NH4	2.4						
				NO3	0.2						
			15-30	Total	336	1.0	14	37	3		
			30-70	Total	131	1.6	10	26	3		
Washington, USA	Pseudotsuga	32-59	Profile	Total N	1360-15400						Turner et al. 1979
B.C., Canada	Pseudotsuga	Various	0-60	Total N	1660		350	2580	900		Klinka et al. 1981
			0-60	Extr. P. Exch.cations	2390	17	165				
			0-75		2248	71	270				
			0-90		1770						
			0-60		8050		112	1780	500		
			0-80		2080	117	380				
			0-65		1090	43	180				
			0-50		2980		465				
			0-75		3860	135	650				
			0-25		6900		7				
							240	1300	240		
			0-70		4880	25	430				
Washington, USA	Pseudotsuga		0-71		9930						Heilman, 1979
Washington, USA	Pseudotsuga		0-76	Total	2340						Heilman, 1979
England, UK	Pseudotsuga	21	0-70			204	87	6240	250	Na 105	Ovington, 1958
New Mexico, USA	Pseudotsuga, Abies	200	0-10	Total	504	9.6	175	1008	60		Calculated from Vitousek et al. 1982
				NH4	3.9						
			10-40	Total	1728	14.9	421	1080	104		
				NH4	7.6						
				NO3	0.2						
			40-60	Total	721	14.1	141	1261	65		
				NH4	3.9						
				NO3	0.2						
B.C., Canada	Pseudotsuga, Alnus rubra	23	0-50	Total N Bray P Exch. cations Walkley-Black C	2376	27	181	1020	122	C 50,880	Binkley, 1983

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
B.C., Canada	Pseudotsuga, Alnus sinuata	23	0-50	Total N Bray P Exch. cations Walkley-Black C	1900	33	182	822	126	C 41,080	Binkley et al. 1984
England, U.K.	Quercus	45	0-70			54	213	343	254	47	Ovington, 1958
Indiana, USA	Quercus	81	0-15	Total NH4 NO3	1762 2.9 0.5	71	159	217	49		Calculated from Vitousek et al. 1982
			15-30	Total 890 NH4 NH3	77 9.3 0.9	416	214	64			
			30-70	Total NH4 NO3	3121 26.2 1.2	184	25	1997	749		
Korea	Quercus acutissima	12	0-35	Total N Exch. P+K	4560	46	1720				Mun et al. 1977
Belgium	Quercus	115-160	Root-zone		13800	2100	767	13865	1007	Org.Mat. 300000	Duvigneud-Denaeyer in Cole & Rapp, 1980
	Quercus-mixed	80			4480	920	157	13600	151	220000	
England, U.K.	Quercus pet.	20	0-60			3	141	269	192	54	Ovington, 1958
England, U.K.	Quercus rob.	45	0-70			36	329	424	301	70	Ovington, 1958
England, U.K.	Quercus rub.	20	0-60			4	110	238	156	52	Ovington, 1958
New England, USA	Quercus, Acer rubrum	55	0-15	Total NH4 NO3	3319 1.6 0.2	1.6	45	92	14		Calculated from Vitousek et al. 1982
			15-30	Total NH4 NO3	1332 4.7 0.1	0.7	43	44	13		
			30-70	Total NH4 NO3	1725 3.8 0.3	1.0	135	69	41		
New England, USA	Quercus, Pinus	65	0-15	Total NH4 NO3	676 0.3 0.1	0.8	53	27	16		Calculated from Vitousek et al. 1982
			15-30	Total NH4 NO3	312 1.7 0.3	0.3	61	31	19		
			30-70	Total NH4 NO3	1490 4.5 0.5	0.5	194	99	60		

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg.	Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
Tennessee, USA	Quercus, Carya	30-80	Root-zone		4700	1200	38000	3600	10900	Org.Mat 116000	Harris in Cole & Rapp, 1980
England, U.K.	Thuji plicata	20	0-60			3	150	258	191	63	Ovington, 1958
Oregon, USA	Tsuga heterophylla Picea sitchensis	30	Soil	Total N Extract.P Exch.Ca Mg K	32900	70	675	1600	1900		Grier (unpubl.) cited in Cole et al.
	Tsuga Heterophylla Picea sitchensis	121	Soil	Total N Extract.P Exch.Ca Mg K	34900	100	720	1600	1900		
Oregon, USA	Tsuga mertensiana	130	Soil	Total N Extract.P Exch.Ca Mg K	5200	18	220	280	70		Grier (unpubl.) cited in Cole et al.
Japan	Tsuga sieboldii	120-443	Root-zone		2732.0	1.3	62.0	49.0	21.0		Ando in Cole & Rapp, 1980
Oregon, USA	Tsuga heter.	120	0-15	Total	8754	57.7	423	746	822		Calculated from Vitousek et al. 1982
				NH4	8.1						
				NO3	3.1						
			15-30	Total	7554	27.2	79	262	218		
			30-70	Total	17929	0.4	125	448			
								384			
England, U.K.	Tsuga heter.	20	0-60			4	105	279	177	78	Ovington, 1958
Washington, USA	Tsuga heter.		0-122		9160						Heilman, 1979
Washington, USA	Tsuga heter.		0-152		14380						Heilman, 1979
B.C., Canada	Tsuga, Pseudotsuga	Various	0-80	Total N Exch. cations Extract P.	6630	95	350	6550	390		Klinka et al. 1981
			0-70		4570	18	87	500	40		
			0-65		4650	16	150	330	25		
			0-60		5700		1400	3690	1730		
			0-35		9380		760	4520	2052		
			0-75		3030		590	2100	220		
			0-75		3300			1800	425		
			0-60		4700		310	4025	1030		
			0-95		11100	14	520	7120	1590		
			0-90		6900	21	200	1920	60		

Table 6 Forest Soil Nutrient Content

Location	Dominant Veg. Age	Depth (cm)	Method	Content kg/ha N	P	K	Ca	Mg	Other	Reference
England, U.K.	Unplanted	0-70			414	152	8560	163	91	Ovington, 1958
Japan	Varied	0-70	Exch.							Tsutsumi et al 1978
	lower slope			8670	27.9	236.2	1933	447		
	mid			7480	34.3	237.7	552	216.9		
	upper			5870	258.2	258.6	518	111.7		

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Kochi, Japan	Abies		Total	6339	45.1	2.78	20.86	46.99	7.03		Ando et al. 1977
New York, USA	Abies bals.	25	Leaves	2900	34.4	2.5	3.3	30.9	4.4		Chandler, 1943
Japan	Abies firma	97-145	Overstorey	5376	31.6	1.9	11.4	37.0	4.7		Ando in Cole & Rapp, 1980
New England, USA	Abies, Betula	75	Total	4020	62						Vitousek et al. 1982
USSR	Abies, Quercus		Total ash	287							Utenkova, 1962'
			Herb. ash	36							
	Abies		Total	120							Utenkova, 1962'
			Herb. ash	48							
Washington, USA	Abies, Tsuga	200	Total	2180	12						Vitousek et al. 1982
New York, USA	Acer sac. & mix	30-70	Leaves	2900	15.2	3.0	12.6	45.8	5.8		Chandler, 1941
Montreal, Canada	Acer sac.		Leaves	3400							Coldwell & de Long, 1950'
New York, USA	Acer sac. & others	30-70	Leaves	3300	16.9	3.45	9.4	73.6	11.7		Chandler, 1943
Conn., USA	Acer sac. & mix		Total	2100							Scott, 1955
N.Hampshire, USA	Acer, Betula, Fagus	110	Overstory	5860	54.2	4.0	18.3	40.7	5.9		Whittaker in Cole & Rapp, 1980
New England, USA	Acer, Fagus, Betula	66	Total	4780	64						Vitousek et al. 1982
Indiana, USA	Acer, Fagus, Quercus	95	Total	5230	48						Vitousek et al. 1982
										Mn Fe Zn	
N. Hampshire	Acer, Fagus, Betula	uneven	Total	5702	54.2	4.0	18.3	40.7	5.9	10.3 .4 .6	Gosz et al. 1972
			Branches	1193	10.4	.9	1.7	11.1	.9	1.2 .1 .1	
			Limbs	74	.1	0.0	0.0	0.1	0.1	0.0 0.0 0.0	
			Trunks	805	.6	.0	.3	.9	.1	0.1 0.0 0.0	
			Bark	97	.7	.0	.1	.7	.0	0.1 0.0 0.0	
			Hard. fol.	2692						7.8 0.2 0.4	
			+Con. fol.	108	29.9	1.9	12.6	23.3	3.8		
			Bud scales	85	1.2	.1	.2	.7	.1	0.1 0.0 0.0	
			Flowers	23	.8	.0	.0	.1	.0	0.0 0.0 0.0	
			Fruit	165	2.8	.3	1.4	.8	.2	0.1 0.0 0.0	
			Frass	180	2.5	.1	1.0	.9	.2	0.2 0.0 0.0	
			Misc.	166	3.7	.3	.4	1.1	.1	0.2 0.1 0.0	
			Shrubs	66	.6	.3	.3	.7	.2	0.2 0.0 0.0	
			Herbacisus	48	9.0	.1	.3	.3	.3	0.3 0.0 0.0	

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Toronto, Canada	Acer, Quercus	60-200	Total	4300							Bray & Gorham, 1964
			Leaves	3100							
			Stem,bark	1300							
			Ash	361							
B.C., Canada	Alnus rubra	23	Non-woody	5710	132	5.3	16	51	10		Binkley, 1983
	Pseudotsuga		Woody	675	5	0.1	0.3	3	0.3		
Washington, USA	Alnus rubra	40	Total	4900	90						Vitousek et al. 1982
B.C., Canada	Alnus rubra	18	total	7740	168	12	18	102	21		Binkley et al. 1982
	Pseudotsuga										
Washington,	Alnus rubra	30	Overstory	3700	87.0	6.2	39.0	67.0	10.0		Turner, 1975
Korea	Alnus sibirica	12	Total	5120	89.0	8.9	59.0				Mun et al. 1977
B.C., Canada	Alnus sinuata	23	Non-woody	3840	112	6.1	15	37	12		Binkley et al. 1984
	Pseudotsuga		Woody	1370	9	0.4	0.6	7	0.6		
Juneau, Alaska	Alnus, Sal.	12-30	Total	2533							Hurd, 1971
			Non-wood	1827							
Kunadacs, Hungary	Betula	30	Total	3600							
Vesijako, Finland	Betula	91	Total	1800							Viro, 1955'
			Leaves	1300							
			Other	500							
Veldre, Norway	Betula	52	Total	1900							Mork, 1942'
			Leaves	1300							
			Other	600							
Finland	Betula		Total	1900							Aaltonen, 1948'
Japan	Betula lat.		Leaves	1600							Ohmasa and Mori, 1937'
N. Carolina, USA	Betula lutea	50	Boles & Branc	440	.06	.3	2.2	1.1			Weaver, 1972
			Twigs & Bark	415	.23	1.1	2.7	.6			
			Reproductive	213	.18	.6	.8	.5			
			Decid. Fol.	2883	2.96	12.8	35.7	16.4			
			Everg. Fol.	523	.52	1.8	3.2	1.6			

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
N. Carolina, USA	Betula lutea	100+	Boles & Branc	1070	.17	.8	5.3	2.4			Weaver, 1972
			Twigs & Bark	1096	.60	3.8	9.6	2.9			
			Reproductive	260	.49	.7	2.0	4.8			
			Decid. Fol.	3188	2.38	12.7	47.7	18.4			
			Everg. Fol.	0							
Alaska, USA	Betula papyrif.	50	Overstorey	2650	18.0	5.0	8.3	34.5	9.2		Van Cleve in Cole & Rapp, 1980
Holme Fen, UK	Betula verruc.		Total								Ovington, 1963
			Leaves	3431							
			Seeds	283							
Dalarna, Sweden	Betula pub.		Leaves	1700							Sjors, 1954'
Japan	Broadleaf -mixed		Foliage								Iwatsubo 1976
			-broad	2360	22.21	.75	21.55	24.29	3.16		
			-conifer	1451	7.25	.33	6.18	10.16	1.43		
			Branch & bark	281	1.47	.06	.28	1.24	.14		
			Misc.	1043	9.28	.70	6.60	5.89	1.20		
			Total	5135	40.21	1.84	34.63	41.58	5.93		
Japan	Camptotheca		Total	6100	65.0	11.0	80.0	75.0	53.0		Kawahara et al. 1968
S.E. England	Castanea		Total	3566							Anderson, 1973
			Leaf	3306							
			Twigs	257							
			Other	273							
Japan	Castanea cren.		Leaves	1900							Ohmasa and Mori, 1937'
Hino, Japan	Chamae.	40	Total	2514	15.17	.73	3.56	22.29	2.72		Kawahara, 1971
			Leaf	1965	12.68	.61	3.16	20.17	2.52		
			Branch	278							
			Bark	74	2.49	.12	.40	2.12	.20		
			Other	197							
	Chamae.	40	Total	5427	33.80	1.97	10.64	46.41	6.06		
			Leaf	4064	29.94	1.76	7.82	42.50	5.48		
			Branch	624							
			Bark	141	3.86	.21	2.82	3.91	.58		
			Other	598							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Japan	Chamae. obt.		Leaves	1800							Ohmasa and Mori, 1937[1]
Nagano, Japan	Conifer -subalpine		Needles								Terada et al. 1972
			-conifer(C)	2061	9.3	1.16	2.58	19.64			
			-broad(B)	373	4.0	.22	.67	2.88			
			Branches-(C)	964	2.0	.31	.16	5.84			
			-(B)	92	.3	.04	.08	.40			
			Bark -(C)	105	.3	.03	.03	.39			
			-(B)	13	.06	.01	.01	.05			
			Reprod'tive(C)	110	.8	.13	.14	.17			
			-(B)	35	.3	.05	.10	.09			
			Bud Scales	28	.2	.02	.04	.10			
			Lichen, Moss	51	.4	.03	.06	.06			
			Sasa litter	3	.01	.00	.01	.01			
			Unid'd	290	.2	.06	.13	.77			
			Total	4252	18.8	2.17	4.18	31.36			
Japan	Crypto. jap		Leaves	3800							Ohmasa and Mori, 1937[1]
Kyoto, Japan	Decid, mix		Total	3485	35.31	3.48	11.55	39.87	11.08		Katagiri & Tsutsumi, 1973
			Leaves	2863	28.54	2.82	9.45	33.24	10.19		-avg. 6 sites
			Branches	243							
			Flowers	195	6.77	.66	2.10	6.55	0.86		
			Other	184							
	Decid, mix		Total	3415	44.88	3.17	10.82	33.27	8.12		Katagiri & Tsutsumi, 1973
			Leaves	2844	38.2	2.73	9.53	28.27	7.51		-avg. 5 sites
			Branhes	314							
			Flowers	44	6.67	.43	1.29	5.00	.61		
			Other	214							
Stradbroke Is. Qld., Australia	Eucalyptus	?	Total	6426	39.6	2.1	6.0	36.4	11.2	Na 7.7	Rogers and Westman 1977
Maroondah, Victoria, Australia	Eucalyptus regnans	38	Overstory	9810	34.8	2.2	11.7	36.1	8.6	Na 8.4	Feller (unpublished data)
			Understory	2330	14.7	0.8	5.4	18.1	3.0	Na 1.9	
	E. obliqua-E. dives	38	Overstory	6557	25.4	1.4	8.9	26.7	8.6	Na 7.6	
			Understory	201	1.2	0.1	0.7	0.5	0.3	Na 0.2	
Minnesota, USA	Fagus	?	Total		40	10	10	82			Bakuzis, 1971

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Sweden	Fagus	90	Leaves	3010	36.1	2.71	7.95	19.20	3.29		Nilsson, 1978
			Other	1410	13.8	1.09	3.54	4.77	.79		
			Total	4420	49.9	3.80	11.5	24.0	4.08		
S.E. England	Fagus		Total	4665							Anderson, 1973
			Leaf	3857							
			Twigs	231							
			Other	577							
Japan	Fagus cren.		Leaves	2800							Ohmasa and Mori, 1937[1]
Ashu, Japan	Fagus cren.		Total	4213	41.46	3.08	9.16	35.38	5.82		Kawahara, 1971
			Leaf	3487	39.94	2.97	8.93	33.38	5.71		
			Branch	582	1.52	.11	.23	2.00	.11		
			Other	144							
Ugod, Hungary	Fagus sylv.	25	Total	2500							Jaro, 1958[1]
As, Norway	Fagus sylv.	25	Total	3100							
Godollo, Hungary	Fagus sylv.	45	Total	3700							
Zurich, Switzerland	Fagus sylv.	60	Total	2800							Ehwald (data Liebundgut), 1957[1]
		120	Total	1700							
Germany	Fagus sylv.	80	Overstory	4046	54.3	4.3	17.5	17.8	1.6		Ulrich in Cole & Rapp, 1980
		122		5378	49.4	4.0	15.9	16.2	1.4		
				3700							
Brunlanes, Norway	Fagus sylv.	80	Total	2500							Bonnevie-Svendsen & Gjems, 1957[1]
Ugod, Hungary	Fagus sylv.	80	Total	3000							
Ugod, Hungary	Fagus sylv.	80	Total	3200							
Ugod, Hungary	Fagus sylv.	80	Total	4100							
Solling, W.Germany	Fagus sylv.	125	L		53.0	4.3	21.9	15.0	1.5	Al 0.5 Cl 0.8 Fe 1.96 Na 0.9 Mn 6.59 S 3.2	Ulrich & Mayer, 1972

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Solling, W. Germany	Fagus sylv.	125	Total	2980	49.40	4.0	16.0	16.2	1.45		Ulrich et al. 1974
Sweden	Fagus sylv.	45-130	Overstory	5690	69.0	5.0	14.4	31.7	4.3		Nihlgard 1972
Denmark	Fagus sylv.	5-200	Leaves	2600							Moller, 1945[1]
Germany	Fagus sylv.	21- 40	Total	3500							Danckelmann, 1887[1]
		41- 60	Total	4200							
		61- 80	Total	4600							
		81-100	Total	5000							
		100	Total	4500							
Bavaria, Germany	Fagus sylv.	30- 60	Total	3400							Ebermayer, 1876[1]
		60- 90	Total	3400							
		90	Total	3300							
Germany	Fagus sylv.	41- 60	Total	3500							Danckelmann, 1887[1]
		61- 80	Total	3900							
		81-100	Total	4200							
Thasandt, Germany	Fagus sylv.	50- 55	Total	4200							Ebermayer, 1876 (data of Krutzsch)[1]
			Total	3500							Ehwald, 1957[1] (data of Dietrich)[1]
			Total	2500							Ehwald, 1957[1]
			Total	3500							(data of Wiedemann)[1]
S. Sweden	Fagus sylv.		Total	5700							Andersson, 1970
			Leaves	3600							
UK	Fagus sylv.		Total	5800							Mason, 1970
			Leaves	3400							
Soro, Denmark	Fraxinus acel.	12	Leaves	2400							Boysen-Jensen, 1930[1]
USA	Hardwoods		Leaves	4221	45.89	2.92	10.8	33.9	13.7	S 5.93	Brinson et al. 1980
			Woody Twigs & branches	779	7.10	0.33	0.82	4.86	0.62	S 0.228	
			Bark	96	1.04	0.04	0.09	0.96	0.09	S 0.0460	
			Woodpecker	30	0.29	0.01	0.13	0.20	0.05	S 0.0241	
			Reproductive	1000	12.18	1.72	8.44	3.35	1.91	0.474	
			Epihytes 13	0.16	0.16	0.01	0.04	0.07	0.02	S 0.0125	
			Misc.	285	4.11	0.34	0.77	1.74	0.54	S 0.481	
			Total	6428	72.78	5.38	21.1	45.1	17.0	S 7.19	

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Norway (Grue)	Larix decid.	90	Total	2100							Bonnevie-Svendsen & Gjems, 1957[1]
N. Island, N. Zealand	Larix dec.	43	Total	3530	25.8	2.4	4.3	20.8	4.0		Will, 1958
			Needles	2076							
Tennessee,	Liriodendron	50	Overstorey	4290	31.3	2.8	19.0	77.7			Harris in Cole and Rapp, 1980
	Liriodendron, Carya, Quercus	30-80		4330	16.2	2.7	19.1	8.3			
S. Carolina, USA	Mix	1- 60	Total	5153							Metz, 1952
			Leaves	3657	20.99			40.04	9.25		
			Branches	1489							
	Mix	1- 40	Total	4434							
			Leaves	3402	26.27			45.87	9.71		
			Branches	1032							
	Mix	1- 60	Total	5727							
			Leaves	4101	28.49			33.79	12.03		
			Branches	1626							
	Mix, decid.	1- 45	Total	4834							Metz, 1952
			Leaves	3963	24.70			94.81	22.35		
			Branches	870							
	Mix, decid.	1-150	Total	5108							
			Leaves	4398	29.48			109.73	24.20		
			Branches	710							
	Mix, decid.	1- 50	Total	4536							
			Leaves	3917	31.19			80.88	17.04		
			Branches	618							
Japan	Mix broad Lower slope		Litterfall	4800	78.5	6.21	26.4	136	16.9		Katagiri & Tsutsumi, 1978
			Branchfall	2110	8.7	.69	2.5	23.7	1.2		
	Mix broad Upper slope		Litterfall	3190	32.2	1.65	8.6	52.5	6.3		
			Branchfall	900	3.6	.17	.9	8.0	.5		
Japan	Mix broad, upper slope		Leaves	2444	19.9	2.1	8.4	23.9	8.0		Katagiri & Tsutsumi, 1973
			Branches	189							
			Flowers	298							
			Others	173							
			Total	3104	25.4	2.7	11.1	29.6	8.7		
	mid slope		Leaves	2884	23.4	2.6	7.8	30.9	9.9		
			Branches	228							
			Flowers	165							
			Other	131							
			Total	3408	28.1	3.0	8.8	35.5	10.4		
	lower slope		Leaves	2796	37.8	3.3	11.1	40.0	11.6		
			Branches	289							
			Flowers	354							
			Other	246							
			Total	3685	51.0	4.6	15.2	51.2	13.2		

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Japan	Mix broad, lower slope		Litter	3250	43.9	3.2	13.4	53.6	9.1		Katagiri & Tsutsumi, 1976
			Lge branches	1280	6.6	.4	1.8	16.0	1.1		
	Mix broad, upper slope		Litter	3480	35.3	1.9	10.2	52.7	7.4		
			Lge branches	1540	7.0	.4	2.2	7.5	1.1		
Minamata, Japan	Mix, broad		Total	7523	72.48	2.79	16.35	72.63	13.81		Kawahara, 1971
			Leaf	3991	49.11	2.04	15.15	33.91	9.07		
			Branch	3165							
			Bark+Other	366	23.37	.75	3.20	38.72	4.74		
Lund, Sweden	Mix, decid.		Leaves	2800							Lindquist, 1938[1]
N. Carolina, USA	Mix, decid.		Total	4250	33.25	4.93	17.98	43.64	6.54		Cromack, 1973
			Leaves	2773	23.57	3.48	13.00	34.11	6.10		
			Stems	893	4.62	.77	.68	6.45	.10		
			Other	582		.70					
Belgium	Mixed decid.	80	Overstory		50.0	2.4	21.0	110.0	5.6	Org.Mat. 5287	Duvigneud-Denaeyer in Cole & Rapp, 1980
New Zealand	Nothofagus		Leaves	4142	27.84	1.89	6.78	41.06	7.63		Miller, 1963
			Twigs	1652	6.65	.39	.74	25.49	2.49		
			Total	5772							
Craigieburn, N. Zealand	Nothofagus sol.		Total	3700							Wardle, 1970
			Total	3100							
Wairarapa, N. Zealand	Nothofagus sol.		Total	5700							Bagnall, 1972
Solling, W. Germany	Picea abies	125	(-branches)	3390	40.7	3.6	7.6	14.0	1.29		Ulrich et al. 1974
Moscow, USSR	Picea abies	45-68	Total	6200							Ehwald, 1957
			Total	6900							
Thasant, Germany	Picea abies		Total	3800							Ehwald, 1957 (data of Zimmerle)[1]
Nodebo, Denmark	Picea abies		Leaves	1600							Bornebusch, 1937[1]

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Evo, Finland	Picea abies	68	Total	2800							Viro, 1955[1]
			Leaves	1900							
			Other	900							
Hyyfiala, Finland	Picea abies	78	Total	2200							Viro, 1955[1]
			Leaves	1700							
			Other	400							
Velikije Luki, USSR	Picea abies & herb		Total	4500							Ehwald, 1957 (data of Bykova)[1]
	Picea abies & herb		Total	3700							
New York, USA	Picea abies	24	Leaves	3900	36.9	3.2	14.1	70.1	8.2		Chandler, 1943
Germany	Picea abies	34	Overstorey		41.5	3.5	1.2	14.9	1.7	Org.Mat. 2924	Ulrich in Cole & Rapp, 1980
		87			47.1	4.0	12.7	17.0	1.9	3393	
		115			43.3	3.7	1.2	15.6	1.7	3076	
As, Norway	Picea abies	39	Total	3100							Mork, 1942[1]
			Leaves	2500							
			Other	600							
USSR	Picea abies	45	Overstorey		23.8	2.6	10.6	28.3	4.2	Org. Mat. 3700	Kazimrov and Morozova 1973
Erzgebirge, Germany	Picea abies	46	Total	4500							Krutzsch, 1896[1]
Eidsberg, Norway	Picea abies	50	Total	3200							Krutzsch, 1896
Sweden	Picea abies	60	Overstorey		58.0	4.8	10.7	19.8	3.1	Org. Mat. 5720	Nihlgard 1972
Brjansk, USSR	Picea abies & herb	70	Total	4900							Ehwald, 1957[1]
			Leaves	3300							
			Other	1600							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Grue, Norway	Picea abies	80	Total	2000							Krutzsch, 1986
Germany	Picea abies	21- 40	Total	3100							Danckelmann, 1887'
		41- 60	Total	3700							
		61- 80	Total	3800							
		81-100	Total	3600							
		100	Total	3400							
Ringsakes, Norway	Picea abies	30-40	Total	2000							Krutzsch, 1896
Brunlanes, Norway	Picea abies	45- 65	Total	4500							Krutzsch, 1896
Finland	Picea abies		Total	1600							Aaltonen (from Svinhuhood), 1948'
Bavaria, Germany	Picea abies	30	Total	4500							Ebermayer, 1876'
		30-60	Total	3400							
		60-90	Total	2900							
		90	Total	2800							
Velikiue Luki,	Picea abies, Betula	38-90	Total	2000							
			Leaves	1500							
			Other	500							
			Total	2700							
			Leaves	2100							
			Other	600							
										Org.Mat.	
Alaska, USA	Picea mariana	51	overstorey		1.1	1.4	.03	.11	.09	143	Van Cleve in
		55			1.6	.12	.26	4.0	.17	290	Cole & Rapp, 1980
		130			3.6	.4	.7	4.1	.3	534.3	
New York, USA	Picea rubens	150	Leaves	1900	16.0	1.8	6.2	14.1	3.5		Chandler, 1944
N. Wales, UK	Picea sit.	30	Foliage	2100	24.4	5.19	5.87	8.24			Owen, 1954
Vologda, USSR	Picea uliginosa	100-	Needles	555	4.22	.61	1.83	10.65	.55		P'yavchenko, 1960
		150	Leaves	930	8.93	.96	1.02	21.48	3.81		
			Woody	1140	2.74	.51	1.25	2.96	.68		
			Total	4638	35.10	5.74	19.67	62.22	12.67		
		70-	Needles	552	1.99	.30	.94	5.52	1.10		
		200	Woody	406	.61	.29	.57	.69	.26		
			Total	1158	3.41	.73	1.82	8.09	1.48		

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
New Mexico, USA	Picea, Abies	300	Total	1106	5.6						Vitousek et al. 1982
N. Carolina, USA	Picea, Abies	50	Boles & Branc.	510	.09	.3	2.5	1.7			Weaver, 1972
			Twigs & Bark	1033	.53	2.3	4.1	1.6			
			Reproductive	1071	1.17	3.6	2.6	1.7			
			Decid. Fol.	285	.33	1.0	3.0	1.4			
			Everg. Fol.	3115	2.55	8.5	17.5	7.1			
Minnesota, USA	Pinus	?	Total		35	4	5	19			Bakuzis, 1971
Cloquet, Minn. USA	Pinus	50	Leaf litter	2151	14.7	2.7	2.9	18.0			Alway & Zon, 1930
			Ash	55.8							
Australia	Pinus	37	Total	3500							Bohmerle, 1906[1]
Czechoslovakia	Pinus	94	Total	3600							Perina & Virtrova, 1958[1]
			Leaves	2200							
			Other	1400							
Cloquet, Minn. USA	Pinus	100	Leaf litter	2446	10.4	2.4	3.5	15.5			Alway & Zon, 1930
			Ash	51.3							
Cass Lake, Minn USA	Pinus	250	Leaf litter	2137	15.8	3.2	3.7	22.5			Alway & Zon, 1930
			Ash	73.4							
S. Carolina, USA	Pinus	20- 25	Total	6023							Metz, 1952
			Leaves	4798	16.15			22.09	7.56		
			Branches	1225							
		30- 40	Total	4398							
			Leaves	3149	14.17			18.57	5.98		
			Branches	1249							
		10	Total	4351							
			Leaves	4042	12.53			17.38	6.06		
			Branches	309							
Ontario, Canda	Pinus banks.	30	Trees	3729	20.52	1.20	4.88	13.31	1.73		Foster, 1974
			Herb	331	4.67	.40	2.19	1.66	.40		
Aomori, Japan	Pinus dens		Total	3262	15.58	1.68	3.97	19.98	2.82		Satoo, 1970
			Total	3902	18.22	1.76	4.29	24.81	5.51		
			Total	4434	26.37	1.80	6.87	29.26	1.79		
			Total	3860	18.65	1.86	5.51	29.57	2.86		
			Total	4493	26.57	1.78	7.31	34.16	1.99		

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass (kg/ha/yr)	N	P	K	Ca	Mg	Other	Reference
Japan	Pinus densi.		Leaves	2500							Ohmasa and Mori, 1937[1]
	Pinus thuss.		Leaves	3600							
Kashihata, Japan	Pinus densifl.	20	Total	7756	28.75	2.50	9.09	25.00	4.85		Kawahara, 1971
			Leaf	5193	27.64	1.88	8.81	23.52	3.45		
			Branch	1240							
			Bark	447	1.11	.62	.28	1.48	1.40		
			Other	876							
Indiana, USA	Pinus echinata	33	Total	4960	38						Vitousek et al, 1982
Tennessee,	Pinus echinata	30	Overstorey	4130	37.5	2.5	14.4	51.0	7.6		Harris in Cole & Rapp, 1980
Missouri, USA	Pinus echinata		Total	3800							Anonymous[1]
Minn., USA	Pinus hardwoods mix		Total	1139	25.5	2.3	5.7	28.5	4.2		Grigal & McColl, 1975
			Needles	470	5.5	.5	1.2	9.0	.9		
			Leaves	253	10.0	.9	2.8	12.4	2.6		
			Wood	258	6.3	.5	1.2	5.9	.7		
			Other	158	11.5	.9	2.1	4.7	.9		
Nevada, USA	Pinus jeffreyi		Total	2000	12.5	1.8	3.8	3.3	1.8	Cu .008 Fe .567 Mn .318 Na .399 Zn .035	Stark, 1973
Scotland	Pinus nigra	40	Total	2615	11.0	1.85	3.35	13.50	2.22	Na 1.08	Miller et al, 1976
			Needles	2133	9.2	1.72	3.08	12.20	2.00	.95	
			Branches	327	1.0	.07	.15	1.05	.15	.10	
			Cones	13	.8	.07	.12	.25	.07	.03	
			Other	142							
New Mexico, USA	Pinus ponderosa	200	Total	2320	6.4						Vitousek et al, 1982
SE Australia	Pinus rad.	30	Total	3788							Florence & Lamb, 1974
		30	Total	3690							
		30	Total	3657							
		30	Total	4137							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
North Island, N. Zealand	Pinus rad.	4-6	Total	4237	34.0	3.3	13.2	27.7	5.1		Will, 1959
		39	Total	7107	39.0	4.6	14.1	28.6	6.0		
			Needles	3334							
		26	Total	5982	37.0	4.5	14.5	20.3	5.0		
			Needles	4064							
	Pinus nigra	43	Total	7593	34.7	3.2	17.1	48.9	7.2		
			Needles	4925							
Victoria, Australia	Pinus radiata	15	Aboveground control	3475	22	1.6	8.6	20	5.9	Na 1.6 Cl 2.5	Cromer et al. 1984
			Irrigated waste water	3970	25	2.3	11.2	23	6.1	Na 2.2 Cl 2.6	
			Fertilized	3500	22	2.1	8.6	19	5.6	Na 1.6 Cl 2.1	
			Irrigated + fertilized	3970	26	2.7	10.9	22	6.0	Na 2.1 Cl 2.3	
New York, USA	Pinus resinosa	24	Leaves	3800	24.9	2.6	12.6	20.6	6.7		Chandler, 1943
New England, USA	Pinus resinosa	55	Total	7260	40						Vitousek et al. 1982
Conn., USA	Pinus resinosa	30- 50	Total	4000							Lunt, 1951[1]
	Pinus strobus		Total	4000							
N. Carolina, USA	Pinus strobus	16	Total	3245	26.50	3.70	5.50	19.20	2.70		Cromack, 1973
			Needes	3184	26.27	3.66	5.32	19.08	2.70		
			Stems	34	.14	.03	.10	.10	.00		
			Other	27	.10	.02	.10	.00	.00		
New York, USA	Pinus strobus	24	Leaves	3100	29.1	2.0	5.2	17.6	6.1		Chandler, 1943
		65	Leaves	2900	33.4	1.5	5.2	17.6	4.7		
N. Carolina,	Pinus strobus	60-200	Overstory	4369	33.9		18.1	44.5			Swank in Cole & Rapp, 1980
Minn., USA	Pinus strobus		Total								Ovington, 1963
			Leaves	2965	15.6	2.0	2.6	27.3	4.4		
			Cones	188	1.8	.2	1.0	.7	.3		
Conn., USA	Pinus strobus		Total	1700							Ehwald, 1957 (data of Abramova)[1]

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Central Sweden	Pinus sylv.	120-150	Needles	930	3.8	0.25	0.71	3.30	0.35	Na 0.07 S 0.41	Bringmark, 1977
			Cones	25	0.1	0.01	0.03	0.01	0.01	Na 0.00 S 0.01	
			Twigs	106	0.5	0.02	0.03	0.16	0.01	Na 0.00 S 0.05	
			Other	290	0.9	0.01	0.27	1.02	0.12	Na 0.01 S 0.06	
Evo, Finland	Pinus sylv.	88	Total	1800							Viro, 1955[1]
			Leaves	1200							
			Other	600							
Vilppula, Finland	Pinus sylv.	58	Total	2700							Viro, 1955[1]
			Leaves	1600							
			Others	1100							
Bavaria, Germany	Pinus sylv.	25- 50	Total	2900							Ebermayer, 1876[1]
		50- 75	Total	3000							
		75-100	Total	3600							
		80	Total	4000							Ebermayer, 1876[1] (data of Hastig)
		100	Total	3800							
		120	Total	3600							
Brjansk, USSR	Pinus sylv. & herb		Total	3200							Ehwald, 1957 (data of Sacharov)[1]
			Leaves	2700							
			Other	500							
	Pinus sylv. & herb		Total	6900							
			Leaves	4700							
			Other	2200							
Voronezh, USSR	Pinus sylv.	20	Leaves	2500							Rodin and Basilevich 1967
		40	Leaves	2300							
		60	Leaves	1900							
		80	Leaves	2000							
		100	Leaves	1300							
Marschallsruhe Germany	Pinus sylv.	45	Total	3900							
Evo, Finland	Pinus sylv.	50	Total	2300							Viro, 1955[1]
			Leaves	1700							
			Other	600							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Bavaria, Germany	Pinus sylv.	21- 40	Total	3300							Danckelmann, 1887[1]
		41- 60	Total	3200							
		61- 80	Total	3200							
		81-100	Total	3100							
		100	Total	3000							
		21- 40	Total	2400							
		41- 60	Total	2300							
		61- 80	Total	2200							
		81-100	Total	2000							
		100	Total	1900							
Kiev, USSR	Pinus sylv.	10,45,10s	Total	2400							Ehwald, 1957[1]
Finland	Pinus sylv.		Total	2600							Aaltonen (from Svinhuhood), 1948[1]
Thasant, Germany	Pinus sylv.		Total	2000							Ehwald, 1957[1]
			Total	1000							
			Total	3000							
Eberswalde, Germany	Pinus sylv.		Total	3600							Lespeyres, 1898[1]
Cheshire, UK	Pinus sylv.		Total	4800							Kendrick, 1959[1]
			Leaves	4100							
			Other	700							
Spiess, Germany	Pinus sylv.	54	Total	3600							
USSR	Pinus sylv., Quercus		Total	1300							Sonn, 1960[1]
	Pinus sylv., Acer		Total	2000							
	Pinus sylv., Vacc	30	Total	4500							
Moscow, USSR	Pinus sylv., Acer		Total	3000							Ehwald, 1957 (data of Nesterou)[1]
	Pinus sylv., Acer		Total	3600							
	Pinus sylv. & mix		Total	4200							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
N. Carolina, USA	Pinus taeda	11	Needles	6200	35.0	6.5	12.2	22.7	5.6		Jorgensen et al. 1980
			Branches	774	2.7	0.2	0.6	2.1	0.1		
			Leaves	9	0.1	0.1	0.1	0.1	0.1		
			Fine material	508	13.8	0.8	0.8	0.9	0.3		
		32	Needles	4390	23.8	3.9	9.6	15.1	3.8		
			Branches	800	2.3	0.2	1.0	2.1	2.0		
			Leaves	60	0.5	0.1	+0.2	0.8	0.2		
			Fine material	285	7.3	0.8	0.8	0.6	0.4		
N&S Carolina, USA	Pinus taeda	11-15	Total	7749	53.24	7.54	13.90	26.17	6.20		Wells & Jorgensen, 1975
		16-17		3374	25.84	3.59	7.00	10.44	3.14		
		24-27		5129	33.68	3.56	9.15	16.60	4.07		
		28-29		2213	15.60	1.90	3.87	8.13	2.08		
		31-39		6033	36.91	5.17	12.19	19.61	4.75		
N. Carolina, USA	Pinus taeda	14	Needles	4750	26.8	3.05	4.92	4.75	3.52		Wells et al. 1975
			Branches	572	1.7	.10	.15	1.31	.11		
			Other	240	1.9	.15	.23	.50	.11		
			Needles	5136	30.7	3.19	5.46	6.38	3.28		
			Branches	1118	4.0	.26	.41	2.16	2.06		
			Other	372	2.8	.21	.38	.78	.16		
Shiga, Japan	Pinus, Chamaecyparis		Total	5235	26.1	1.13	8.39	40.47	2.97		Kawahara 1971
Kyoto, Japan	Pinus, Quercus		Total	7756	28.8	2.50	9.09	25.00	4.85		
			Total	4508	49.3	4.93	12.32	46.29	6.23		
Wellington, N. Zealand	Podocarpus + Metrosideros		Total	6865							Daniel, 1975
			Leaves	3229							
			Fruit+seeds	579							
			Insects	8							
			Twigs <28cm	1056							
			Twigs >28cm	1992							
Lunadacs, Hungary	Populus	24	Total	4400							
Vosonegh, USSR	Populus	30	Total	6000							Sviridova, 1960'
	Populus	30	Total	5200							
	Populus	55	Total	5400							
	Populus	55	Total	4600							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Minnesota, USA	Populus	49	Total	3675	33	6.7	19	60	8.0		Perala and Alban 1979
	Picea	41	Total	5253	41	5.1	12	60	4.1		
	Pinus res.	41	Total	5468	34	3.1	13	24	5.3		
	Pinus banks.	41	Total	5322	41	3.9	11	28	5.0		
Erd, Hungary	Populus alba	30	Total	4600							Rodin & Basilevich 1967
Erd, Hungary	Populus alba	15-20	Total	3500							Rodin & Basilevich 1967
Godollo, Hungary	Populus nigra	35	Total	4000							Rodin & Basilevich, 1967
New Mexico, USA	Populus trem.	60	Total	2530	15						Vitousek et al. 1982
										Fe Mn	
USSR	Populus trem.	10	Total	3850							Rodin & Bazilevech, 1967
			Leaves	3750	93	9	53	63	10	1 1	
			Other	100							
		25	Total	4110							
			Leaves	3620	90	9	51	61	9	1 1	
			Other	490							
		50	Total	4880							
			Leaves	4470							
			Other	410							
Voronezh, USSR	Populus trem.	10	Total	3900							Remezov & Bykova, 1953[1]
		25	Total	4100							
		50	Total	4900							
										Fe Mn Zn	
USA	Populus trem.	10	Total	1320							Van Cleve & Noonan, 1975
			Leaves	1100	9.0	2.0	5.2	23.9	3.7	.6 .2 .1	
			Twigs	210							
			Other	7							
		50	Total	2190							
			Leaves	1780	19.7	4.4	8.8	42.6	6.3	.7 .7 .2	
			Twigs	320							
			Other	89							
			Total	2220							
			Leaves	1620	13.5	2.7	4.7	28.1	5.3	.6 .4 .2	
			Twigs	440							
			Other	160							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Canada	Populus trem.	69	Total	2346							Cragg et al. 1977
			Leaves	1734	14.5	3.1	10.6	35.8	5.7	.1 .1 .4	
			Twigs	349							
			Detritus	169							
			Other	94							
Stockholm Sweden	Populus trem.		Leaves	1900							Andersson & Enander, 1948[1]
	Betula pub.		Total	1700							Knudson & Mauritz-Hansson, 1939[1]
			Leaves	1600							
			Other	100							
	Picea abies		Leaves	3100							Lindberg & Norming, 1943[1]
Alberta, USA	Populus trem.		Total	2500	28	5	20	56	6	Cu .01 Fe .12 Mn .13 Na .12 Zn .58	Lousier & Parkinson, 1976
Minn., USA	Populus trem.		Total								Ovington, 1963
			Leaves	2101	24.0	2.3	2.6	27.9	4.4		
			Catkins	543	10.9	1.1	1.6	7.9	1.0		
USA	Populus trem., mix	17	Total	2555							Crow, 1974
			Leaves	2280							
			Other	275							
Juneau, Alaska	Populus, Alnus	16-38	Total	2890							Hurd, 1971
			Non-wood	1654							
B.C., Canada	Pseudotsuga	23	Non-woody	1630	16	1.7	2.8	15	2		Binkley et al. 1984
			Woody	85	0.2	<0.0	<0.0	0.4	<0.0		
Washington, USA	Pseudotsuga	300	Total	3800	27						Vitousek et al. 1982
Washington, USA	Pseudotsuga	45	Total	3300	21						Vitousek et al. 1982
Washington, USA	Pseudotsuga menziesii	45	Total	1800							Dimock, 1958[1]

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Washington, USA	Pseudotsuga	22	Leaves	2680	18.8	3.2	9.7	22.9	4.4		Turner, 1975
			Branch	156							
			Herbs	1892	14.1	2.1	10.9	29.1	7.0		
			Moss	8	.03	.01	.03	.12	.02		
		30	Leaves	2919	18.5	4.1	6.1	31.7	3.7		
			Branch	719	2.9	.7	.7	7.0	.0		
			Herbs	796	5.6	.8	4.2	12.6	2.9		
			Moss	151	.6	.1	.6	2.3	.4		
		42	Leaves	1713	21.1	2.3	6.6	35.7	6.3		
			Branch	856							
			Herbs	560	3.9	.5	2.5	8.3	2.0		
			Moss	83	.3	.1	.3	1.3	.2		
		73	Leaves	2278	17.1	2.3	6.1	34.5	4.3		
			Branch	649							
			Stem	2440	4.9	.2	.5	.2	.2		
			Herbs	100	.7	.1	1.8	.2	.2		
			Moss	467	1.9	.3	2.2	7.2	1.3		
		95	Leaves	2358	27.2	3.1	5.2	38.1	3.2		
			Branch	2474							
			Herbs	51	.3	.04	.2	.8	.2		
			Moss	297	1.2	.2	1.1	4.6	.8		
Cedar Falls, Wash. USA	Pseudotsuga	30	Total	1758	10.92	.20	2.27	10.17	3.05		Rahman, 1964
Washington, USA	Pseudotsuga	36	Total		13.6	.2	2.7	11.1			Cole et al., 1967
		42	Total				4.7	17.8	2.0		Grier & Cole, 1972
N. Island, N. Zealand	Pseudotsuga	39	Total	2776	21.9	2.3	5.7	22.1	2.8		Will, 1958
			Needles	1436							
		31	Total	2776	20.6	2.9	4.7	26.4	2.6		
			Needles	2085							
Washington, USA	Pseudotsuga menziesii	45	Needles								Turner, 1977
			control	1880	14.1						
			Low fert	1710	13.0						
			High fert	1290	11.2						
			Carbohyd. fert.	2390	14.3						
Voight Creek, Wash. USA	Pseudotsuga	50	Total	2116							Reukema, 1964

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Prescott, Oregon USA	Pseudotsuga	60	Total	3430						S Na	Rickard, 1975
			Needles	1980	20.0	2.0	2.4	28.0	1.4	2.8 .8	
			Broadleaves	570	7.6	1.5	1.5	12.0	1.1	0.9 0.4	
			Cones	300							
			Twigs	260							
			Other	320							
Oregon, USA	Pseudotsuga menziesii	450	Overstorey	6140	18.8	4.5	7.3	40.4	3.3		Grier in Cole & Rapp, 1980
Oregon, USA	Pseudotsuga		Total	5652	23.70	4.75	6.32	53.57	4.31		Abee, 1973
			Needles	2015	8.75	2.33	3.16	34.15	1.94		
			Reprod.	873	3.14	.35	.74	.91	.72		
			Woody	1830							
New Mexico, USA	Pseudotsuga, Abies	200	Total	3900	18						Vitousek et al. 1982
Oregon, USA	Pseudotsuga, Tsuga	55-450	Tree Mortality	1500-4500							Sollins, 1982
S. Sweden	Quercur robus		Total	5300							Andersson, 1970
			Leaves	3300							
Minnesota,	Quercus	?	Total		56	3	59	83			Reiners, 1972
New England, USA	Quercus	65	Total	4220	36						Vitousek et al. 1982
Indiana, USA	Quercus	81	Total	6800	62						Vitousek et al. 1982
Korea	Quercus acutissima	12	Total	6300	87.0	9.0	90.6				Mun et al. 1977
Kallo,Hungary	Quercus	76	Total	3800							
Derkul steppe, USSR	Quercus	25	Total	3300							Sonn, 1960[1]
	Quercus, Frax	50	Total	3100							
	Quercus, mix	15	Total	4300							
	Quercus, Acer	50	Total	5200							
	Quercus, Aegop.	210	Total	4100							
	Quercus, mix	130	Total	4100							
	Quercus	170	Total	1400							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass (kg/ha/yr)	N	P	K	Ca	Mg	Other	Reference
Boone City, Missouri USA	Quercus		Leaves	3726							Rochow, 1975
			Woody	860							
			Leaves	3652							
			Woody	1170							
			Leaves	6107							
			Woody	644							
			Leaves	3620							
			Woody	896							
			Leaves	1876							
			Woody	1344							
			Leaves	3951							
			Woody	783							
			Leaves	3565							
			Woody	762							
			Leaves	5026							
			Woody	288							
			Leaves	4821							
			Woody	2927							
Georgia, USA	Quercus alba		Total	7564			28.97	74.76	15.36		Monthly mean for 8 monthsx12
	Pinus taeda	34	Total	4212			7.06	9.35	2.80		
Tennessee, USA	Quercus alba	30-80	Overstory	4800	36.5	2.7	19.8	49.1	8.7		Harris in Cole & Rapp, 1980
	Quercus prinus	30-80		4450	34.1	2.4	16.4	45.0	7.5		
Washington, USA	Quercus alba	100-125	Total	6200							Hole & Nielsen[1]
			Leaves	4600							
			Other	1500							
Grabels, France	Quercus cacc.		Total	2608	23.0	1.0	9.0	47.0	3.0		Rapp, 1969
			Leaves	1584							
			Wood	491							
			Other	533							
St. Ply du Fesc, France	Quercus cacc.		Total	2278	19.0	1.0	9.0	33.0	2.0		Rapp, 1969
			Leaves	1405							
			Wood	243							
			Other	626							
Petsag, Hungary	Quercus cerris	35	Total	3300							Rodin & Basilevich, 1967

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Godollo, Hungary	Quercus cerris	45	Total	3800							Rodin & Basilevich, 1967
Ugod, Hungary	Quercus cerris	70	Total	2700							Rodin & Basilevich, 1967
Kallo, Hungary	Quercus cerris	83	Total	3400							Rodin & Basilevich, 1967
France	Quercus ilex	150	Overstory	3840	32.8	2.8	16.2	63.9	4.6		Loissant & Rapp in Cole & Rapp, 1980
Rouquet, France	Quercus ilex	130-150	Total	3842	33.0	3.	16.0	64.0	4.0		Rapp, 1969
			Leaves	2446							
			Wood	800							
			Other	596							
Madeleine, France	Quercus ilex		Totl	6998	87.0	10.0	38.0	122.0	10.0		Rapp, 1969
			Leaves	2723							
			Wood	1496							
			Other	2779							
California, USA	Quercus lull.	50-100	Total	1							
	Pinus pondes.	150	Total	2100							
	Mix. decid	50	Total	4500							
Belgium	Quercus mixed	115-160	Overstory	5600	59.0	3.4	28.0	66.0	9.7		Duvigneud-Denaeyer in Cole & Rapp, 1980
Ashu, Japan	Quercus mong.		Total	4508	49.32	4.95	12.32	46.29	6.23		
			Leaf	3719	45.02	4.32	9.80	40.09	5.43		
			Branch	361	4.30	.63	2.52	6.20	.80		
			Other	428							
U.K.	Quercus pet.		Leaves		21.05	.92	6.3	16.80	2.74		Carlisle et al. 1966
			Twigs		7.73	.39	1.6	4.18	.53		
			Male fl.		4.31	.31	1.2	.68	.24		
			Buds		3.08	.20	.5	1.08	.15		
			Acorns		.44	.03	.2	.23	.04		
UK	Quercus pet.		Total	3900							Carlisle et al. 1966
			Leaves	2100							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Yarner Wood, UK	Quercus petr.		Total								Rodin & Basilevich 1967
			Leaves	3127							
			Flowers	31							
Kunadacs Hungary	Quercus robur	51	Total	4000							Rodin & Basilevich, 1967
Kallo,Hungary	Quercus robur	60	Total	4400							Rodin & Basilevich, 1967
Matra,Hungary	Quercus robur	70	Total	4700							Rodin & Basilevich 1967
Japan	Quercus serr.		Leaves	2300							Ohmasa and Mori, 1937'
Laool,Hungary	Quercus sessil	75	Total	4600							
Illinois	Quercus-Carya -Liriodendron	70 -100	Total	5688			25.8	99.5	12.6		Pearson, 1978
Illinois	Quercus-Carya	150	Total								
			Xeric	6200	57	4	41	111	8		Rolfe et al. 1978
			Mesic	7100							
Japan	Quercus, mixed moist soil		Leaf	3260	50.80	1.66	9.78	30.86	5.41		Katagiri et al. 1978
			Branch	1340	6.97	.27	1.02	12.54	1.69		
			Other	530	8.85	.61	.80	4.49	.83		
			Total	5130	66.62	2.54	11.60	47.89	7.93		
New England, USA	Quercus, Acer	50	Total	4890	41						Vitousek et al. 1982
UK	Quercus, Betula	80	Overstory	3700	63.5	2.6	19.0	83.3	9.7		Satchell in Cole & Rapp, 1980
Arnhem, Netherlands	Quercus, Betula		Total	3700							Witkamp & Van der Drift, 1961'
			Leaves	2700							
			Other	1000							
	Betula, Quercus		Total	4100							
			Leaves	2500							
			Other	1600							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Japan	Quercus,mix -dry soil		Leaf	4000	40.72	1.70	9.67	47.44	5.31		Katagiri et al. 1978
			Branch	900	7.30	.19	.89	11.35	.74		
			Other	560	10.11	.52	1.39	4.29	.78		
			Total	5460	58.13	2.41	11.95	63.08	6.83		
Oregon, USA	Thuja plic.		Total	2052	12.7	1.8	7.3	45.9	.9		Tarrant et al. 1951
	Pseud. menz.	350		1897	16.3	2.9	2.9	17.8	.5		
	Ab. amab.			1696	21.2	2.0	4.1	15.5	1.0		
	Acer macro.			1414	16.2	1.7	16.0	22.9	.2		
	Pseud. menz.	100		881	7.5	.8	1.8	8.6	.2		
	Pinus			1292	9.9	1.5	3.9	8.0	1.1		
	Alnus rub.		Total	1256	29.6	1.6	12.4	10.3	.1		
	Tsuga het.			1003	7.7	1.1	1.9	6.0	.6		
	Picea sit.			862	10.0	.9	2.0	4.2	.8		
	Pinus pond.	100		770	6.0	.8	1.8	8.6	.6		
	Pinus pond.	350		589	3.0	.4	2.0	2.5	.4		
	Pinus cont.			273	2.7	.2	1.2	1.5	.2		
Japan	Thujopsis dol.		Leaves	3900							Ohmasa and Mori, 1937'
	Larix kaem.		Leaves	2000							
	Abies sach.		Leaves	1100							
	Pic. jeg.		Leaves	1600							
	Pic. gleh.		Leaves	1500							
New York, USA	Tilia am. & mix	30-70	Leaves	2900	21.6	3.1	14.6	83.6	12.1		Chandler, 1941
New York, USA	Tilia am. & mix	30-70	Leaves	3100	17.6	4.7	21.4	78.2	10.0		Chandler, 1941
Godollo, Hungary	Tilia cord.	45	Total	3600							Rodin & Basilevich 1967
Kochi, Japan	Tsuga		Total	5236	36.4	1.81	10.12	32.60	5.33		Ando et al. 1977
New York, USA	Tsuga cana.	150	Leaves	1500	14.5	1.0	3.8	9.5	1.9		Chandler, 1943
Oregon, USA	Tsuga mert.		Total	5949	23.39	3.85	5.01	50.76	3.08		Abee, 1973
			Needles	2247	11.48	2.59	3.07	33.35	1.68		
			Reprod.	871	3.92	.51	.66	2.62	.46		
			Woody	2124							

Table 7 Litterfall Biomass & Nutrients

Location	Dom. Veg.	Age	Component	Biomass	kg/ha/yr N	P	K	Ca	Mg	Other	Reference
Oregon, USA	Tsuga mert.		Total	6390	35.23	5.60	10.08	56.36	4.22		Abee, 1973
			Needles	2953	16.55	3.82	5.98	36.95	2.68		
			Reprod.	1281	7.06	.69	1.43	2.06	.70		
			Woody	1138							
Oregon, USA	Tsuga nest.		Total	5143	23.30	5.15	7.21	50.50	3.52		Abee, 1973
			Needles	3204	14.67	4.18	5.28	38.11	2.43		
			Reprod.	742	2.40	.36	.62	1.13	.45		
			Woody	811							
Oregon, USA	Tsuga mert.		Total	4798	34.12	5.60	7.56	119.91	3.40		
			Needles	2538	12.41	2.48	3.61	33.24	1.90		
			Reprod.	545	2.18	.23	.49	1.10	.26		
			Woody	817							
	Abies		Total	7060	35.53	5.38	10.32	41.30	4.53		
			Needles	3727	22.26	4.01	7.92	28.51	3.07		
			Reprod.	528	3.12	.35	.60	.69	.29		
New York, USA	Tsuga occid.	65	Leaves	2300	13.0	0.9	5.4	46.4	3.2		Chandler, 1943
Japan	Tsuga sieboldii	120-443	Overstorey	4686	20.2	1.5	6.8	24.8	3.6		Ando in Cole & Rapp, 1980
Washington, USA	Tsuga, Picea	120	Total	6200	44						Vitousek et al. 1982
Erd, Hungary	Ulmus	40	Total	4900							Rodin & Basilevich, 1967
Japan	Zelk. serrata		Leaves	1400							Ohmasa and Mori, 1937[1]

[1]From Bray & Gorham, 1964, or Rodin and Basilevich, 1967.

Table 8 Defoliation

Location	Dom. Veg.	Age	Component	kg/ha/yr Biomass	N	P	K	Ca	Mg	Other	Reference
North Carolina, USA	Mixed hardwoods		Insect bodies	1-3			0.01-0.05	0.002-0.01	0.001-0.01		Schowalter et al. 1981
			Frass	200-1000			3-20	0.4 0.7	0.4-1		
Scotland	Pinus nigra	40	Bird droppings		.01-6						Miller, Cooper & miller 1976
USSR	Quercus	33	Frass	330	10.7	.7	10.6	6.2	2.6		Rafes, 1971
			Bodies	15	1.4	.2	.4	.1	0.0		
	Quercus	59	Frass	230	7.5	.5	7.4	4.3			
			Bodies	10	1.0	.2	.3	0.0			
		74	Frass	350	11.4	.7	11.2	6.5	2.7		
			Bodies	17	1.6	.3	.5	.1	0.0		
		228	Frass	750	24.4	1.5	24.1	14.0	5.7		
			Bodies	35	3.4	.5	1.1	.1	.1		
England	Quercus	40-120		0-570	0-6.5	0-.81	0-3.5	0-1.6	0-.39	Na 0-.13	Carlisle et al, 1966
Japan	Tsuga, Betula		Insect bodies	2.45	.1	.01	.02	.01			Shidei & Kira 1977
			Faeces & dust	122.27	.56	.09	.15	.07			

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
Japan	"Hinoki"		T		6.3	.12	13.1	16.6	4.2		Iwatsubo & Tsutsumi, 1967
			S		.7	.02	1.6	1.7	.4		
	Broadleaf		T		5.70	.42	39.1	13.1	3.7		
			S		1.7	.06	9.3	4.6	1.1		
Washington, USA	Abies amabilis		T		2.6	0.5	12.3	6.0	2.2		Turner & Singer, 1976[1]
Washington, USA	Abies grandis		T			0.89	0.32	3.77	2.51	0.26	Tiedemann et al. 1980[1]
New Brunswick,	Acer rubrum	55	S	1.78	.16		2.22	.32	.08	.13	Mahendrappa, 1974
N.Hampshire, USA	Acer, Betula, Fagus	110	T	Org.Mat. 104	4.7	.6	26.1	5.0	1.5		Whittaker in Cole & Rapp, 1980
			S	11.5	.5	.1	3.4	.4	.1		
Oregon, USA	Alnus		T		6.30						Tarrant et al. 1968
			S		.02						
Washington, USA	Alnus rubra		T&S		10.6	1.3	15.0	12.4	5.58		Turner et al. 1976[1]
Washington,	Alnus rubra	30	T		8.8	1.0	12.2	10.0	5.0		Turner, 1975
			S		.1		.4	.2	.08		
Cedar Falls, Wash. USA	Alnus rubra		T		2.80	.08	13.02	5.76	2.96		Rahman, 1964
	Alnus rubra		S		.24	.01	.95	.40	.12		
S. Norway	Betula		T			0.2	6.2	3.0	1.5	7.8	Horntvedt and Joranger, 1974[1]
									Cl	13.8	
									SO4-S	5.7	
Russia	Betula		T					8.2	1.6		Sokolov, 1972[1]
									Cl	1.5	
									SO4-S	1.0	
									NH4-N	2.4	
									NO4-N	0.2	
N. Carolina USA	Betula lutea	50	T				16.9	5.3	2.7		Weaver, 1972
		100+	S				1.0	.5	1.7		
New Brunswick, Canada	Betula papyrif.	61	S	.76	.04		.11	.08	.02	.09	Mahendrappa, 1974
Alaska, USA	Betula papyrif.	50	T	Org.Mat. 30.33	2.1	.20	1.46	1.01	.55		Van Cleve in Cole & Rapp, 1980
			S	3.42	.1	.006	.11	.03	.01		

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
Japan	Broadleaf										
	-upper slope		T		6.3	.91	39.3	23.3	8.9		Katagiri & Tsutsumi, 1978
	-lower slope		T		4.3	.32	20.2	8.8	4.3		
Kyoto, Japan	Broadleaf		T		6.15	.19	28.94	13.05	4.63		Tsutsumi, 1978
			S		3.26	.06	6.25	5.16	1.66		
	Broadleaf		T		5.70	.42	39.12	13.07	3.70		
			S		1.62	.06	9.31	4.57	1.14		
	Chamaecyparis		T		7.37	.03	11.82	16.21	3.09		
			S		1.09	.01	1.38	1.79	.44		
	Chamaecyparis		T		6.27	.12	13.13	16.64	4.24		
			S		.68	.02	1.57	1.71	.38		
Japan	Broadleaf		T&S		8.5	.22	32.6	15.8	6.1		Iwatsubo & Tsutsumi, 1967
Japan	Campotheca Chamaecyparis	Young Mature	T		4.9	1.5	27.5	25.3	10.0		Tsutsumi, 1977
			T		4.44	1.08	20.99	25.56	5.77		
	Pinus										
Kyoto, Japan	Campotheca		T&S		5.3	1.5	27.5	25.3	10.4		Iwatsubo, 1976
S. Norway	Conifer						83.8	32.6	11.2	41.2	Haughbotn, 1973[1]
									SO4-S	69.1	
							30.8	17.1	6.2	10.9	
									SO4-S	21.1	
S. Norway	Conifers near factory		T				42.0	48.1	10.1	39.1	Haughbotn, 1973[1]
									SO4-S	111.2	
S. Georgia	Cypress swamp		T			0.96	6.55	6.24	2.59		Schlesinger, 1978[1]
									NO3-N	2.68	
Coastal California, USA	E. globus		T			0.27	11.39	8.52	4.22	16.32	McColl & Bush, 1978[1]
									NH4-N	1.81	
									NO3-N	0.50	
Maroondah, Victoria, Australia	E. regnans	38	T		0.4	0.1	30.8	13.4	5.9	11.5	Feller, unpublished data
			S		0.2	0.0	5.9	3.0	1.9	3.4	
	E. obliqua-	38	T		- 0.1	0.0	14.9	5.5	6.7	8.8	
	E. dives		S		0.0	0.0	0.2	0.1	0.1	0.3	
New Zealand	Eucalyptus		T				13.38	8.01	7.29	25.43	Attiwill, 1966[1]
W. Australia	Eucalyptus		T&S			0.52	22.8	9.8	8.9	6.6	Prebble & Stirk, 1980[1]

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	C	N	P	K	Ca	Mg	Na	Reference
				Input kg/ha/yr							
Stradbroke Is, Queensland, Australia	Eucalyptus	?	T		35	0	8.5	14	7.2	44	Westman, 1978
			S		- 0.8	0	0.9	0.8	1.1	8.1	
Solling, W. Germany	Fagus	125	T&S		28.4	.47	29.0	26.9	14.6	14.6	Ulrich et al. 1974
										S 53.4	
										Cl 33.3	
	Picea abus	85	T&S		33.7	.64	30.1	34.6	5.0	17.6	
										S 88.6	
										Cl 39.7	
C. Europe	Fagus		T		4.8	.09	7.3	8.6	1.3		Ulrich, 1975
Sweden	Fagus sylvatica	90	T	1971	4.4	0.27	0.1				Nilsson, 1978
				1973 (defoliated)	12.2	1.47	25.0				
Paris, France	Fagus sylvatica	+6	T			0.23	9.40	14.73	5.75		Lemee, 1974[1]
									NH4-N	8.04	
									NO3-N	6.84	
		30				0.29	11.53	15.29	6.16		
									NH4-N	7.18	
									NO3-N	7.00	
		50-90				0.62	17.30	18.16	6.15		
									NH4-N	8.46	
									NO3-N	6.08	
		Over 200				0.88	36.53	28.39	11.58		
									NH4-N	10.37	
									NO3-N	8.84	
Denmark	Fagus sylvatica										Astrup and
	Mull soil		T			1.58	31.8	23.6	11.7	45.5	Bulow-Olson, 1972[1]
	Mor soil					2.18	33.7	17.6	7.5	34.9	
S. Sweden	Fagus sylvatica	100	T		8.5	111	9.3	9.0	3.00	13.7	Nihlgard, 1970
			S		.4	11	3.2	1.1	.039	2.0	
Germany	Fagus sylvatica	80	T		19.6	.4	15.9	22.0	3.3		Ulrich in Cole & Rapp, 1980
			S		2.5		6.6	4.3	.6		
		122	T		19.6	.4	15.9	22.0	3.3		
			S		2.5		6.6	4.3	.6		
Solling, W.Germany	Fagus sylvatica	125	T		22.5	.58	18.1	26.6	3.45	11.3	Ulrich & Mayer, 1972
									Al	1.5	
									Cl	38.0	
									Fe	1.51	
									Mn	2.81	
									S	40.8	
			S		2.6	.02	7.5	5.8	.69	2.3	
									Al	.3	
									Cl	6.5	
									Fe	.3	
									Mn	.88	
									S	16.5	

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	C	Input kg/ha/yr N	P	K	Ca	Mg	Na	Reference
Sweden	Fagus sylvatica	45-130	T&S		1.0	.1	11.2	6.6	2.5		Nihlgard, 1972
Tennessee, USA	Liriodendron		T		11.05	0.37	18.35	21.65	3.4		Henderson et al. 1977[1]
Tennessee, USA	Liriodendron	50	T		9.4	.4	31.7	17.8			Harris in Cole & Rapp, 1980
			S		.1	.002	1.0	.4			
	Liriodendron, Carya, Quercus	30-80	T&S		12.0	.4	18.4	21.9	3.4		
SE England	Mix con.		T			19.8	13.4	4.6			Madgwick & Ovington, 1959
Belgium	Mixed decid.	80	T		.9	.6	16.0	6.2	5.6		Duvigneud, Denaeyer in Cole & Rapp, 1980
			S		6.0		.8	.9	.6		
Great Britain	Mixed decid.	80	T		8.8	.7	30.3	22.8	11.9		Satchell in Cole & Rapp, 1980
			S		.4	.03	4.8	5.2	2.4		
N. Carolina, USA	Mixed decid.		T				30.5	8.1	3.1	8.6	Cromack & Monk, 1975
	Pinus strobus		T				30.5	6.3	2.0	7.2	
Florida, USA	Mixed decid.		T			2.0	11.8	8.5	5.0		Ewel et al. 1975
			S			.3	4.7	1.9	.2		
SE England	Mixed decid.		T			25.0	13.8	6.8			Madgwick & Ovington, 1959
N. Carolina, USA	Mixed decid.		T			.6	17.5	.6	3.8		Strain, 1971
			S			.0	.7	2.0	.2		
New Zealand	Mixed hardwood		T		2.32	.74	22.04	4.18	3.42	16.15	Neary et al. 1978
N. Carolina, USA	Mixed hardwoods		T&S		5.09	0.61	18.13	14.49	4.00		Wells et al. 1972[1]
									NH4-N	1.16	
									NO3-N	1.46	
S. Carolina, USA	Mixed hardwoods						30.5	8.1	3.1	8.6	Best & Monk, 1975[1]
Tennessee, USA	Mixed hardwoods		T						SO4-S	32.0	Lindberg et al. 1979[1]
Georgia, USA	Mixed hardwoods						6.67	3.30	.67	3.72	Torreneuva, 1975[1]
N. Dakota, USA	Mixed hardwoods		T	east slope		0.88	11.5	12.1	4.0	3.1	Killingbeck and Wali, 1978[1]
									Cl	8.6	
									SO4-S	7.4	
									NO3-N	0.20	
				west slope		0.39	16.2	23.4	5.3	4.1	
									Cl	8.6	
									SO4-S	14.6	
									NO3-N	0.20	

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
Illinois, USA	Mixed hardwoods		T&S			0.28	4.02	7.92	0.37		Weaver & Brown, 1979[3]
									NO3-N	0.11	
New Hampshire, USA	Northern hardwoods		T&S		11.71	0.73	30.45	7.62	2.17	0.66	Eaton et al. 1973[3]
									Cl	26.06	
									SO4-S	26.05	
									H2O	478	
New Zealand	Nothofagus		T		2.69	0.56	31.05	13.45	13.45	73.98	Miller, 1963[3]
									Cl	160.29	
									Cl	10.42	
Russia	Picea abies		T					10.9	2.3		Sokolov, 1972[3]
									Cl	1.9	
									SO4-S	2.0	
									NH4-N	3.2	
									NO3-N	0.2	
S. Norway	Picea abies		T			0.1	7.4	3.9	1.6	9.8	Horntvedt and Joranger, 1974[3]
									Cl	19.5	
									SO4-S	8.6	
S. Sweden	Picea abies	55	T		21.5	430	22.6	14.7	5.25	22.6	Nihlgard, 1970
			S		2.6	71	4.5	2.7	.90	3.6	
USSR	Picea abies	45	T&S		1.6	.3	1.9	2.5			Kazimirov, 1973
Germany	Picea abies	34	T&S		3.7	.2					Ulrich in Cole & Rapp, 1980
		87	T&S		3.7	.2	23.6	19.0	.2		
		115	T&S		3.7	.2					
Sweden	Picea abies	60	T&S		16.0	.4	25.2	13.9	5.2		Nihlgard, 1972
Minnesota, USA	Picea mariana		T&S		7.16	0.62	4.04	5.27	1.31	1.18	Verry & Timmons, 1977[3]
									NH4-N	1.67	
									NO3-N	1.67	
Alaska, USA	Picea mariana	51	T		.8	.1	.83	1.14	.14		Van Cleve in Cole & Rapp, 1980
		55	T		.8	.09	.83	1.1	.14		
		130	T		.8	.09	.83	1.14	.14		
New Brunswick, Canada	Picea rubens	46	S	1.48	.10		.41	.25	.04	.07	Mahendrappa, 1974
	Picea glauca	32	S	5.61	.29		4.53	.61	.18	.28	
	Pinus resinosa	42	S	.64	.03		.16	.14	.02	.11	
	Pinus strobus	40	S	1.55	.09		.94	.15	.05	.13	
	Larix	52	S	3.44	.09		1.05	.38	.12	.17	
	Abies balsamea	49	S	7.90	.21		2.43	.45	.13	.20	

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	C	Input kg/ha/yr N	P	K	Ca	Mg	Na	Reference
Maritime Wales	Picea sitchensis		T				9.4	21.7	22.8	132.2	Potts, 1978[3]
N. Carolina, USA	Picea, Abies	50	T				16.8	7.3	1.8		Weaver, 1972
			S				.7	.4	.6		
Tennessee, USA	Pinus		T		10.6	0.37	19.65	26.25	3.8		Henderson et al. 1977[3]
Ontario, Canada	Pinus banks.	30	T		.01	.12	10.00	6.56	1.12		Foster, 1974
	Pinus banks.	30	S		5.13	.01	1.60	.58	.13		
Tennessee, USA	Pinus echinata	30	T&S		2.9	.3	18.7	17.4	2.8		Harris in Cole & Rapp, 1980
Grabels, France	Pinus halep.		T		1.1	.6	8.0	11.6	2.7	20.2	Rapp, 1969
Nevada, USA	Pinus jeffrey		T&S		9.61	2.03	6.83	5.17	2.72	0.33	Stark, 1973[3]
New Zealand	Pinus nigra		T				8.41	0.94	1.53	18.72	Will, 1955, 1959[1]
						0.65	25.78	4.82		81.54	
						1.27	20.44	3.24		29.62	
Scotland	Pinus nigra	40	T		8	.13	28	12	12	98	Miller, Cooper and Miller, 1976
			S		1	.02	4	4	3	22	
NW Spain	Pinus radiata		T		15.2		76.1	20.5	13.9	57.6	Calvo de Anta et al. 1979[3]
									Cl	69.8	
									SO4-S	41.6	
									H2O	857	
New York, USA	Pinus resinosa		T&S	good site		0.39	3.7	6.0	1.16		Yawney et al. 1978[3]
				poor site		0.35	3.5	5.0	1.27		
Virginia, USA	Pinus strobus		T				5.17	4.15	0.73	3.58	Parker, 1982[3]
									Cl	2.52	
									SO4-S	6.27	
S. Carolina, USA	Pinus strobus						30.5	6.3	2.0	7.2	Best & Monk, 1975[3]
N. Carolina, USA	Pinus strobus	15	T&S				28.0	2.0			Swank in Cole & Rapp, 1980
N. Carolina, USA	Pinus strobus	60-200	T&S				24.1				Swank in Cole & Rapp, 1980

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
S. Norway	Pinus sylv.		T			0.0	6.8	3.7	1.9	12.3	Horntvedt and Joranger, 1974[1]
									Cl	21.9	
									SO4-S	7.8	
S. Sweden	Pinus sylv.		T				10.34	14.89	3.62	11.4	Richter & Granat, 1978[1]
									Cl	22.90	
									SO4-S	21.91	
							5.89	9.33	1.79	10.5	
									Cl	21.69	
									SO4-S	13.46	
									NH4-N	1.48	
									NO3-N	6.43	
C. Scotland	Pinus sylv.		T					10.0	5.4		Nicholson et al. 1980[1]
									SO4-S	29.0	
Finland	Pinus sylv.	28	T		4.82	.08	5.78	7.44			Malkonen, 1974
			S		.10		.23	.44			
N. Carolina, USA	Pinus taeda	11	T		9.3	0.5	11.7	4.5	1.8		Jorgensen et al. 1980
		32	T		3.7	0.3	6.6	6.5	1.8		
N. Carolina, USA	Pinus taeda		T&S		4.54	0.74	9.60	9.79	2.37		Wells et al. 1972[1]
									NO4-N	0.76	
									NO3-N	2.08	
N. Carolina, USA	Pinus taeda		T		4.61	0.37	4.06	4.14	1.15		Wells & Jorgensen, 1975, Wells et al. 1975[1]
					4.44	0.36	3.54	4.28	1.42		
					3.71	0.34	6.56	5.61	1.83		
					8.60	0.48	11.24	4.90	1.85		
									SO4-S	9.89	
									NH4-N	1.49	
									NO3-N	2.47	
					8.48	0.52	10.06	4.10	1.76		
									SO4-S	12.70	
									NH4-N	0.74	
									NO3-N	2.45	
Georgia, USA	Pinus taeda						4.13	2.02	0.39	3.74	Torreneuva, 1975[1]
N. Carolina, USA	Pinus taeda		T		1.0	.30	5.08	.0	.09		Wells et al. 1975
					2.7	.26	5.07	.1	.89		
Shiga, Japan	Pinus,		T		4.43	1.08	21.0	25.55	5.80	9.72	Tsutsumi, 1978
	Chamaecyparis		S		.31	.04	.77	2.0	.41	.95	
	Chamaecyparis		T		19.59	1.76	41.17	20.7	7.58	15.69	
			S		17.76	1.53	34.97	14.46	6.37	14.88	

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
New Brunswick, Canada	Populus grand.	44	S	3.03	.20		2.07	.88	.18	.20	Mahendrappa, 1974
New Mexico, USA	Populus trem.		T				3.23	2.23	0.36	0.24	Graustein, 1980[1]
									Cl	1.36	
									SO4-S	1.64	
									NO3-N	0.31	
	Picea englemanni Abies concolor						6.0	5.2	0.82	0.62	
									Cl	3.7	
									SO4-S	4.21	
Minnesota, USA	Populus trem.		T&S		8.62	1.54	18.28	18.66	4.02	1.34	Verry & Timmons, 1977[1]
									NH4-N	1.97	
									NO3-N	1.64	
Oregon, USA	Pseud. menz.	450	T		3.2	1.0	13.2	7.0	2.0		Grier in Cole & Rapp, 1980
Oregon, USA	Pseud. menz.		T		5.55						Tarrant et al. 1968
			S		.09						
	Mixed		T		3.69						
			S		.04						
New Zealand	Pseudotsuga		T			4.50	27.13	5.62		34.93	Will, 1959[1]
Cedar Falls, Wash. USA	Pseudotsuga	30	T		1.10	.22	8.16	4.31	2.61		Rahman, 1964[1]
		30	S		.16	.03	1.13	.81	.50		
Washington, USA	Pseudotsuga	22	T		2.9	1.8	7.0	5.2	1.5	Mn 1.7	Turner, 1975
		30	T		2.9	1.5	17.5	12.6	2.9	.5	
			S		.02	.01	.4	.2	.1	.02	
		42	T		3.7	1.3	7.5	5.4	1.0	.5	
		73	T		3.6	2.1	9.8	5.8	3.1	.9	
			S		.04	.01	.32	.23	.03	.01	
		95	T		1.2	1.11	11.1	8.6	.1	.5	
			S		.05	.02	.5	.3	.05	.01	
Washington, USA	Pseudotsuga	36	T		1.5	.3	10.7	3.5			Cole et al. 1967
			S		.2	.1	1.6	1.1			
		42	T				28.3	2.05	4.9		Grier & Cole, 1972
			S				4.0	3.8	.6		
Oregon, USA	Pseudotsuga		T		4.0	2.3	17.4	6.0	2.6		Abee, 1973
	Tsuga mert.		T		3.0	2.4	15.7	4.4	2.0		
	Tsuga mert.		T		3.7	3.0	30.3	2.1	1.4		
	Tsuga mert.		T		2.7	3.3	23.4	5.1	2.3		

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
Oklahoma, USA	Quercus		T		14.3	2.07	15.0	12.1	2.77		Johnson Risser, 1974[1]
Coastal England	Quercus		T&S			3.3	0.40	28.5	19.3	0.6	Brown, 1974[1]
England	Quercus		T&S		8.82 9.31	1.31 0.92	28.14 29.74	17.18 20.98	9.36 13.23	55.55 89.36	Carlisle et al. 1966, 1967[1]
Eastern France	Quercus				26	0.3	21.4	12.3			Aussenac et al. 1972[1]
Belgium	Quercus		T S			.6 .0	16.0 .8	6.2 .9	5.6 .6		Duvigneaud & Denaeyer-de Smet, 1970
Minn, USA	Quercus Frax. Acer		T T		5.54 5.49	.66 .59		7.59 10.52	3.07 3.78		Reiners, 1972
France	Quercus ilex	150	T S		.5 1.2	1.6 .3	21.3 6.5	23.3 7.8	3.6 .8		Loissant in Cole & Rapp, 1980
Rouquet, France	Quercus ilex		T		- .4	2.0	19.2	16.0	1.1	8.9	Rapp, 1969
Madeleine, France	Quercus ilex		T		9.6	3.1	38.2	23.2	4.8	20.0	Rapp, 1969
Gabriac, France	Quercus lanu.		T		4.1	.2	12.7	1.1	2.4	9.3	Rapp, 1969
Belgium	Quercus mixed	115-160	T S		2.2 .2		9.0 2.0		7.0		Duvigneud, Denaeyer in Cole & Rapp, 1980
Hungary	Quercus petraea		T		21.30	2.34	28.51	26.76	5.01 Cl SO4-S	2.41 15.41 49.64	Szabo & Csortos, 1975[1]
Illinois, USA	Quercus prinus		T		- .31	.10	5.04	1.58			Ostman and Weaver, 1979
Tennessee, USA	Quercus prunus		T		10.6	0.37	17.65	21.25	2.9		Henderson et al. 1977[1]
NW Spain	Quercus robur		T		5.1		60.8	20.5	11.3 Cl SO4-S H2O	42.7 35.8 33.9 780	Calvo de Anta et al. 1979[1]
Bogle Crag Wood, England	Quercus pet.	uneven	T S		8.82 - .01	1.31 .004	28.14 1.48	17.18 1.90	9.36 .58	55.55	Carlisle et al. 1966, 1967

Table 9 Throughfall & Stemflow

Location	Dom. Veg.	Age	T/S[1]	Input kg/ha/yr C	N	P	K	Ca	Mg	Na	Reference
Virginia, USA	Quercus, Liriodendron		T				9.22	4.13	1.08 Cl SO4-S	4.24 3.02 6.36	Parker, 1982[2]
Tennessee, USA	Quercus, Carya		T		11.45	0.57	23.85	23.85	3.7		Henderson et al. 1977[3]
Illinois, USA	Quercus, Carya	150	T S		3 1	1	21 16	12 13	4 1		Rolfe, Akhtar & Arnold, 1978
Tennessee, USA	Quercus, Carya	30-80	T&S		12.4	.6	23.9	24.1	3.7		Harris in Cole & Rapp, 1980
	Quercus prinus	30-80			11.6	.4	17.7	21.5	2.9		
Illinois, USA	Quercus, Carya, Liriodendron		T S		.78 .19	3.15 .15	3.78 .24	6.64 1.28	.37 <0.01		Brown, 1980
Central Sweden	Scots pine		T				2.15	2.36	1.31 NH4-N 0.59 NO3-N	2.13 0.88	Bringmark, 1980[3]
							1.92	1.60	0.41 NH4-N NO3-N	2.59 1.01 1.26	
USA?	Taxodium		T S T&S		9.6 0.71 10.31	1.29 0.26 1.55	10.4 1.56 11.96	13.3 9.59 15.31	6.9 0.70 7.60		Brinson et al. 1980
Minn, USA	Thuja occid.		T		6.05	.51		10.69	3.68		Reiners, 1972

[1]T-Throughfall
S-Stemflow
[2]Based on 9 months data
[3]Cited in Parker 1983

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Hokkaido, Japan	Abies	Mixed	Total litter	In / mass	Weight	.107	Shidei & Tsutsumi, 1962
	Picea	30	Total litter	In / mass	Weight	.012	
	Picea & Abies	Mixed	Total litter	In / mass	Weight	.077	
	Abies	40	Total litter	In / mass	Weight	.045	
	Abies	40	Total litter	In / mass	Weight	.085	
	Abies	40	Total litter	In / mass	Weight	.123	
	Abies	40	Total litter	In / mass	Weight	.106	
	Abies	30	Total litter	In / mass	Weight	.067	
	Abies	30	Total litter	In / mass	Weight	.038	
Washington, USA	Abies amab.	175	Total		Weight	.56	Turner & Singer, 1976[1]
New Hampshire, USA	Acer, Fagus		Betula	L.B.[2]	Weight	.85	Gosz et al. 1973
			Acer			.51	
			Fagus			.37	
Japan	Broad -mix -lower slope		Total Litter	In / mass	Weight	1.55	Katagiri & Tsutsumi, 1978
					N	.85	
					P	1.22	
					K	7.10	
					Ca	1.36	
					Mg	2.09	
	Broad -mix -upper slope				Weight	.28	
					N	.15	
					P	.18	
					K	.81	
					Ca	.46	
					Mg	.43	
Japan	Castanopsis -moist soil		Total Litter	In / mass	Weight	1.08	Katagiri et al. 1978
					N	1.08	
					P	.87	
					K	2.54	
					Ca	.79	
					Mg	1.48	
	Cyclobal. -dry soil		Total Litter	In / mass	Weight	.26	
					N	.20	
					P	.19	
					K	.47	
					Ca	.49	
					Mg	.31	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Japan	Chamaecyp.		Total Litter	In / mass	Weight	.318	Kawahara, 1971
					N	.340	
					P	.480	
					K	1.48	
					Ca	.500	
					Mg	.625	
England, UK	Conifer		Pinus	L.B.[1]	Weight	.65	Hayes, 1965
			Picea			.46	
			Abies			.46	
Kyoto, Japan	Cripto	50-60	Total litter	In / mass	Weight	.303	Shidei & Tsutsumi 1962
	Fagus	mix	Total litter	In / mass	Weight	.400	
	Quercus	mix	Total litter	In / mass	Weight	.545	
N.Carolina, USA	Decid., mix		Total litter	L.B.[1] (1 yr)	Weight	.70	Cromack & Monk, 1975
					N	.12	
					P	.34	
					K	1.76	
					Ca	.34	
					Mg	1.46	
			Pinus	C/N regress[1]	Weight	.43	
			Quercus			.60	
			Quercus			.72	
			Acer			.78	
			Cornus			1.26	
Oregon, USA	Douglas-fir	430	Logs	Regress	Weight	.043	MacMillan et al. unpublished
						.0084	
Stradbroke Is. Qld, Australia	Eucalyptus	?	Total	L.B.[1]	Weight	.24	Rogers & Westman, 1977
Maroondah, Victoria Australia	Eucalyptus regnans	38	Total	In/Biomass[4]	Weight	.26	Feller, unpublished
					N	.13	
					P	.27	
					K	.53	
					Mg	.30	
					Ca	.43	
					Na	2.00	
	Eucalyptus obliqua E. dives	38	Total	In/Biomass[4]	Weight	.52	
					N	.20	
					P	.51	
					K	1.08	
					Mg	.66	
					Ca	.67	
					Na	2.16	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Mt. Disappoint., Victoria, Australia	Eucalyptus	even	Total litter	In/Biomass[4]	Weight	.163	Attiwill, 1968
					P	.165	
					K	.256	
					Mg	.245	
					Ca	.189	
					Na	.484	
			Branch wood	L.B.[1] (2 yrs)	Weight	.092	
			Leaves	L.B.[1] (2 yrs)	Weight	.269	
Brisbane, Qld, Australia	Eucalyptus		Overstory	L.B.[2], Tether	Weight	.50-.61	Birk, 1977
			Pultenaea	Tether		.54-.79	
			Acacia	Tether		.38	
			Grass	Quadrats		.50	
			Overstory	In/Biomass[4]		.68	
			Woody			.24	
			Pultenaea			2.42	
			Acacia			.98	
			Grass			.13	
Kosciusko, NSW, Australia	Eucalyptus pauc.		Foliage	L.B.[2] (1 yr)	Weight	.776-.633	Macauley, 1975
					P	.598-.431	
					N	2.302-1.204	
Tennessee, USA	Fagus		Mix			.43[5]	
	Decid.		Mix			.511[5]	
	Quercus		Mix			.616[5]	
Japan	Fagus crenata		Total Litter	Input / mass	Weight	.362	Kawahara, 1971
					N	.395	
					P	.453	
					K	1.04	
					Ca	.316	
					Mg	.582	
Roudsea Wood, UK	Fraxinus, Betula		Foliage-Birch	L.B.[1]	Weight	1.772	Bocock & Gilbert, 1957
			Birch	(6 mos)		2.405	
			Lime			.799	
			Oak			.301	
			Oak			.185	
	Quercus, Betula		Birch			.301	
			Birch			.342	
			Lime			.248	
			Oak			.261	
			Oak			.186	
	Betula		Birch			.328	
			Birch			.288	
			Lime			.198	
			Oak			.248	
			Oak			.186	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Nagano, Japan	Larix	10	Total litter	In / mass	Weight	1.055	Shidei & Tsutsumi, 1962
	Larix	28	Total litter	In / mass	Weight	.296	
	Larix	48	Total litter	In / mass	Weight	.264	
Tennessee, USA	Liriodendron	48	Liriodendron	C/N regress[1]	Weight	.690	Ausmus & Witkamp, 1974
	Quercus		Fraxinus			.986	
			Carya			.927	
			Quercus			.630	
			Acer			.897	
			Cornus			1.105	
			Branches			.304	
			Flowers			1.253	
			Roots			1.135	
			Liriodendron	Lignin regress[1]	Weight	.852	
			Fraxinus			.768	
			Carya			.788	
			Quercus			.707	
			Acer			.883	
			Cornus			1.152	
			Branches			.385	
			Flowers			.844	
			Roots			.925	
Japan	Magnolia		Foliage	L.B.[2]	Weight	.654[4]	Kawahara & Sato, 1974
				Tether		1.05-1.514[4]	
	Cyclobalanopsis		Foliage	L.B.[2]	Weight	.431[4]	
				Tether		.916[4]	
Japan	Mix decid.		Larix	L.B.[3]	Weight	.58[4]	Kawahara, 1975
			Chamaecyparus			.635[4]	
			Mixed			.635[4]	
New Brunswick, Canada	Mix decid.		Acer foliage	L.B.[2]	Weight	.46-.87	MacLean, 1978
			Prunus fol.			.47-.90	
			Populus fol.			.31-.48	
			Betula fol.			.48-.70	
			Acer branch			.06-.11	
			Prunus branch			.04-.10	
			Populus branch			.20-.30	
			Betula branch			.10-.19	
			Understory			.43-1.25	
			Forest floor			.19-.27	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Quebec, Canada	Mix decid.		Populus	Wire screen	Weight	.52	Coldwell & deLong, 1950
			Acer			.63	
			Betula			.64	
Wakayama	Mixed con.	mix	Total litter	In / mass	Weight	.095	Shidei & Tsutsumi
Japan	Chamaecyparis	65	Total litter	In / mass	Weight	.097	1962
Roudsea Wood, UK	Mor		Foliage-Ash	L.B.[2] (1 yr)	Weight	1.609	Bocock, 1964
			Ash			.288	
	Modor		Foliage-Ash	L.B.[2] (1 yr)		1.609	
			Oak			.511	
Tennessee, USA	Picea		Mix decid.	L.B.[2] (1 yr)	Weight	.342[3]	Shanks & Olson, 1961
	Tsuga		Mix			.415[3]	
	Pinus		Mix			.515[3]	
Alaska, USA	Picea glauca		Needles	L.B.	Weight	.14	Piene & van Cleve, 1978
			Cellulose	(1 yr)	Weight	.12	
Ontario,	Picea rubens		Forest floor	In/Biomass			Gordon, 1979
Canada	dry	64			Weight	.059	
					N	.059	
					P	.200	
					K	.333	
					Ca	.250	
					Mg	.333	
	fresh	138			Weight	.015	
					N	.012	
					P	.062	
					K	.067	
					Ca	.200	
					Mg	.500	
	moist	147			Weight	.017	
					N	.010	
					P	.053	
					K	.043	
					Ca	.083	
					Mg	.045	
	wet	130			Weight	.017	
					N	.016	
					P	.045	
					K	.048	
					Ca	.143	
					Mg	.067	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Kumanoto,	Pinus	40	Total litter	In / mass	Weight	.169	Shidei & Tsutsumi
Japan	Pinus	11	Total litter	In / mass	Weight	.100	1962
Hyogo, Japan	Pinus	60	Total litter	In / mass	Weight	.109	Shidei & Tsutsumi 1962
Hiroshima	Pinus	mix	Total litter	In / mass	Weight	.212	Shidei & Tsutsumi
Japan	Pinus	mix	Total litter	In / mass	Weight	.143	1962
Shiga, Japan	Pinus	150	Total litter	In / mass	Weight	.133	Shidei & Tsutsumi
	Chamae.	30	Total litter	In / mass	Weight	.675	1962
	Chamae.	30	Total litter	In / mass	Weight	.660	
	Chamae.	30	Total litter	In / mass	Weight	.500	
	Chamae.	30	Total litter	In / mass	Weight	.165	
Tennessee, USA	Pinus		Foliage	L.B.[1]	Weight	.47	Witkamp & Olson, 1963
				Tether		1.10	
Japan	Pinus		Quercus	L.B.[1]	Weight	.58[1]	Kawahara, 1975
			Pinus	L.B.[1]		.616[1]	
			Mixture	L.B.[1]		.616[1]	
New Brunswick,	Pinus banksiana						
		29	Needles	L.B.(2 yr)	Weight	.28	MacLean, 1978
Canada			Branches			.03	
		57	Needles			.23	
			Branches			.08	
Japan	Pinus densiflora		Total Litter	In / mass	Weight	.405	Kawahara, 1971
					N	.226	
					P	.116	
					K	.226	
					Ca	.079	
					Mg	.211	
Japan	Pinus densiflora		Needles	L.B.	Weight	.47	Kawahara & Sato, 1977
			Branches 1-2 cm	Tether	Weight	.20	
			5- 6 cm	Tether	Weight	.12	
			9-10 cm	Tether	Weight	.07	
			Roots .9 cm	L.B.	Weight	.20	
			2.5 cm	3 yr	Weight	.16	
			5.5 cm	3 yr	Weight	.14	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Nevada, USA	Pinus jeffreyi				Weight	.11	Stark, 1973[1]
Netherlands	Pinus nigra	22	Total	In/Biomass[4]	C	.058	Minderman, 1968
					Cellulose	.111	
	Pinus sylvestris	85	Total	In/Biomass[4]	C	.0165	
					Cellulose	.070	
California, USA	Pinus ponderosa	150	Total	In/Biomass[4]	Weight	.029	Jenny et al. 1949
	Conifirs	50	Total			.029	
New Zealand	Pinus radiata		Total Litter	L.B.[2],[5]			Gadgil & Gadgil 1978
			-clearcut		Weight	1.14	
					Weight	1.17	
			-stand		Weight	.89	
					Weight	.82	
N. Carolina, USA	Pinus strobis		Needles	L.B.	Weight	.46	Cromack & Monk, 1973
	Mix dec.		Quercus		Weight	.61	
			Quercus		Weight	.72	
			Acer		Weight	.77	
			Cornus		Weight	1.26	
N.Carolina, USA	Pinus strobis			L.B.[1]	Weight	.42-.52	Cromack, 1972[1]
Tennessee, USA	Pinus taeda	19	Needles	L.B.[1] (1 yr)		.58[5]	Thomas, 1968
			Cornus fol.			1.27[5]	
			Mixed			.58[5]	
Tennessee, USA	Pinus virg.				Weight	.45-.46	Sollins et al. 1973[1]
	Pinus taeda					.51-.58	
Finland	Pinus,		Foliage	L.B.[3]	Weight	.26-.40	Mikola, 1960[1]
	Betula				Weight	.30-.46	
Alberta, Canada	Populus		P. tremuloid	L.B.[1] (1 yr)	Weight	.292	Lousier & Parkinson, 1976
				L.B.[1] (5 yr)		.113	
			P. balsomifera	L.B.[1] (1 yr)	Weight	.264	
				L.B.[1] (5 yr)		.131	
				Tether		.485	

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Alberta, Canada	Populus trem.		Epilobium against stems	L.B.[1] (1 yr)	Weight Weight	.848 .16 .377	Krauler, 1976
Alaska, USA	Populus, Betula		Populus Betula	L.B.[2]	Weight	.34-.48 .38-.52	Van Cleve, 1971
Oregon, USA	Pseudotsuga	450	Tsuga logs Pseudo. logs	Known age Known age	Weight Weight	0.025 0.012	Graham 1981
Washington, USA	Pseudotsuga	450	Boles	In / mass	Weight	0.028	Sollins, 1982
Washington, USA	Pseudotsuga	22 30 30 42 73	Total litter	In/Biomass[4]	Weight	.134 .164 .231 .150 .092	Turner & Long, 1975
B.C., Canada	Pseudotsuga dry mesic moist dry mesic moist	120	Needles Forest Floor	L.B.(1 yr) In/Biomass	Weight Weight Weight Weight Weight Weight	.43 .43 .43 .015 .017 .040	de Catanzaro, 1979
Oregon, USA	Pseudotsuga		Needles Branches Cones Bark	L.B.[2]	Weight	.22-.31 .059-.089 .047-.083 .005-.040	Fogel & Cromack, 1977
Netherlands	Quercus	Old	Total	In/Biomass[4]	C	.019	
California, USA	Quercus	50-100	Total	In/Biomass[4]	Weight	.117	Jenny et al. 1949
Tennessee, USA	Quercus		Acer Liriodendron Quercus	L.B.[2]	Ca Ca Weight Ca Weight Ca	.55 .54 .44 .38 .33 .35	Thomas, 1970

Table 10 Litter Decomposition

Location	Dom. Veg.	Age	Component	Method	Component	K(%)	Reference
Tennessee, USA	Quercus		Foliage	L.B.[2]	Weight	.70	
				Tether		1.67	
	Acer		Foliage	L.B.[2]		.64	
				Tether		1.47	
	Liriodendron		Foliage	Tether		3.22	
Fontainbleau, France	Quercus		Total	In/Biomass[4]	Weight	.31-.46	Lemee & Bichaut, 1973
				L.B.[2]	Weight	.20-.66	
Netherlands	Quercus			L.B.[2] (1 yr)	Phenols	.100	Minderman, 1968
				In/Biomass[4]		.105	
				L.B.[2]	Waxes	.25	
				In/Biomass[4]		.29	
				L.B.[2]	Lignin	.50	
				In/Biomass[4]		.69	
				L.B.[2]	Cellulose	.75	
				In/Biomass[4]		1.38	
				L.B.[2]	Hemicell	.90	
				In/Biomass[4]		2.30	
				L.B.[2]	Sugars	.99	
				In/Biomass[4]		4.60	
Tennessee, USA	Quercus alba		Mixed (ave)	L.B.[2] (1 yr)	Weight	1.021	Witkamp, 1966
	Pinus echinata					1.021	
	Acer rubrum					.994	
Missouri,USA	Quercus alba		Total litter	In/Biomass[4]	N	.188	Rochow, 1975
					P	.230	
					K	.340	
					Ca	.197	
					Mg	.238	
Oregon, USA	Tsuga het.	121	Logs	Volume loss	Weight	.008	Grier, 1978
	Picea sit.					.004	

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[1] From Fogel and Cromack, 1977
[2] Litter bag
[3] Based on Cromack, 1972
[4] Bases on Jenny et al (1949)
[5] Calculated from percent weight loss x/x0 = exp(-kt)

Table 11 Annual Uptakes (kg/ha/yr)

Location	Vegetation	Age	Comp.	N	P	K	Ca	Mg	Other	Reference
England	Abies grandis	20		30-75						Ovington, 1957a
Korea	Alnus sibirica	2	Total	120	12	70				Mun et al. 1977
USSR	Betula	35 20		146 94						Bazilevich'
USSR	Betula	42		135						Smirnova & Gorodentseva, 1958'
England	Betula	6-55		56	4.1	28	5.6	4.1	Na .6	Ovington, 1959a
Finland	Betula	40	Tree	109.6	10.9	47.8	77.1			Malkonen 1977
Oregon, USA	Bryophyte in Pseudotsuga forest	450		4.05	0.74	1.36	3.32	0.27		Binkley and Graham 1981
Norway	Bryophyte in conifer plantation			10.0	1.1	4.0	4.0			Tamm 1953
Canada	Bryophyte in conifer plantation			5.0	1.0	3.5	.9	.5		Weetman & Timmer 1967
Great Britain	Bryophyte in oakwood					14.0	3.9-4.4	3.6-4.2		Rieley et al 1979
Japan	Chamaecyparis			49.4	3.8	18.9	64.7	8.6		Kawahara 1971
England	Conifers			8-38						Ovington 1957a
Stradbroke Is. Qld, Australia	Eucalyptus	?	Tree Underst.	18 4.0	21 5.6	19 4.8	15 0.9	22 2.3	Na 16 0.7	Westman, 1978
C. Europe	Fagus			58.2	5.8	34.4	27.2	3.5	S 8.5	Ulrich, 1975
Minnesota, USA	Fagus	?		50	13	15	96			Bakuzis 1971
Japan	Fagus cren.			54.7	4.2	15.8	61.7	9.2		Kawahara 1971
C. Europe	Fagus sylvatica	120		144						Rodin & Bazilevich, 1967
Germany	Fagus sylvatica	90		70						Ebermayer, 1876'

Table 11 Annual Uptakes (kg/ha/yr)

Location	Vegetation	Age	Comp.	N	P	K	Ca	Mg	Other	Reference
Solling, W. Germany	Fagus sylvatica	125		71.9	4.89	45.9	33.3	3.20	Cl 27.5 Fe 3.70 Mn 6.03 Na 5.7 S 35.8	Ulrich & Mayer 1972
Sweden, Norway	Hylacomium splendens (Moss)		Total	10	1.1	4	4	4		Tamm 1953
England	Larix	20		16-33						Ovington, 1957a
England	Larix decidua	45		<11						Ovington, 1957a
Japan	Mixed broad -lower slope -upper slope			 108.2 41.8	 9.69 2.64	 76.5 31.2	 226.7 83.5	 28.9 10.7		Katagiri et al 1978
Kyoto, Japan	Mixed broad Chamaecyparis			86.7 31.9	4.2 1.3	98.6 21.1	95.5 61.7	26.3 9.3		Iwatsubo 1976
Wales	Mosses		Total			14	4.2	3.9		Rieley 1979
New Zealand	Nothofagus			40	3.3	34	84	12		Miller, 1963
USSR	Picea			61 62	3.2 2.7	18 12	56 48	9 7		Sonn, 1960[1]
England	Picea abies	20		44-49						Ovington, 1957a
USSR	Picea exc.	72 55		30 114						Remezov et al, 1959[1]
USSR	Picea exc.	125		47						Rudnova et al.[1]
USSR	Picea exc.	200		75						Marchenko & Karlov, 1961[1]
England	Picea omo.	47		11-18						Ovington, 1957a
England	Picea omo.			49	5	32	24	5	Na 1.8	Ovington, 1961
USSR	Picea sylv.	120		19						P'yavchenko, 1960[1]

Table 11 Annual Uptakes (kg/ha/yr)

Location	Vegetation	Age	Comp.	N	P	K	Ca	Mg	Other		Reference
Germany	Pine	20		18.57	1.31	5.04	10.73	1.80	Si	.85	Ramann, 1887[1]
		60		10.60	1.25	2.68	7.10	1.17		.44	
		120		7.75	.44	1.92	5.50	.87		.33	
	Spruce	20		15.15	1.38	5.57	8.37	2.10		.65	
		60		18.45	1.34	6.12	13.90	2.20		.68	
		120		13.70	1.78	4.34	11.36	1.53		.47	
Minnesota, USA	Pinus	?		45	5	7	29				Bakuzis 1971
Japan	Pinus dens.			38.8	3.8	14.3	38.7	5.6			Kawahara 1971
England	Pinus nigra	20		20-43							Ovington, 1957a
		47		9-14							
Scotland	Pinus nigra	40		17-187	4.4-9.2	14-44	26-36	7.6-11.1			Miller, Miller & Pauline 1976
New Zealand	Pinus rad.	0-22		13	1.5	13	8.9	3.5	Na	.3	Madgwick et al 1977
									Mn	.3	
									Zn	.15	
		2-4		62	7.9	49	24.4	10.5	Na	.6	
									Mn	1.0	
									Zn	.32	
		8-10		43	7.4	44	5.9	13.9	Na	.5	
									Mn	.4	
									Zn	.32	
Central Sweden	Pinus sylv.	120-140	Tree abovegr.	6.5	0.6	3.5	6.9	1.1	Na	0.6	Bringmark 1977
									S	1.4	
			belowgr.	10.0	2.0	9.2	5.7	2.5	NA	0.4	
									S	2.2	
			Understory	16.5	2.0	4.1	4.5	1.0	Na	0.32	
									S	2.9	
Germany	Pinus sylv.	80		48							Ebermayer, 1876[1]
	Picea exc.	90		48							
Finland	Pinus sylv.	28		19.0	2.5	9.8	11.1				Malkonen, 1974
		47		28.2	3.1	11.2	11.6				
		45		38.8	4.2	17.9	19.4				

Table 11 Annual Uptakes (kg/ha/yr)

Location	Vegetation	Age	Comp.	N	P	K	Ca	Mg	Other	Reference
England	Pinus sylv.	20-23		180	13	65	83	18	Na 11	Ovington, 1959b
England	Pinus sylv.			139	11	58	56	12		Ovington, 1959a
Quebec, Canada	Pleurozium shreberi (Moss)		Total	5	1.0	3.5	.9	.5		Weetman & Timmer 1967
USSR	Populus	25		143						Remezov et al, 1959[1]
		50		154						
Washington, USA	Pseudotsuga	22	Tree	27.6	11.2	30.2	29.3	9.2	Mn 7.0	Turner, 1975
			Underst.	16.7	2.8	19.9	20.0	4.9	1.6	
		30	Tree	27.4	6.4	30.0	46.7	8.7	8.3	
			Underst.	6.6	.5	8.3	12.5	2.8	2.0	
		42	Tree	34.0	10.1	32.9	42.0	9.8	7.3	
			Underst.	7.3	.5	8.0	12.8	2.3	1.8	
		73	Tree	24.0	2.4	24.6	41.0	5.4	7.3	
			Underst.	3.7	1.5	2.6	6.1	.3	1.8	
		95	Tree	12.1	2.7	27.7	52.4	5.1	7.8	
			Underst.	2.3	.7	1.7	3.5	.9	1.4	
Washington	Pseudotsuga menziesii	45	Control	17						Turner 1977
			Low fer.	31						
			High fert.	63						
			Carbohy. fert.	4						
Oklahoma, USA	Quercus	80		103.0	11.0	81.6	304.2	23.9	Mn 12.3	Johnson & Risser, 1974
Korea	Quercus acutissima	12	Total	131	13	112				Mun et al. 1977
Minnesota, USA	Quercus	?		88	70	79	56			Bakuzis 1971
USSR	Quercus robur	43		91						Mina, 1955[1]
		220		83						
USSR	Quercus robur	12		80						Remezov et al. 1959[1]
		48		104						
USSR	Tilia cord.	40		105						Remezov et al, 1959[1]
		74		131						

[1]In Rodin & Bazilevich, 1967
[2]In Ovington, 1962

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component		N	P	K	Ca	Mg	Other	Reference
N.W. USA	Acer saccharum	70	Foliage-mid crown		1.98-2.32	0.10-0.12	0.55-0.74	0.86-1.02	0.14-0.16	Mn766-1175' Na 58-82' Fe 59-73' Zn 32-71' Al 32-38' Cu 3-5' Co 3-6'	Lea et al. 1980
Prince George, B.C. Canada	Abies lasiocarpa	110-350	Wood (stem divided into 10 equal sections)	Top10	.060	.005	.123	.155	.029		Kimmins, 1974
				9	.065	.002	.118	.159	.029		
				8	.055	.005	.137	.165	.033		
				7	.054	.005	.144	.204	.047		
				6	.064	.002	.127	.144	.035		
				5	.050	.004	.086	.100	.023		
				4	.040	.005	.075	.080	.018		
				3	.050	.004	.070	.075	.017		
				2	.049	.002	.063	.075	.016		
				1	.050	.002	.061	.070	.019		
			Bark	Top10	.530	.085	.18	.680	.094		
				9	.42	.075	.16	.89	.088		
				8	.38	.059	.15	.90	.077		
				7	.36	.059	.14	.83	.095		
				6	.36	.059	.15	.81	.082		
				5	.31	.060	.14	.80	.070		
				4	.31	.060	.13	.85	.062		
				3	.32	.055	.14	.93	.058		
				2	.35	.054	.14	.97	.048		
				1	.33	.074	.13	.95	.031		
			Branches>2.5		.16	.07	.08	.59	.052		
			2.5>0.6cm.		.20	.045	.119	.56	.050		
			Twigs & Foliage								
			Upp.crown		.70	.14	.22	.50	.077		
			Mid.crown		.72	.15	.25	.50	.080		
			Low.crown		.67	.16	.22	.61	.096		
B.C., Canada	Abies amabalis		current needles		.91-.99	.12-.16	1.2-1.10	.30-.41	.07-.08	S 1200'	Beaton et al.1965
Oregon	Abies amabalis		Leaves			.18	1.05	.43	.12	S .06 B 26' Zn 33' Fe 40' Mn 825'	Will & Youngberg, 1979

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
New York, USA	Abies balsamea						1.15			Chandler, 1944
B.C., Canada	Abies balsamea	300+	Wood	.05	.01	.06	.06	.01		Krumlik, 1978
			Bark	.24	.04	.13	.49	.03		
			Large branch	.15	.02	.09	31	.02		
			Small branch	.22	.03	.12	.29	.03		
			Fol+twigs	.74	.10	.33	.44	.07		
Maine, USA	Abies balsamea		Branches	.31	.11	.36	.84	.08		Young, 1971
			Stem	.28	.06	.23	.53	.06		
			Stump+roots	.25	.07	.19	.64	.06		
USA	Abies balsamea		Needles	1.955	.187	.662	.661	.120	Cu 10.9[1] Fe 294[1] Mn †125[1] Na 313[1] Zn ¤35[1]	Stark, 1973
California, USA	Abies concolor	8	Current needles low elev. site	1.38	0.12	1.23	0.53	0.14	Mn 89.3[1]	Isik 1978
			Current needles mid elev. site	1.41	0.11	1.10	0.33	0.10	Mn 54.5[1]	
			Current needles high elev. site	1.13	0.18	1.09	+0.32	0.14	Mn 195.7[1]	
Oregon	Abies grandis		Foliage		.14	1.00	.45	.12	S .06 B 23[1] Zn 31[1] Fe 50[1] Mn 790[1]	Will & Youngberg, 1979
Idaho, USA	Abies grandis	20-30, Fert.	Needles-new	1.29	.19	.90				Loewenstein
			Needles-old	1.00	.14	.58				
			Branches-new	.98	.18	.86				& Pitkin 1971
			Branches-old	.52	.08	.42				
			Bark	.52	.10	.50				
			Stem	.11	.01	.10				
		unfert.	Needles-new	1.18	.19	1.09				
			Needles-old	1.06	.15	.81				
			Branches-new	.88	.15	.92				
			Branches-old	.43	.06	.34				
			Bark	.50	.07	.48				
			Stem	.08	.01	.08				

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Prince George, B.C. Canada	Abies lasio.	110-125	Aerial: Wood	18.0	8.4	46.9	21.0	37.1		Kimmins, 1974
			Bark	76.3	31.4	19.8	41.3	24.9		
			Live crown	55.7	60.2	33.3	37.7	38.0		
Montana, USA	Abies lasio.		Wood & bark <15 cm dbh	0.11	0.05	0.10	0.34	0.02	Cu 9.1[1] Fe 72[1] Mn 152[1] Na 29[1] Zn 12[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.16	0.07	0.07	0.31	0.002	Cu 10.6[1] Fe 28[1] Mn 111[1] Na 8[1]	
			Wood & bark >30 cm dbh	0.26	0.04	0.11	0.25	0.003	Cu 9.2[1] Fe 39[1] Mn 123[1] Na 20[1] Zn 10[1]	
B.C., Canada	Abies lasioc.	3-6	current needles	1.05-1.85	.18-.26	.70-1.08	.29-.44	.07-.11	S 1200-1600[1]	Beaton et al. 1965
N. Stradbroke, Australia	Acacia concurrens		Current leaves	2.1	.04	.6	.90	.18	Na .12 S .13	Westman & Rogers, 1977
			Older leaves	2.3	.08	.8	.60	.16	Na .15 S .14	
N.E. USA	Acer rubrum	70	Foliage-mid crown	1.72-1.93	0.08-0.13	0.54-0.79	0.80-1.12	0.14-0.20	Mn867-1316[1] Na 75-112[1] Fe 54-65[1] Zn 38-77[1] Al 29-66[1] Cu 4-6[1] Co 3-6[1]	Lea et al. 1980
New York, USA	Acer rubrum						.91			Chandler, 1944
Maine, USA	Acer rubrum		Branches	.69	.07	.24	1.38	.05		Young, 1971
			Stem	.51	.06	.20	1.23	.04		
			Stump+roots	.41	.11	.37	2.01	.07		
Southeast USA	Acer rubrum				0.14	0.64	1.00	0.20	Lignin 12.7	Sharpe et al. 1980

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
USA	Acer rubrum		Leaves	.790	.179	.556	.687	.100	Cu 11.3[1] Fe 146[1] Mn 2388[1] Na 367[1] Zn 46.5[1]	Stark, 1973
Southeast USA	Acer saccharum				0.33	1.17	1.64	0.28	Lignin 15.0	Sharpe et al. 1980
New York, USA	Acer saccharum						1.75			Chandler, 1944
USA	Acer saccharum		leaves	1.926	.122	.750	1.020	.230	Cu 10.5[1] Fe 254[1] Mn 1250[1] Na 348[1] Zn 44.2[1]	Stark, 1973
New Hampshire, USA	Acer saccharum		Leaves	2.19	.18	1.01	.60	.12	S .21	Likens & Bormann, 1970
			Twigs		.18	.93	1.62	.10		
			Branches	.37	.07	.17	.43	.03	.04	
			Stem bark	.55	.03	.29	1.41	.06	.06	
			Light wood	.10	.01	.07	.10	.02	.01	
			Dark wood	.10	.004	.30	.32	.06	.009	
			Roots	.71	.37	.27	.25	.05	.07	
New Hampshire, USA	Acer spic.		Leaves	2.49	.20	1.33	.75	.13	.19	Likens & Bormann, 1970
			Twigs		.14	.56	1.17	.12		
			Branches	.48	.10	.18	.46	.05	.03	
			Bark	.76	.09	.16	1.36	.06	.08	
			Light wood	.07	.008	.04	.09	.01	.01	
			Dark wood	.12	.004	.07	.08	.02	.01	
			Roots	.82	.10	.23	1.25	.07	.06	
New York, USA	Acer spp.									
	May 27			2.31	.29	1.28	.74			Tryon, 1936
	June 26			1.89	.24	.81	1.19			
	July 26			1.89	.23	.69	1.04			
	Aug 26			1.85	.23	.69	1.17			
	Sept 25			1.80	.23	.68	1.37			
Minnesota, USA	Alnus crispa	6	Leaves		0.23	0.74	0.91	0.24	Fe 239[1] Cu 9.1[1] Zn 38[1] Mn 700[1]	Grigal et al. 1979

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Minnesota, USA	Alnus crispa		Leaves	2.28	0.16	0.56	1.07	0.24	Fe 115[1] Cu 3.5[1] Zn 12[1] Mn 318[1] Al 77[1] Na 7.6[1] B 21[1]	Henry 1973
UK	Alnus inc.	21	Leaves	2.65	.36	1.66	2.46	.27	Na .04	Ovington, 1956a
Oregon, USA	Alnus rubra	?	Senescent leaves	2.10					Lignin 9.5 Cellulose 80.6	Cromack et al. 1979
			Bole wood	0.17					Lignin 19.4 Cellulose 29.5	
			Roots (2-5 mm)	0.75					Lignin 17.4 Cellulose 48.0	
B.C., Canada	Alnus rubra	23	Leaves	2.87	0.29	0.91	0.77	0.19	S 0.28	Binkley 1982
			Branches	0.64	0.02	0.27	0.28	0.11		
			Stems	0.21	0.01	0.10	0.08	0.02	S 0.02	
Washington, USA	Alnus rubra	2	Leaves	2.96	0.23	0.85	0.64	0.19	Fe 100[1] Mn 100[1]	Hughes et al. 1968
Korea	Alnus sibirica	12	Leaves	1.33	0.19	0.84				Mun et al. 1977
			Branches	0.56	0.05	0.10				
			Trunks	0.44	0.02	0.06				
			Roots	0.68	0.03	0.55				
B.C., Canada	Alnus sinuata	23	Leaves	5.97	0.35	0.79	0.77	0.19	S 0.29	Binkley 1982
			Stems	0.21	0.01	0.05	0.05	0.02	S 0.02	
B.C., Canada	Alnus sinuata	5	Leaves	2.51	0.39	0.85	1.13	0.19		Binkley 1982
			Stems	0.64	0.15	0.23	0.21	0.04		
			Roots	0.64	0.15	0.23	0.24	0.04		
N. Stradbroke Australia	Banksia aemula		Primary branch bark	.19	.005	.14	.350	.298	Na .298	Westman & Rogers 1977
			Secondary branch wood	.11	.005	.02	.225	.085	.107	
			Secondary branch bark	.26	.005	.07	.375	.240	.155	
			Tertiary (termi.) branch wood	.26	.028	.23	.400	.070	.179	
			Tertiary (termi.) branch bark	.25	.014	.25	.425	.192	.226	
			Root crown wood	.22	.005	.02	.200	.040	.067	
			Root crown bark	.26	.005	.04	.225	.064	.167	
			Tap root wood	.11	.005	.01	.125	.026	.061	
			Tap root bark	.24	.005	.02	.225	.070	.095	
			Lateral root wood	.10	.006	.04	.050	.025	.107	
			Lateral root bark	.16	.006	.02	.125	.070	.160	
			Flowers	.8	.08	.5	.08	.08	Na .14 S .08	
			Current leaves	.7	.05	.4	.14	.08	Na .15 S .08	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
			Older leaves	1.0	.04	.4	.13	.10	Na .13 S .10	
			Stem wood	.1	.005	.01	.150	.021	Na .074	
			Stem bark	.20	.005	.05	.350	.123	Na .202	
			Primary branch wood	.10	.005	.05	.200	.044	Na .071	
New Hampshire, USA	Betula alleghaniensis		Leaves	2.78	.20	1.14	.88	.25	.14	Likens & Bormann, 1970
			Twigs		.21	.52	.96	.16		
			Branches	.44	.03	.10	.42	.03	.04	
			Stem bark	.60	.03	.13	.96	.04	.04	
			Light wood	.09	.01	.03	.06	.01	.02	
			Dark wood	.10	.01	.11	.09	.02	.02	
			Roots	.61	.08	.14	.37	.04	.07	
N.E. USA	Betula alleghaniensis	70	Foliage-mid crown	2.45-2.63	0.12-0.15	0.80-0.96	0.92-1.18	0.23-0.30	Mn1070-1650[1] Na 65-145[1] Fe 69-87[1] Zn399-439[1] Al 62-87[1] Cu 6-7[1] Co 4-6[1]	Lea et al. 1980
UK	Betula alba	21	Leaves	1.44	.33	1.09	1.99	.29	.03	Ovington, 1956a
New York, USA	Betula lutea						1.21			Chandler, 1944
USA	Betula lutea		leaves	2.055	1.360	.731	.757	.320	Cu 12.0[1] Fe 335[1] Mn 286[1] Na 372[1] Zn 125[1]	Stark, 1973
N.E. USA	Betula papyrifera		Leaves							Lang et al. 1982
			Late summer	2.79	0.193	0.937	0.233	0.113	Na 0.0056	
			Leaf fall	2.47	0.168	0.500	0.384	0.148	Na 0.0060	
			Twigs	2.31	0.157	0.121	0.311	0.121	Na 0.0038	
			Wood							
			Branch 1-5 cm	0.222	0.034	0.089	0.082	0.027	Na 0.0017	
			Branch 5-10 cm	0.128	0.022	0.066	0.072	0.027	Na 0.0026	
			Bole	0.115	0.009	0.040	0.084	0.020	Na 0.0012	
			Roots							
			<1 mm	1.51	0.082	0.182	0.182	0.066	Na 0.0025	
			1-5 mm	1.10	0.068	0.170	0.187	0.068	Na 0.0021	
			0.5-1 cm	0.85	0.052	0.142	0.138	0.051	Na 0.0016	
			1-2.5 cm	0.61	0.039	0.119	0.107	0.043	Na 0.0013	
			>2.5 cm	0.48	0.038	0.097	0.105	0.037	Na 0.0010	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Maine, USA	Betula papyrifera		Branches	.67	.04	.10	1.05	.05		Young, 1971
			Stem	.53	.04	.10	1.04	.04		
			Stump+roots	.35	.06	.16	.89	.06		
UK	Betula verr.		Leaves	2.85	.17	1.56	1.57	.27		Ovington & Madgwick, 1959a
			Stem	.14	.01	.07	.25	.02		
USSR	Betula verr.		Leaves	2.36	.19	.73	1.13	.67	S .08	Bazilevich[1]
			Stem	.26	.02	.07	.13	.04	.01	
			Fine roots	1.46	.11	.17	.60	.16	.07	
Minamata, Japan	Broad-mixed		Leaf	1.48	.081	.59	.55	.19		Katagiri et al. 1978
			Branch	.50	.042	.30	.46	.10		
			Stem	.16	.009	.17	.19	.03		
Japan	Broad, decid.		Foliage	2.4-2.9	.12-.33	.7-1.4	.6-2.0			Tsutsumi 1971
	Needles, decid.		Foliage	2.0-2.5	.14-.22	.5-1.0	.4-1.0			
	Pinus		Foliage	.9-1.2	.05-.13	.4-.9	.5-1.0			
	Broad evergr.		Foliage	1.3-1.9	.07-.11	.5-1.0	.6-1.2			
	Needle,evergr.		Foliage	.9-1.5	.06-.19	.3-.5	.5-1.4			
	Cryptomeria.		Foliage	.9-1.3	.08-.13	.4-.8	.6-1.4			
USSR	Carpinus bet.		Leaves		.13	1.35	1.49	.33	Na .36 S .07	Dzens-Litovskaya, 1960[1]
			Stem+branch		.02	.28	.54	.11	Na .05 S .02	
Southeast USA	Carya				0.07	0.83	1.71	0.24	Lignin 16.9	Sharpe et al. 1980
New York, USA	Carya allia						2.62			Chandler, 1944
New York, USA	Carya cord.						2.50			Chandler, 1944
New York, USA	Carya ovata						1.94			Chandler, 1944
USA	Carya ovata		Leaves	1.189	.237	.862	.687	.231	Cu 12.9[1] Fe 438[1] Mn 3580[1] Na 215[1] Zn 345[1]	Stark, 1973

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
USA	Castanea dentata		Leaves	1.472	.255	.750	.807	.162	Cu 9.9¹ Fe 100¹ Mn 1325¹ Na 325¹ Zn 31.3¹	Stark, 1973
UK	Castanea sat.		Leaves	2.59	.17	.95	.57	.22	.05	Ovington, 1956a
UK	Castanea sat.	46	Leaves	2.50	.22	1.10	.67	.29	.02	Ovington, 1956a
Oregon, USA	Ceanothus velut.	7	Leaves	1.78						Cromack et al. 1979
			Stems	0.36						
			Roots	0.43						
			Nodules	2.37						
Haney, B.C.	Chamaecyparis nootkatensis, Thuja plicata		Branches	20.0	15.4	9.2	22.4			Kimmins & Krumlik, 1976
			Stembark	17.1	15.4	24.5	34.6			
			Stemwood	22.9	38.4	54.1	20.6			
Maine, USA	Chamaecyparis		Branches	.38	.04	.05	2.28	.07		Young, 1971
			Stem	.28	.02	.08	2.45	.07		
			Stump+roots	.31	.06	.16	2.22	.09		
UK	Chamaecyparis	20	Needles	.92	.06	.30	1.02	.19	.03	Ovington, 1956a
Czechoslovakia	Cornus sanguinea L.		Buds	5.018	.884	1.741	1.117	.312	Ash 7.619	Klimo, 1975
			Leaves	2.367	.272	1.390	2.554	.630	Ash11.409	
			Fruits	1.275	.323	1.312	.276	.116	Ash 3.850	
			Fruit-stalks	1.267	.222	2.084	.850	.211	Ash 6.726	
			Annual shoots	1.720	.322	.774	.936	.253	Ash 4.614	
			Branches<5mm	.930	.192	.516	.641	.149	Ash 6.160	
			Branches 5-10mm	.825	.144	.165	.459	.100	Ash 2.845	
			Stem-Wood	.614	.084	.160	.182	.050	Ash 1.703	
			Stem-Bark	1.556	.222	.714	.218	.143	Ash 6.955	
			Roots <1mm	1.275	.188	.664	.799	.419	Ash 7.523	
			Roots 1-2mm	.878	.171	.387	.638	.235	Ash 3.927	
			Roots 2-5mm	1.008	.169	.277	.513	.166	Ash 2.995	
			Roots 5-20mm	.993	.167	.246	.404	.134	Ash 3.199	
			Stumps	.450	.056	.191	.378	.073	Ash 1.839	
Southeast USA	Cornus florida				0.14	1.24	1.80	0.55	Lignin 3.9	Sharpe et al. 1980

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
UK	Corylus < 1 cm		Total	.97	.07	.20	1.10	.06	.018	Sykes & Barr, 1973
	1			.55	.03	.11	.58	.02	.007	
	2			.38	.02	.06	.50	.01	.004	
	3			.32	.02	.06	.48	.01	.003	
	4			.32	.02	.06	.55	.02	.003	
	6			.29	.02	.08	.41	.02	<.003	
	> 6			.28	.02	.08	.34	.02	<.003	
Japan	Cryptomeria -moist soil	1	Foliage	1.51	.57	1.01				Harada, 1970
			Twig	1.41	.46	.95				
			Stem	.37	.10	.36				
			Root	.52	.11	.36				
		3	Foliage	.97	.34	1.08				
			Twig	1.38	.18	.67				
			Branch	.50	.11	.20				
			Stem	.35	.06	.22				
			Root	.52	.06	.37				
		5	Leaf	1.16	.25	.84				
			Twig	.73	.39	1.04				
			Branch	.46	.11	.20				
			Stem	.25	.05	.17				
			Root	.30	.05	.24				
		12	Leaf	1.13	.25	.64				
			Twig	.57	.16	.46				
			Branch	.26	.09	.18				
			Stem	.12	.02	.14				
			Root	.30	.05	.25				
	Cryptomeria -dry soil	1	Leaf	1.33	.43	.01				
			Twig	1.38	.34	.92				
			Stem	.44	.11	.44				
			Root	.65	.11	.55				
		3	Leaf	.86	.30	.76				
			Twig	1.45	.23	.53				
			Stem	.31	.07	.22				
			Root	.55	.09	.37				
		5	Leaf	1.06	.27	.88				
			Twig	.69	.16	.65				
			Branch	.30	.09	.25				
			Stem	.27	.05	.17				
			Root	.23	.05	.25				
		12	Needles	.99	.20	.70				
			Twigs	.60	.16	.14				
			Branches	.28	.14	.17				
			Stems	.17	.05	.13				
			Roots	.31	.05	.25				

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other		Reference
Pakthongchai, NE Thailand	Dry Dipterocarps forest		Leaves	1.75	.164	.96	.86	.62			Tsutsumi, Kan & Khemanark 1967
			Branches	.51	.072	.45	.82	.16			
			Stem	.25	.025	.27	.54	.10			
	Dry Evergreen forest			1.78	.094	.84	1.16	.46			
			Branches	.61	.041	.35	.76	.19			
			Stem	.25	.015	.18	.44	.25			
Australia	E. obliqua		stemwood	.08	.002	.01	.01	.03	Na	.01	Feller, 1981
			stembark	.16	.007	.05	.02	.15		.06	
			live branches	.13	.013	.07	.08	.13		.04	
			dead branches	.16	.008	.03	.09	.10		.04	
			leaves	.69	.053	.41	.25	.57		.16	
			roots	.12	.023	.30	.11	.06		.06	
	E. dives		stemwood	.15	.003	.03	.01	.03		.02	
			stembark	.46	.016	.13	.15	.48		.06	
			live branches	.16	.007	.07	.06	.16		.03	
			dead branches	.16	.005	.02	.02	.10		.01	
			leaves	.96	.060	.44	.21	.58		.12	
Australia	Eucalyptus signata		Primary branch bark	.46	.005	.25	1.100	.140	Na	.179	Westman & Rogers, 1977
			Secondary branch wood	.15	.005	.02	.125	.014		.062	
			Secondary branch bark	.30	.014	2.70	1.425	.192		.190	
			Tertiary (termi.) branch wood	.26	.016	.14	.250	.630		.286	
			Tertiary (termi.) branch bark	.48	.016	.30	.800	.168		.143	
			Root crown wood	.17	.005	.01	.075	.003		.036	
			Root crown bark	.28	.015	2.10	1.775	.189		.190	
			Tap root wood	.18	.004	.01	.150	.010		.048	
			Tap root bark	.33	.007	.06	.500	.030		.076	
			Lateral root wood	.31	.018	.12	.175	.050		.071	
			Lateral root bark	.35	.011	.12	.450	.140		.119	
			Flowers	1.0	.09	.5	.39	.21	Na	.13	
									S	.09	
			Current leaves	1.3	.08	.5	.34	.20	Na	.16	
									S	.10	
			Older leaves	1.4	.075	.5	.38	.185	Na	.145	
									S	.10	
			Live stem wood	.21	.005	.01	.075	.003	Na	.171	
			Dead stem wood	.27	.005	.02	.175	.043	Na	.062	
			Live stem bark	.26	.008	1.60	1.500	.200	Na	.202	
			Dead stem bark	.38	.010	.06	.900	.100	Na	.090	
			Primary branch wood	.16	.005	.01	.100	.003	Na	.048	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other		Reference
Australia	Eucalyptus umbra ssp. umbra		Primary branch bark	.30	.005	.09	.225	.039		.090	Westman & Rogers, 1977
			Secondary branch wood	.12	.005	.01	.200	.001		.029	
			Secondary branch bark	.30	.012	.14	.300	.117		.131	
			Tertiary (termi.) branch wood	.44	.010	.07	.250	.060		.100	
			Tertiary (termi.) branch bark	.42	.014	.14	.700	.230		.143	
			Root crown wood	.22	.005	.01	.100	.001		.033	
			Root crown bark	.37	.005	.03	.375	.018		.071	
			Tap root wood	.17	.004	.01	.100	.010		.040	
			Tap root bark	.35	.008	.03	.325	.020		.071	
			Lateral root wood	.38	.024	.09	.100	.044		.071	
			Lateral root bark	.34	.013	.13	.400	.090		.107	
			Current leaves	1.25	.08	.6	.18	.16	Na	.15	
									S	.08	
			Older leaves	1.1	.05	.5	.355	.20	Na	.14	
									S	.09	
			Live stem wood	.20	.005	.01	.150	.003	Na	.076	
			Dead stem wood	.23	.005	.03	.175	.043	Na	.064	
			Live stem bark	.31	.005	.07	.550	.042	Na	.210	
			Dead stem bark	.41	.005	.02	.350	.110	Na	.060	
			Primary branch wood	.19	.005	.02	.175	.001	Na	.026	
Ise, Mie Pref Japan	Evergr. Br. L.		Leaf	1.57	.102	.88	.52	.35			Tsutsumi et al. (unpublished).
			Branch	.38	.071	.29	.38	.11			
			Stem	.19	.035	.16	.17	.06			
N.E. Thailand	Evergr. Br.L.		Leaf	1.78	.094	.84	1.16	.49			Tsutsumi et al.1967
			Branch	.61	.041	.35	.76	.19			
			Stem	.25	.015	.18	.44	.25			
Minamata, Japan	Evergreen Br.L.		Leaf	1.22	.082	.68	.89	.35			
			branch	0.34	.034	.18	.50	.07			Kawahara 1971
			Stem	0.14	.012	.13	.26	.04			
Kumamoto, Japan	Evergreen Br.L. Forest		Leaves	1.52	.086	.83	1.19	.89			Tsutsumi, Kan & Khemanark 1967
			Branches	.47	.033	.50	.86	.30			
			Stem	.16	.011	.23	.32	.15			

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Hitoyoshi, Kumamoto Pref Japan	Evergreen Br.L.		Leaf	1.92	.078	.59	0.65	.29		Shidei et al. (unpublished)
			Branch	.57	.039	.30	0.64	.14		
			Stem	.20	.009	.13	.31	.04		
N.E. USA	Fagus grand.	70	Foliage-mid crown	2.47-2.48	0.11-0.13	0.71-0.84	0.73-.77	0.18-0.19	Mn925-1764[1] Na 60-223[1] Fe 86-92[1] Zn 37-68[1] Al 32-60[1] Cu 5-7[1] Co 2-4[1]	Lea et al. 1980
Southeast USA	Fagus grandifolia				0.03	0.31	0.84	0.07	Lignin 19.2	Sharpe et al. 1980
New York, USA	Fagus grandifolia						.75			Chandler, 1944
USA	Fagus grandifolia		Leaves	1.355	.142	1.247	1.047	.170	Cu 15.5[1] Fe 222[1] Mn 1875[1] Na 320[1] Zn 23[1]	Stark, 1973
New Hampshire, USA	Fagus grandifolia		Leaves	2.23	.18	.88	.55	.15	.17	Likens & Bormann, 1970
			Twigs		.20	.58	1.23	.23		
			Branches	.30	.03	.12	.47	.03	.05	
			Bark	.75	.04	.22	2.53	.05	.07	
			Light wood	.11	.01	.07	.06	.02	.03	
			Dark wood	.12	.002	.10	.08	.02	.03	
			Roots	.64	.12	.24	.36	.05	.04	
USSR	Fagus orien.		Leaves		.30	1.20	1.40	.43	S .16	Dzhafarov, 1960[1]
Australia	Fagus regnans		stemwood	.02	.002	.18	.02	.03	Na .01	Feller, 1981
			stembark	.13	.016	.36	.10	.63	.06	
			live branches	.12	.009	.38	.04	.26	.02	
			dead branches	.12	.004	.05	.03	.19	.02	
			leaves	1.29	.105	.86	.23	.49	.09	
			roots	.18	.018	.44	.13	.05	.08	
UK	Fagus sylv.	38	Leaves	2.57	.18	.99	.97	.19	.03	Ovington, 1956a
Germany	Fagus sylv.		Leaves	1.71	.60	1.73	.73	.23	S .10	Ebermayer, 1876[1]
			Branches	.70	.06	.04	.42	.08	tr.	
			Stem	.36	.02	.07	.32	.04	tr.	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
UK	Fraxinus	< 1 cm		.79	.08	.56	.77	.08	.012	Sykes & Barr, 1973
		1		.50	.04	.31	.54	.05	.008	
		2		.31	.02	.18	.41	.03	<.003	
		3		.26	.02	.14	.40	.03	<.003	
		4		.22	.02	.13	.32	.02	<.003	
		6		.19	.01	.11	.32	.02	<.003	
		8		.18	.01	.11	.31	.02	.004	
		10		.16	.01	.09	.22	.02	.005	
		12		.15	.01	.10	.14	.01	.006	
		> 12		.16	.01	.11	.14	.01	<.003	
Czechoslovakia	Fraxinus		Leaves	2.68	.34	2.24	2.26	.51	Ash12.02	Klimo, 1975
			Annual shoots	1.10	.15	.81	.79	.17	Ash 3.90	
			Branches <2cm							
			Bark	1.00	.06	.66	1.75	.14	Ash 5.08	
			Wood	.69	.05	.17	.16	.03	Ash .60	
			Branches 2-5cm							
			Bark	.89	.06	.56	1.27	.08	Ash 3.53	
			Wood	.63	.04	.18	.24	.04	Ash 1.05	
			Branches >5cm							
			Bark	.57	.03	1.11	1.55	.12	Ash 4.48	
			Wood	.62	.03	.23	.27	.04	Ash 1.44	
			Stem - Bark	.59	.03	.57	1.95	.11	Ash 4.80	
			Stem - Wood	.27	.02	.27	.08	.03	Ash .69	
			Underground parts							
			0-0.1cm	1.39	.12	.16	.22	.29	Ash19.41	
			0.1-1cm Bark	.98	.05	.72	1.37	.36	Ash10.50	
			Wood	.55	.10	.30	.49	.25	Ash 3.03	
			1-2cm Bark	1.08	.05	.71	1.15	.22	Ash14.97	
			Wood	.65	.07	.13	.22	.06	Ash 1.41	
			2-5cm Bark	.70	.07	.76	1.36	.21	Ash14.27	
			Wood	.30	.03	.06	.19	.04	Ash 1.49	
			5-10cm Bark	.77	.04	.51	2.70	.28	Ash14.39	
			Wood	.54	.09	.13	.13	.07	Ash 1.26	
			>10cm Bark	.66	.08	.60	1.17	.19	Ash12.31	
			Wood	.49	.07	.09	.23	.06	Ash 1.30	
Southeast USA	Fraxinus				0.09	0.86	2.82	0.29	Lignin 16.8	Sharpe et al. 1980
New York, USA	Fraxinus amer.						2.19			Chandler, 1944
USSR	Fraxinus excel.		Leaves	1.36	.51	1.88	1.96	.43	S .22	Remezov et al, 1959'
			Branches	.71	.21	.58	.70	.08		
			Stem	.24	.07	.30	.32	.03		

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Southeast USA	Gleditsia triacanthos				0.35	1.65	3.15	0.35	Lignin 25.1	Sharpe et al. 1980
Southeast USA	Juglans nigra				0.31	1.12	2.14	1.02	Lignin 6.6	Sharpe et al. 1980
USA	Juniperus utahensis		needles	.778	.106	.447	1.463	.137	Cu 9.2[1] Fe 114[1] Mn 17[1] Na 395[1] Zn 7.8[1]	Stark, 1973
Southeast USA	Juniperus virg.				0.05	0.41	4.64	0.12	Lignin 22.8	Sharpe et al. 1980
Southeast USA	Kalmia latifolia				0.01	0.30	1.58	0.18	Lignin 21.5	Sharpe et al. 1980
USA	Larix laricina		needles	1.762	.165	.387	.700	.132	Cu 9.9[1] Fe 378[1] Mn 458[1] Na 313[1] Zn 25[1]	Stark, 1973
UK	Larix lept.		Needles	2.32	.18	.50	.54	.16	Na .04	Ovington, 1956a
	Tsuga heter.		Needles	1.98	.12	.47	.38	.13	.07	
	Pseudotsuga		Needles	1.27	.09	.38	.74	.17	.16	
	Picea omor.		Needles	1.07	.08	.32	.52	.13	.05	
	Pinus nigra		Needles	1.15	.07	.38	.74	.12	.07	
	Larix deci.		Needles	2.16	.22	.48	.61	.17	.06	
	Pinus sylv.		Needles		.13	.56	.62	.09	.03	
	Abies gran.		Needles	1.46	.11	.46	.91	.16	.02	
	Larix lept.		Needles	1.24	.21	.47	1.03	.12	.02	
Montana, USA	Larix occidentalis		Wood & bark <15 cm dbh	0.12	0.07	0.07	0.14	0.02	Cu 8.7[1] Fe 39[1] Mn 167[1] Na 24[1] Zn 13[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.06	0.05	0.04	0.11	0.006	Cu 9.5[1] Fe 56[1] Mn 71[1] Na 17[1] Zn 42[1]	
			Wood & bark >30 cm dbh	0.05	0.04	0.04	0.12	0.01	Cu 9.0[1] Fe 33[1] Mn 81[1] Na 23[1] Zn 10[1]	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Germany	Larix sp.	100	Needles	1.26	.22	.66	.74	.21	S .05	Ebermayer, 1876[1]
			Stem	.20	.01	.04	.06	.01	S tr.	
Southeast USA	Liquidambar styra.				0.28	0.98	1.44	0.43	Lignin 14.2	Sharpe et al. 1980
New York, USA	Liriodendron		Leaves				3.24			Chandler, 1944
	Juniperus virg.						2.93			
Southeast USA	Liriodendron tulip.				0.23	1.18	1.55	0.47	Lignin 14.6	Sharpe et al. 1980
UK	Nothofagus	21	Leaves	2.60	.15	.87	.91	.21	.03	Ovington, 1956a
Southeast USA	Nyssa sylvatica				0.10	0.58	1.26	0.86	Lignin 14.0	Sharpe et al. 1980
New York, USA	Ostrya virg.						2.27			Chandler, 1944
USSR	Picea	200	needles 1st.yr.	1.60	.14	.88	.31	.14		Rodin & Basilevich, 1967
			Branches	1.00	.04	.24	.26	.07		
			Bark	.89	.04	.29	.86	.08		
			Wood	.47	.004	.06	.07	.02		
			Fine roots	1.22	.14	.26	.44	.17		
USSR	Picea	90-120	needles 1st.yr.	1.28	.09	.71	.14	.09		Rodin & Basilevich, 1967 1967
			Branches	.57	.08	.04	.30	.08		
			Wood & Bark	.16	.08	.04	.01	.01		
B.C., Canada	Picea engleman.	3-6	current	1.26-1.72	.21-.29	.71-.80	.44-.58	.13-.15	S 1300-1900[1]	Beaton et al. 1965
		200-250	needles	.92-1.08	.12-.20	.70-.88	.28-.33	.11-.12	S 1200-1400[1]	
Sweden	Picea	25	Needles-N	1.33	.13	.59	.87		Si .45	Tamm, 1955
			April 17-S	1.20	.11	.51	.78		.36	
			July 16-N	1.12	.10	.58	1.26		.72	
			S	1.04	.08	.47	1.00		.55	
			Oct 19-N	1.34	.15	.81	1.67		.95	
			S	1.26	.12	.60	1.28		.71	
UK	Picea abies	46	Needles	1.40	.12	.46	.98	.11	.03	Ovington, 1956a
UK	Picea abies	46	Needles	1.53	.12	.50	.66	.09	.06	Ovington, 1956a

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
UK	Picea abies	19	Needles	1.43	.10	.41	.64	.13	.02	Ovington, 1956a
Quebec, Canada	Picea abies -good		Needles-top	1.32	.27	.61	.40	.21		Stewart & Swan, 1962
			-lower	1.08	.20	.59	.35	.16		
	Picea abies -poor		Needles-top	1.40	.23	.64	.33	.14		
			-lower	1.19	.22	.43	.38	.14		
Sweden	Picea abies	30	Stem wood	.063	.056	.05	.076	.009	Mn .009	Tamm, 1955
			bark	.51	.080	.34	.87	.066	Mn .071	
			Branches	.42	.056	.25	.41	.043	Mn .033	
			Needles	1.15	.150	.62	.58	.102	Mn .91	
			Dead branches	.50	.040	.068	.53	.026	Mn .038	
USA	Picea abies		Needles	1.02	.09	.39	1.96	.23		Lutz & Chandler, 1947
	Picea rube.		Needles	.89	.10	.35	.79	.20		
Montana, USA	Picea engleman.		Wood & bark <15 cm dbh	0.08	0.03	0.09	0.21	0.01	Cu 8.8[1] Fe 179[1] Mn 81[1] Na 20[1] Zn 21[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.10	0.05	0.10	0.33	0.02	Cu 9.0[1] Fe 36[1] Mn 77[1] Na 22[1] Zn 24[1]	
			Wood & bark >30 cm dbh	0.14	0.07	0.05	0.16	0.009	Cu 9.3[1] Fe 26[1] Mn 71[1] Na 24[1] Zn 12[1]	
New York, USA	Picea excel.						1.60			Chandler, 1944
Germany	Picea excel.	90-120	Needles -1 yr	1.28	.09	.71	.14	.09	Na .05 S .03	Ebermayer, 1876[1]
			Branches	.57	.08	.27	.30	.08	Na .02 S .03	
			Stem+bark	.16	tr.	.04	.01	.01	Na tr. S tr.	
USSR	Picea excel.	120	Cones	.36	.03	.27	.02	.07	Na .01 S .01	Manakov, 1961[1]
			Needles	.84	.07	.38	.52	.07	Na .03 S .03	
			Branches	.74	.05	.24	.30	.07	Na .03 S .02	
			Stem	.09	.02	.04	.09	.02	Na .005 S .01	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
USSR	Picea excel.	200	Needles -1 yr	1.60	.19	.88	.31	.14	S .08	Marchenko & Karpov, 1962[1]
			Branches	1.00	.04	.24	.26	.07	S .05	
			Bark	.89	.04	.29	.86	.08	S .04	
			Stem	.47	.004	.06	.07	.02	.02	
			Fine roots	1.22	.14	.26	.44	.17	.14	
USSR	Picea excel.		Needles < 1 yr	1.62	.09	1.35	.47	.16	S .09	Parshevnikov, 1959a[1]
			3 yr	1.56	.08	.62	.64	.14	.10	
			5 yr	1.54	.08	.55	.81	.14	.14	
			8 yr	1.53	.07	.46	1.17	.14	.19	
USSR	Picea excel.		Needles < 1 yr	1.60	.14	.88	.31	.14	S .08	Marchenko & Karpov, 1962[1]
			2 yr	1.36	.15	.64	.74	.19	.08	
Prince George, B.C. Canada	Picea glauca	110-125	Aerial: Wood	25.4	12.6	48.5	22.1	30.4		Kimmins, 1974
			Bark	41.4	33.9	23.9	52.2	38.1		
			Live crown	33.2	53.5	27.6	25.7	31.5		
Prince George, B.C. Canada	Picea glauca	110-350	Wood Top10	.059	.005	.053	.10	.011		Kimmins, 1974
			(stem divided 9	.049	.005	.049	.085	.009		
			into 10 8	.055	.005	.049	.095	.009		
			equal 7	.060	.003	.050	.090	.008		
			sections) 6	.054	.002	.049	.099	.008		
			5	.040	.005	.050	.120	.010		
			4	.049	.002	.047	.075	.007		
			3	.049	.002	.050	.090	.007		
			2	.050	.002	.047	.065	.005		
			stump 1	.050	.003	.047	.050	.005		
			Bark 10	.320	.043	.122	.730	.068		
			9	.38	.044	.122	.82	.067		
			8	.23	.035	.105	.92	.065		
			7	.26	.035	.107	1.02	.061		
			6	.25	.035	.096	1.14	.056		
			5	.25	.030	.096	1.10	.050		
			4	.22	.030	.093	1.16	.050		
			3	.24	.025	.095	1.03	.043		
			2	.22	.020	.093	1.20	.046		
			1	.23	.025	.089	1.25	.045		
			Branches >2.5cm	.16	.010	.070	.52	.028		
			Branches 2.5>0.6	.30	.035	.105	.70	.047		
			Twigs Upp.crown	.58	.075	.183	.58	.074		
			Twigs Mid.crown	.62	.085	.197	.47	.077		
			Low.crown	.62	.105	.215	.42	.077		
			Foliage							
			Upp.crown	1.07	.146	.229	.28	.064		
			Mid.crown	.92	.140	.204	.32	.064		
			Low.crown	.90	.135	.236	.28	.074		

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Quebec, Canada	Picea glauca -good		Needles-top	1.41	.27	.57	.45	.13		Stewart & Swan, 1962
			-lower	1.33	.24	.75	.40	.04		
	Picea glauca -poor		Needles-top	1.13	.21	.28	.63	.12		
			-lower	1.15	.20	.31	.54	.08		
USA	Picea mariana		needles	1.195	.125	.437	.387	.007	Cu 9.7[1] Fe 148[1] Mn 1438[1] Na 316[1] Zn 2.5[1]	Stark, 1973
New Hampshire, USA	Picea rubens		Leaves	1.26	.10	.49	.30	.06	.11	Likens & Borman, 1970
			Twigs		.20	.81	.09	.09		
			Branches		.10	.34	.25	.05		
			Bark	.35	.04	.18	.68	.04	.05	
			Light wood	.05	.001	.02	.06	.01	.01	
			Roots	.31	.04	.26	.59	.05	.05	
New York, USA	Picea rubens						.62			Chandler, 1944
Maine, USA	Picea rubens		Branches	.26	.06	.15	1.06	.08		Young, 1971
			Stem	.15	.03	.13	.40	.04		
			Stump+roots	.22	.05	.20	1.47	.06		
USA	Picea rubens		needles	1.327	.135	.412	.784	.007	Cu 8.9[1] Fe 234[1] Mn 1375[1] Na 392[1] zn 62.5[1]	Stark, 1973
B.C., Canada	Picea sitchen.	7-110	Current needles	1.10-1.15	.14-.18	.82-.83	.42-.64	.09-	S 1200-1400[1]	Beaton et al. 1965
USSR	Pinus	80-100	needles 1st.yr.	1.56	.12	.53	.14	.08		Rodin & Basilevich, 1967
			2nd.yr.	1.18	.03	.12	.31	.09		
			Sm. Branches	.68	.06	.26	.23	.08		
			Wood & Bark	.15	tr	.02	.09	.01		
Oregon	Pinus monticola		Foliage		.21	1.10	.23	.11	S B 22[1] Zn 32[1] Fe 35[1] Mn 230[1]	Will & Youngberg, 1979
					.20	1.10	.24	.10	S .09 B 30[1] Zn 45[1] Fe 45[1] Mn 240[1]	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
USSR	Pinus	95	Needles	1.29	.16	.45	.34	.10		Rodin & Basilevich 1967
			Branches	.49	.07	.32	.48	.07		
			Wood	.11	.01	.10	.09	.02		
Oregon	Pinus ponderosa		Foliage		.22	.90	.20	.10	S .06 B 22[1] Zn 36[1] Fe 25[1] Mn 110[1]	Will & Youngberg 1979
					.20	1.00	.20	.09	S .08 B 24[1] Zn 35[1] Fe 25[1] Mn 115[1]	
					.23	1.05	.22	.10	S .06 B 21[1] Zn 34[1] Fe 30[1] Mn 185[1]	
					.23	1.30	.23	.09	S .08 B 25[1] Zn 38[1] Fe 35[1] Mn 100[1]	
					.25	.97	.21	.12	S .08 B 30[1] Zn 47[1] Fe 25[1] Mn 140[1]	
Quebec, Canada	Pinus banksiana -good		Needles-top	1.58	.20	.54	.31	.11		Stewart & Swan, 1962
			-lower	1.41	.16	.51	.31	.11		
	Pinus banksiana -poor		Needles-top	1.45	.16	.49	.27	.09		
			-lower	1.45	.16	.42	.27	.08		
USA	Pinus banksiana		needles	1.716	.177	.587	.281	.130	Cu 9.6[1] Fe 153[1] Mn 60[1] Na 308[1] Zn 43.8[1]	Stark, 1973
Ontario, Canada	Pinus banksiana	20-65	Needles-top	.99	.13	.31	.26	.06		Morrison, 1973
			midde	.95	.11	.26	.29	.06		
			lower	1.04	.07	.39	.30	.07		
			Branches-top	.29	.02	.19	.19	.05		
			midde	.24	.02	.17	.18	.03		
			lower	.27	.01	.14	.19	.02		
			dead	.23	.01	.04	.12	.01		
			Stembark	.24	.02	.16	.37	.03		
			Stemwood-top	.10	.01	.08	.07	.01		
			midde	.06	.004	.05	.07	.01		
			lower	.07	.005	.06	.07	.01		
			Cones-new	.21	.04	.11	.02	.01		
			old	.23	.02	.04	.03	.01		

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Ontario, Canada	Pinus banksiana	30	Root wood	.07	.01	.04	.09	.02		Morrison, 1974
			Root bark	.25	.03	.08	.30	.06		
			Roots 8-10 cm	.08	.01	.06	.15	.02		
			6- 8 cm	.06	.01	.05	.10	.01		
			4- 6 cm	.10	.01	.06	.10	.02		
			2- 4 cm	.11	.02	.08	.13	.02		
			1- 2 cm	.17	.02	.09	.17	.03		
			< 1 cm	.23	.03	.08	.24	.05		
Ontario, Canada	Pinus banksiana	65	Aerial: Wood	36.3	24.2	47.9	45.2	51.1		Morrison 1973
			Bark	9.3	8.8	8.2	23.2	9.0		
			Live crown (incl. cones & dead branches)	49.0	61.6	41.2	28.8	35.6		
Oregon	Pinus contorta		Foliage		.17	.85	.22	.12	S .08 B 28[1] Zn 55[1] Fe 40[1] Mn 225[1]	Will & Youngberg, 1979
					.14	.70	.21	.09	S .05 B 26[1] Zn 35[1] Fe 40[1] Mn 280[1]	
					.16	.90	.22	.09	S .08 B 20[1] Zn 43[1] Fe 35[1] Mn 330[1]	
					.17	.68	.22	.10	S .06 B 25[1] Zn 51[1] Fe 35[1] Mn 215[1]	
Royce Mtn. Oregon USA	Pinus contorta		Foliage		.16	.90	.22		S .08 B 20[1] Zn 43[1] Fe 35[1] Mn330[1]	Will & Youngberg, 1979
Montana, USA	Pinus contorta		Wood & bark <15 cm dbh	0.07	0.03	0.03	0.10	0.002	Cu 8.7[1] Fe 11[1] Mn 120[1] Na 19[1] Zn 11[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.06	0.02	0.03	0.18	0.002	Cu 8.9[1] Fe 24[1] Mn 140[1] Na 20[1] Zn 12[1]	
			Wood & bark >30 cm dbh	0.06	0.03	0.03	0.08	0.02	Cu 59[1] Fe 31[1] Mn 75[1] Na 28[1] Zn 12[1]	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
B.C., Canada	Pinus contorta	3-40	current needles	.97-1.77	.09-.19	.35-.62	.15-.26	.08-.14	S 900-2100[3] B 2.5-4.3[3] Cl 104-148[3] Co .05-.06[3] Cu 2.1-2.7[3] Fe 58-63[3] Mn 290-410[3] Mo .06-.09[3] Zn 44-52[3] Al 490-630[3] Si 540-1200[3]	Beaton et al. 1965a & b
Prince George, B.C. Canada	Pinus contorta	110-125	Aerial: Wood	36.1	31.3	65.0	30.6	44.4		Kimmins, 1974
			Bark	34.2	39.9	19.2	58.5	40.9		
			Live crown	29.6	28.8	15.8	10.9	14.7		
Montana, USA	Pinus contorta	7	New needles	1.26	0.15	0.66	0.15	0.11	Fe 110[1] B 16[1]	DeByle, 1980
			Old needles	1.09	0.11	0.44	0.26	0.09	Fe 172[1] B 18[1]	
			Terminal shoots	1.05	0.13	0.63	0.11	0.10	Fe 302[1] B 14[1]	
			Roots	0.42	0.10	0.38	0.15	0.15	Fe 1335[1] B 26[1]	
Southeast USA	Pinus echinata				0.08	0.32	0.50	0.08	Lignin 28.6	Sharpe et al. 1980
Nevada	Pinus jeffreyi		Needles	1.209	.138	.591	.129	.114	Cu 5.9[1] Fe 42[1] Mn 78[1] Na 145[1] Zn 15[1]	Stark, 1973
			Wood	.072	.007	.045	.074	.013	Cu 3.1[1] Fe 30[1] Mn 19[1] Na 136[1] Zn 5.0[1]	
			Bark	.354	.102	.421	.400	.115	Cu 5.5[1] Fe 33[1] Mn 45[1] Na 98[1] Zn 14.3[1]	
			Roots	.463	.191	.338	.247	.185	Cu 6.5[1] Fe 1313[1] Mn 101[1] Na 113[1] Zn 25[1]	
			Twigs	.573	.072	.276	.407	.111	Cu 63[1] Fe 96[1] Mn 52[1] Na 99[1] Zn 12.4[1]	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
USA	Pinus monophylla		needles	1.000	.122	.536	.525	.187	Cu 8.6[1] Fe 65[1] Mn 30[1] Na 341[1] Zn 16.5[1]	Stark, 1973
Montana, USA	Pinus monticola		Wood & bark <15 cm dbh	0.06	0.02	0.02	0.10	0.02	Cu 6.4[1] Fe 33[1] Mn 42[1] Na 30[1] Zn 12[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.06	0.02	0.02	0.08	0.02	Cu 5.9[1] Fe 37[1] Mn 31[1] Na 25[1] Zn 7[1]	
			Wood & bark	0.06	0.02	0.02	0.08	0.02	Cu 5.8[1] Fe 26[1] Mn 67[1] Na 33[1] Zn 8[1]	
UK	Pinus nigra	21	Needles	.87	.09	.43	.95	.11	.02	Ovington, 1956a
UK	Pinus nigra	46	Needles		.09	.41	.47	.10	.01	Ovington, 1956a
Scotland	Pinus nigra	40	Needles	.9-2.3						Miller & Williams 1968
			Twigs	.5-1.5						
			Live branch	.2-.34						
			Dead branch	.20						
			Bark-upper	.34-1.19						
			Bark-lower	.16-.37						
			Wood-upper	.07-.21						
			Wood-lower	.04-.08						
			Stump	.05-.14						
			Roots	.25-.70						
UK	Pinus nigra		Needles < 1 yr	1.48	.17	.71	.30	.20	Na .04	Wright & Will, 1958
			2 yr	1.42	.15	.61	.70	.14	.07	
			≥ 3 yr	1.30	.15	.54	.95	.12	.13	
Royce Mtn. Oregon USA	Pinus ponderosa		Foliage		.23	1.30	.22	.09	S .08 B 24[1] Zn 38[1] Fe 35[1] Mn100[1]	Will & Youngberg 1979

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Arizona	Pinus ponderosa	60	current needles Basalt med. site	1.00	.18	1.30	.52	.34		Binkley (unpublished)
			sandstone poor site	1.19	.27	1.24	.82	.27		
Arizona	Pinus ponderosa	43	current needles unthinned	1.34	.1	.71	.42	.25	S 1800[1] Zn 108 Mn 151[1]	Wollum & Schubert 1975
			Med. thinning	1.85	.13	1.25	.6	.29	S 2500[1] Zn 98[1] Mn 66[1]	
			Heavy thinning	2.02	.12	1.14	.82	.37	S 2900[1] Zn 111[1] Mn 72[1]	
New Zealand	Pinus radiata		Needles < 1 yr	1.12	.17	.96	.14	.17	Na .02	Will, 1957
			Needles 1-2 yr	1.06	.18	.90	.27	.17	.05	
			Needles 2-3 yr	1.01	.20	1.01	.29	.18	.08	
			Needles 3-4 yr	.99	.25	.85	.35	.18	.13	
			Needles 4-5 yr	.96	.26	.92	.57	.22	.11	
New Zealand	Pinus radiata (av. 127 plots)		Foliage	1.15	.13	.73	.25	.15		Mead & Will 1976
New Zealand	Pinus radiata	26	Needles	1.32	.18	.90	.12			Orman & Will, 1960
			Branches	.30	.02	.20	.15			
			Bark	.17	.02	.17	.13			
			Wood	.05	.007	.06	.03			
New Zealand	Pinus radiata	2-22	Foliage	1.50	.17	.83	.27	.13	Na 61[1] Mn204[1] Zn 50[1]	Madgwick et al, 1977
			Cones	.47	.07	.16	.022	.036	Na 41[1] Mn 11[1] Zn 12[1]	
			Strobili	1.41	.21	.94	.05	.11	Na 36[1] Mn 43[1] Zn 41[1]	
New York, USA	Pinus resin.						.80			Chandler, 1944

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
USA	Pinus resin.		Needles	.68	.07	.30	.76	.18		Lutz & Chandler, 1947
Quebec, Canada	Pinus resin.		Needles-top	1.45	.20	.56	.28	.14		Stewart & Swan, 1962
	-good		-lower	1.26	.19	.65	.27	.13		
	Pinus resin.		Needles-top	1.31	.23	.39	.38	.11		
	-poor		-lower	1.15	.20	.32	.38	.12		
New York, USA	Pinus rigida		Stem heart	.10	.002	.02	.10	.01	.009	Woodwell et al. 1975
			Stem sap	.09	.007	.05	.08	.03	.01	
			Stem bark	.23	.06	.12	.11	.09	.05	
			Inner bark		.15	.48	.16	.12	.10	
			Outer bark		.04	.01	.14	.01	.06	
			Live branch	.18	.04	.11	.19	.08	.04	
			Dead branch	.37	.01	.01	.04	.008	.05	
			Twigs	.58	.12	.36	.12	.11	.10	
			Leaves	.90	.04	.32	.22	.07	.21	
			Fruits	.13	.03	.05	.01	.03	.03	
			Flowers	1.13	.24	1.09	.03	.08	.20	
			Root crown	.14	.02	.06	.06	.02	.02	
			Root wood		.03	.13	.04	.02	.07	
			Root bark		.04	.08	.05	.03	.06	
			Small roots		.06	.28	.10	.18	.18	
			Tab root		.02	.07	.03	.02	.03	
Southeast USA	Pinus rigida				0.10	0.32	0.55	0.08	Lignin 31.5	Sharpe et al. 1980
USA	Pinus stroba		needles	1.929	.132	.625	.525	.122	Cu 10.7[1] Fe 144[1] Mn 303[1] Na 313[1] Zn 41.5[1]	Stark, 1973
New York, USA	Pinus strobis						1.20			Chandler, 1944
Maine, USA	Pinus strobis		Branches	.50	.07	.24	.83	.11		Young, 1971
			Stem	.37	.04	.13	.35	.06		
			Stump+roots	.24	.05	.10	.09	.04		
Maine, USA	Pinus strobis	43	Needles-top	.86	.14	.38	.06	.06		Young et al, 1967
			middle	1.05	.16	.39	.10	.07		
			bottom	1.43	.20	.32	.21	.11		
			Needles-N	1.17	.17	.38	.13	.08		
			Needles-E	1.13	.18	.38	.13	.08		
			Needles-S	1.07	.16	.33	.12	.08		
			Needles-W	1.08	.17	.37	.12	.08		
	Picea rubens	47	Needles-top	.94	.27	.49	.27	.09		
			middle	.96	.22	.48	.23	.07		
			bottom	.97	.22	.57	.24	.07		
			Needles-N	.94	.23	.50	.24	.08		
			Needles-E	.94	.24	.52	.24	.08		
			Needles-S	.99	.25	.51	.26	.08		
			Needles-W	.96	.23	.52	.25	.07		

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Royce Mtn. Oregon USA	Pinus strobus		Foliage		.20	1.10	.24	.10	S .09 B 30' Zn 45' Fe 45' Mn240'	Will & Youngberg, 1979
Southeast USA	Pinus strobus				0.11	0.24	0.65	0.13	Lignin 31.0	Sharpe et al. 1980
New York, USA	Pinus sylv.						.69			Chandler, 1944
Quebec, Canada	Pinus sylv. -good		Needles-top	1.45	.20	.57	.31	.09		Stewart & Swan, 1962
			-lower	1.32	.16	.64	.32	.08		
	Pinus sylv. -poor		Needles-top	1.36	.21	.41	.34	.13		
			-lower	1.30	.19	.40	.36	.12		
Sweden	Pinus sylv.		Stem wood	.05	.004	.034	.053			Popovic & Burgtorf 1964
			bark	.26	.045	.17	.39			
			Live Branch	.32	.037	.18	.28			
			Needles	.92	.092	.30	.44			
			Dead Branch	.19	.011	.03	.24			
Germany	Pinus sylv.	80	Needles -1 yr	1.56	.12	.53	.14	.08	Na .02 S .03	Ebermayer, 1876'
			Needles -3 yr	1.18	.03	.12	.31	.09	Na .01 S .04	
			Branches	.68	.06	.26	.23	.08	Na .02 S .02	
			Stem+bark	.15	tr.	.02	.09	.01	Na .01 S tr.	
USSR	Pinus sylv.		Needles < 1 yr	1.36	.12	.56	.16	.17	Na .01 S .05 Mn .02 Fe .01 Al .05	Bazilevich'
			Needles > 1 yr	1.12	.08	.28	.38	.16	Na .02 S .03 Mn .04 Fe .02 Al .08	
Finland	Pinus sylv.	28	Stem wood	.06	.006	.04	.06			Malkonen, 1974
			Bark	.34	.05	.19	.55			
			Dead branch	.34	.02	.01	.31			
			Live branch	.39	.05	.22	.34			
			Needles - 1 yr	1.22	.15	.73	.21			
			Needles - 2 yr	1.12	.11	.42	.42			
			Needles - 3 yr	1.00	.10	.36	.55			
			Needles - 4 yr	.80	.08	.31	.58			
			Cones	.50	.08	.38	.04			
			Stumps	.10	.02	.08	.07			
			Roots > 1 cm	.13	.02	.08	.07			
		75	< 1 cm	.48	.10	.27	.22			
	Pinus sylv.	47	Stem wood	.07	.005	.03	.05			
			Bark	.38	.06	.22	.32			
			Dead branch	.32	.02	.04	.17			

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other		Reference
			Live branch	.43	.05	.18	.24				
			Needles - 1 yr	1.27	.15	.58	.16				
			2	1.22	.13	.47	.27				
			3	1.20	.12	.38	.32				
			4	1.18	.12	.39	.37				
			Cones	.37	.05	.22	.02				
			Stumps	.09	.01	.07	.06				
			Roots > 1 cm	.09	.01	.08	.06				
			< 1 cm	.50	.08	.30	.15				
USSR	Pinus sylv.	95	Needles	1.29	.16	.45	.34	.10	Na	.02	Remezov et al, 1959'
									S	.11	
			Branches	.49	.07	.32	.48	.07	Na	.01	
									S	.10	
			Stem	.11	.01	10	.09	.02	Na	.01	
									S	.01	
			Fine roots	.36	.06	.15	.33	.07	Na	.02	
									S	.14	
S. Carolina, USA	Pinus taeda	17	Foliage	1.05	0.10	0.37	0.27	0.09			Van Lear, 1980
Southeast USA	Pinus taeda				0.11	0.32	0.59	0.07	Lignin 31.4		Sharpe et al. 1980
S. Carolina, USA	Pinus taeda		Needles-upper	.76	.10	.42	.37	.09			Wells & Metz, 1963
			middle	.83	.09	.36	.55	.15			
			lower	.81	.09	.33	.68	.17			
Mississippi, USA	Pinus taeda	4	Foliage	1.00							Switzer et al, 1968
			Branches	.41							
			Stembark	.42							
			Stemwood	.16							
		8	Foliage	.95							
			Branches	.24							
			Stembark	.24							
			Stemwood	.06							
		18	Foliage	1.08							
			Branches	.23							
			Stembark	.23							
			Stemwood	.06							
		30	Foliage	1.22							
			Branches	.22							
			Stembark	.19							
			Stemwood	.04							
		56	Foliage	1.16							
			Branches	.21							
			Stembark	.17							
			Stemwood	.03							

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Southeast USA	Pinus virginiana				0.10	0.32	0.55	0.08	Lignin 33.6	Sharpe et al. 1980
Southeast USA	Platanus occid.				0.12	1.65	2.67	0.38	Lignin 18.2	Sharpe et al. 1980
New York, USA	Populus trem.						2.21			Chandler, 1944
Utah, USA	Populus trem.									Tew, 1970
	June 9				.36	1.39	.59	.05	Na .04	
	July 20				.22	1.18	1.47	.11	.05	
	Sept 7				.21	.99	2.32	.16	.08	
Maine, USA	Populus trem.		Branches	.57	.04	.20	1.18	.09		Young, 1971
			Stem	.34	.03	.29	1.33	.08		
			Stump+roots	.29	.11	.39	1.16	.14		
USSR	Populus trem.		Leaves	2.49	.25	1.42	1.69	.26	S .14	Remezov et al, 1959[1]
			Stem	.27	.04	.12	.40	.04	.03	
			Roots	.38	.11	.36	.87	.08	.06	
New Hampshire, USA	Prunus pens.		Leaves	2.73	.24	1.71	1.02	.29		Likens & Bormann, 1970
			Twigs	.65	.10	.63	.49	.08		
			Branches	.30	.03	.17	.41	.04		
			Bark	.76	.10	.48	1.11	.11		
			Light wood	.24	.04	.26	.31	.03		
			Roots	.35	.05	.34	.46	.05		
Southeast USA	Prunus serotina				0.32	1.18	1.95	0.48	Lignin 16.1	Sharpe et al. 1980
New York, USA	Prunus serst.						2.14			Chandler, 1944
B.C., Canada	Pseudotsuga	24	3rd yr needles, 3rd whorl from top							Reid 1983
			No alder	1.2	0.4				S 0.13	
			+ Sitka alder	1.4	0.1				S 0.12	
			+ red alder	2.4	0.1				S 0.12	
California, USA	Pseudotsuga macrocarpa	?	Needles							Zinke, 1980
			No poll.	1.08-1.17	0.15-0.16					
			Low poll.	1.06	0.15					
			Mod. poll.	0.99-1.31	0.07-0.16					
			Heavy poll.	1.17-2.02	0.07-0.17					
			Sev. poll.	1.15-2.12	0.06-0.10					

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Oregon, USA	Pseudotsuga	7	Senescent needles	0.50					Lignin 24.1 Cellulose 59.5	Cromack et al. 1979
			Twigs (10 mm)	0.15					Lignin 43.4 Cellulose 26.7	
			Roots (2-3 mm)	0.28					Lignin 25.7 Cellulose 52.6	
Washington & Oregon, USA	Pseudotsuga	55	3rd yr needles,							Reid 1983
	infertile site		lower crown							
			No alder	1.0	0.4				S 0.10	
			+ red alder	1.5	0.2				S 0.08	
	Pseudotsuga fertile site	55	3rd yr needles,							
			No alder	1.4	0.2				S 0.07	
			+ red alder	1.5	0.1				S 0.05	
Montana, USA	Pseudotsuga		Wood & bark <15 cm dbh	0.12	0.07	0.10	0.21	0.02	Cu 9.6[1] Fe 29[1] Mn 93[1] Na 21[1] Zn 15[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.11	0.07	0.03	0.11	0.04	Cu 7.7[1] Fe 17[1] Mn 43[1] Na 18[1] Zn 9[1]	
			Wood & bark >30 cm dbh	0.14	0.07	0.05	0.16	0.009	Cu 9.3[1] Fe 26[1] Mn 71[1] Na 24[1] Zn 12[1]	
Oregon, USA	Pseudotsuga		3rd yr needles lower crown							Reid 1983
			Control	1.3	0.4				S 0.08	
			Thinned	1.4	0.4				S 0.09	
			Thin.+fert.	1.5	0.4				S 0.09	
UK	Pseudotsuga	21	Needles	1.02	.19	.43	1.37	.14	.07	Ovington, 1956a
Oregon & Wash. USA	Pseudotsuga (Av. 10 plots)	2-5	Foliage	1.11	.30	.88	.331	.126	S .19 Fe 82[1] Mn428[1] Zn 34[1] Cu 2[1] B 8[1] Natr-5[1] Cl924[1]	Krueger, 1967

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Colorado, USA	Pseudotsuga	2	Needles	1.28	.23	.72	.10	.08		
B.C., Canada	Pseudotsuga menziesii	13-50	current needles	.88-1.37	.12-.22	.38-.70	.16-.44	.07-.18	B 5-16[1] Cl 90-170[1] Co .10-.45[1] Cu 2.4-5.6[1] Fe 39-68[1] Mn 450-1150[1] Zn 15-41[1] Al 200-750[1] Si 1400-8700[1] S 1400-2500[1] Mo .05-.100[1]	Beaton et al. 1965a & b
California,USA	Pseudotsuga	2	Needles	1.04	.20	.95	.09	.07		
Washington, USA	Pseudotsuga menziesii	28-52								Heilman & Gessel 1963
Upper Pack		Unfert.	Live Branches	.301	.054	.242				
		Fert.	Live Branches	.371	.057	.291				
		Unfert.	Dead Branches	.191	.040	.071				
		Fert.	Dead Branches	.228	.031	.122				
		Unfert.	Bark	.298	.057	.250				
		Fert.	Bark	.336	.061	.313				
		Unfert.	Wood	.052	.007	.056				
		Fert.	Wood	.054	.006	.056				
		Unfert.	Needles	.905	.291	.874				
		Fert.	Needles	1.071	.110	.781				
Darrington		Unfert.	Live Branches	.274	.054	.176				
		Fert.	Live Branches	.315	.053	.168				
		Unfert.	Dead Branches	.174	.024	.049				
		Fert.	Dead Branches	.181	.029	.051				
		Unfert.	Bark	.254	.060	.227				
		Fert.	Bark	.266	.054	.191				
		Unfert.	Wood	.043	.006	.042				
		Fert.	Wood	.043	.005	.039				
		Unfert.	Needles	.900	.334	.512				
		Fert.	Needles	.978	.195	.423				
Lower Pack		Unfert.	Live Branch	.299	.053	.220				
		Fert.	Live Branch	.311	.052	.243				
		Unfert.	Dead Branch	.241	.020	.033				
		Fert.	Dead Branch	.295	.032	.069				
		Unfert.	Bark	.256	.046	.210				
		Fert.	Bark	.283	.045	.213				
		Unfert.	Wood	.050	.005	.029				
		Fert.	Wood	.054	.006	.028				
		Unfert.	Needles	1.010	.341	.884				
		Fert.	Needles	1.066	.173	.688				
Matlock		Unfert.	Live Branch	.363	.047	.256				
		Fert.	Live Branch	.382	.061	.154				
		Unfert.	Dead Branch	.201	.033	.060				
		Fert.	Dead Branch	.234	.039	.025				
		Unfert.	Bark	.362	.070	.343				
		Fert.	Bark	.512	.092	.298				
		Unfert.	Wood	.048	.006	.031				
		Fert.	Wood	.049	.006	.034				

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Whidbey			Unfert. Needles	.973	.269	.495				
			Fert. Needles	1.438	.165	.353				
			Unfert. Live Branch	.305	.053	.208				
			Fert. Live Branch	.392	.051	.234				
			Unfert. Dead Branch	.219	.019	.034				
			Fert. Dead Branch	.268	.041	.085				
			Unfert. Bark	.301	.041	.193				
			Fert. Bark	.337	.044	.208				
			Unfert. Wood	.051	.004	.029				
			Fert. Wood	.051	.004	.026				
			Unfert. Needles	1.051	.362	.620				
			Fert. Needles	1.234	.233	.765				
New Mexico, USA	Pseudotsuga	2	Needles	.97	.22	.96	.10	.11		Van den Driessche, 1969
Oregon	Pseudotsuga menziesii	450	Foliage current	1.07	.22	.84	.39	.11	Na 130'	Sollins et al. 1980
			Old	1.03	.24	.50	.82	.11	Na 110'	
			Boles, branch, twigs	.056	.008	.022	.091	.012	Na 48'	
			Roots >5mm.	.090	.008	.030	.148	.031	Na 30'	
			<5mm.	.620	.100	.170	.69	.12	Na 20'	
			Epiphytes	1.73	.24	.57	.17	.03		
Washington, USA	Pseudotsuga	42	Needles < 1 yr	1.00	.27	.93	.38	.18	Mn .15	Turner & Olson, 1976
			Needles 1 yr	.96	.29	.73	.60	.18	.19	
			Needles 2 yr	.85	.25	.63	.70	.17	.23	
			Needles 3 yr	.79	.28	.52	.90	.13	.26	
B.C., Canada	Pseudotsuga	23	Needles 1-5yrs.	.93	.22	.59	.48	.09	S 3690' Na 52' Mn 729' Zn 20' Fe143' Cu 2'	Binkley, 1982
	Pseudotsuga (with Alnus sin)	23	Needles 1-5yrs.	1.10	.12	.55	.42	.07	S 2120' Na 51' Mn 429' Zn 11' Fe 92' Cu 3'	
	Pseudotsuga (with Alnus rubra)	23	Foliage 1-5yrs.	1.41	.09	.51	.52	.09	S 2380' NA 53' Mn 332' Zn 19' Fe 74' Cu 4'	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Montana, USA	Pseudotsuga	2	Needles	1.37	.21	.92	.18	.12		
B.C., Canada	Pseudotsuga	20	Foliage < 1 yr	1.01	.24	.81	.53	.12		Webber, 1977
			1	1.15	.20	.66	.92	.14		
			2	1.05	.21	.60	1.25	.16		
			3	.98	.25	.62	1.38	.15		
			> 4	.87	.25	.63	1.45	.13		
			Live branch	.48	.11	.41	.76	.11		
			Dead branch	.31	.05	.10	.62	.06		
			Wood	.12	.12	.06	.06	.02		
			Bark	.55	.12	.78	.80	.11		
B.C., Canada	Pseudotsuga	2	Needles	1.31	.25	1.03	.13	.08		
Moravia, Czechoslovakia	Quercus		Leaves	3.56	.17	.69	.82	.22	Ash 4.14	Klimo, 1975
			Annual shoots	1.71	.10	.35	1.29	.19	Ash 6.11	
			Branches <2cm-Bark	.95	.05	.59	1.97	.14	Ash 5.77	
			-Wood	.49	.06	.22	.26	.05	Ash 1.40	
			Branches 2-5cm							
			Bark	1.08	.09	.39	2.38	.10	Ash 6.11	
			Wood	.51	.08	.29	.39	.05	Ash 1.72	
			Branches >5cm-Bark	.94	.09	.44	3.18	.09	Ash 9.25	
			-Wood	.28	.04	.15	.20	.03	Ash .94	
			Stem - Bark	.71	.03	.14	2.85	.09	Ash 5.96	
			Stem - Wood	.34	.01	.07	.04	.02	Ash .58	
			Underground Parts							
			0-0.1cm	1.48	.09	.47	.53	.39	Ash22.56	
			0.1-1cm Bark	1.01	.36	.39	2.32	.28	Ash 9.90	
			Wood	.80	.15	.20	.43	.15	Ash 2.60	
			1-2cm Bark	1.09	.17	.51	1.16	.23	Ash 8.99	
			Wood	.87	.17	.10	.16	.10	Ash 1.54	
			2-5cm Bark	1.16	.13	.57	1.76	.14	Ash .09	
			Wood	.75	.15	.10	.14	.09	Ash 1.34	
			5-10cm Bark	.83	.12	.76	2.99	.22	Ash14.85	
			Wood	.53	.19	.09	.05	.09	Ash 1.23	
			>10cm Bark	1.61	.19	.51	2.77	.26	Ash12.03	
			Wood	.80	.16	.10	.15	.09	Ash 1.43	
UK	Quercus < 1 cm		Total	.88	.06	.22	.76	.06	Na .19	Sykes & Barr, 1973
	1			.58	.04	.18	.55	.03	.02	
	2			.41	.02	.13	.56	.03	<.003	
	3			.36	.02	.13	.68	.02	<.003	
	4			.31	.02	.09	.51	.02	.004	
	6			.28	.01	.09	.65	.02	<.003	
	8			.23	.01	.09	.48	.02	.003	
	10			.19	.01	.08	.59	.02	.003	
	12			.19	.01	.09	.49	.01	<.003	
	> 12			.21	.01	.13	.46	.01	<.003	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Korea	Quercus acuti.	12	Leaves	0.78	0.12	0.75				Mun et al. 1977
			Branches	0.34	0.03	0.12				
			Trunks	0.24	0.02	0.06				
			Roots	0.41	0.04	0.41				
New York, USA	Quercus alba						1.36			Chandler, 1944
New York, USA	Quercus alba		Stem heart	.18	.005	.07	.10	.01	S .01	Woodwell et al. 1975
			Stem sap.	.15	.02	.12	.08	.02	.02	
			Stem bark	.41	.05	.18	2.51	.05	.05	
			Inner bark		.05	.24	2.81	.04	.04	
			Outer bark		.04	.11	3.56	.07	.07	
			Live branch	.28	.07	.24	.57	.06	.06	
			Dead branch	.43	.02	.02	.34	.01	.06	
			Twigs	.56	.08	.39	.64	.08	.07	
			Leaves	.79	.06	.70	.49	.09	.32	
			Fruits	.64	.10	.78	.18	.06	.10	
			Flowers	2.63	.24	1.78	.16	.24	.20	
			Root crown	.16	.02	.16	.07	.01	.03	
			Root wood		.23	.18	.13	.11	.09	
			Root bark		.06	.24	1.63	.11	.08	
			Small roots		.17	.24	.34	.10	.10	
Southeast USA	Quercus alba				0.10	0.38	0.88	0.14	Lignin 17.2	Sharpe et al. 1980
USA	Quercus alba		Leaves	1.885	216	.572	1.181	.062	Cu 10.3[1]	Stark, 1973
									Fe 92[1]	
									Mn 4075[1]	
									Na 313[1]	
									Zn 22.2[1]	
New York, USA	Quercus bori.						1.21			Chandler, 1944
New York, USA	Quercus cocc.		Stem heart	.14	.002	.06	.05	.005	S .01	Woodwell et al. 1975
			Stem sap.	.10	.003	.14	.05	.016	.03	
			Stem bark	.32	.04	.15	.13	.04	.04	
			Inner bark		.06	.26	.19	.04	.04	
			Outer bark		.03	.06	.15	.04	.06	
			Live branches	.31	.03	.21	.52	.04	.03	
			Dead branches	.31	.007	.03	.20	.01	.05	
			Twigs	.47	.07	.25	.51	.28	.05	
			Leaves	.79	.05	.51	.39	.11	.25	
			Fruits	.50	.09	.66	.66	.08	.08	
			Flowers	1.45	.24	1.97	.55	.27	.20	
			Root crown	.22	.03	.12	.07	.01	.03	
			Root wood		.04	.24	.05	.06	.05	
			Root bark		03	.23	.88	.06	.04	
			Small roots		.11	.27	.26	.05	.06	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Southeast USA	Quercus coccinea				0.10	0.38	0.88	0.14	Lignin 16.7	Sharpe et al. 1980
Southeast USA	Quercus falcata				0.10	0.38	0.88	0.14	Lignin 16.7	Sharpe et al. 1980
New York, USA	Quercus ilic.		Stem sap	.12	.02	.13	.05	.02	.03	Woodwell et al. 1975
			Stem bark	.56	.06	.20	1.21	.05	.07	
			Live branch	.40	.04	.17	.51	.03	.04	
			Dead branch	.39	.01	.02	.22	.007	.05	
			Twigs	.77	.09	.27	.58	.03	.06	
			Leaves	1.40	.09	.42	.5	.16	.26	
			Root crown	.29	.08	.20	.09	.02	.08	
			Small roots		.20	.22	.29	.08	.06	
New York, USA	Quercus mort.						1.20			Chandler, 1944
UK	Quercus pet.	20	Leaves	2.91	.16	.74	.49	.21	.02	Ovington, 1956a
Southeast USA	Quercus prinus				0.16	1.02	1.00	0.14	Lignin 25.5	Sharpe et al. 1980
USA	Quercus prinus		Leaves	.887	.358	.662	1.562	.487	Cu 14.6[1] Fe 1250[1] Mn 329[1] Na 332[1] Zn 55[1]	Stark, 1973
UK	Quercus robur	46	Leaves	2.91	.25	1.20	1.03	.22	.02	Ovington, 1956a
Belgium	Quercus robur	89	Twigs - 1 yr	1.3	.10	.36	1.4	.15	S .11	Duvigneaud & Denaeyer-de Smet, 1970
			2	1.0	.08	.29	1.3	.16		
			3	1.0	.08	.26	1.5	.18		
			Branch 1-3 cm	.50	.05	.14	.21	.05		
			Branch-bark	.74	.06	.27	2.4	.27		
			Branch 5-7 cm	.28	.03	.21	.11	.05		
			Branch-bark	.85	.04	.28	2.4	.32		
			Branch 10-15 cm	.13	.003	.17	.07	.15		
			sapwood	.16	.02	.17	.09	.03		
			bark	.57	.03	.20	2.9	.37		
			Branch 20-25 cm	.14	.004	.10	.10	.02		
			sapwood	.24	.02	.19	.12	.04		
			bark	.41	.04	.26	3.2	.31		
			Stem heart	.15	.002	.08	.09	.009	.03	
			sapwood	.19	.02	.16	.13	.08	.01	
			bark	.40	.02	.23	3.4	.30	.06	
			Roots 1-3	.45	.02	.21	.10	.03		
			bark	.52	.03	.39	2.3	.07		
			Roots 5-7	.24	.02	.19	.06	.02		
			bark	.83	.02	.40	2.1	.10		
			Leaves	2.4	.15	1.0	1.0	.14		

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other		Reference
USSR	Quercus robur		Leaves	2.54	.10	1.07	1.16	.23	S	.09	Remezov et al, 1959[1]
			Branches-small	.98	.06	.34	1.11	.08		.06	
			Branches-large	.41	.04	.23	.67	.05		.05	
			Stem	.31	.02	.08	.41	.03		.03	
			Roots-small	.76	.13	.66	1.06	.17		.16	
			Roots-large	.47	.09	.37	.69	.11		.06	
Belgium	Quercus robur	147	Leaves	2.5	.18	1.2	.91	.19			Duvigneaud & Denaeyer-de Smet, 1967
			Buds	1.3	.12	.36	1.1	.09			
			Twigs < 1 yr	1.4	.13	.38	.86	.10			
			Twigs > 1 yr	1.0	.11	.28	.69	.10			
			Branches 1.5-3 cm								
			wood	.37	.05	.15	.09	.03			
			bark	1.1	.08	.32	1.6	.08			
			Branches 3 -5 cm								
			wood	.33	.04	.15	.08	.04			
			bark	.81	.07	.3	1.5	.07			
			Branches 5 -7 cm								
			wood	.26	.03	.21	.09	.03			
			bark	.76	.05	.24	1.9	.06			
			Stem bark	.50	.03	.19	3.2	1.5			
			Sapwood	.25	.02	.22	.05	.03			
			Heartwood	.12	.002	.06	.04	.003			
			Small roots	.87	.07	.35	.97	.20			
			L. mats-wood	.50	.04	.17	.06	.03			
			L. mats-bark	.65	.04	.49	2.2	.14			
USSR	Quercus robur		Leaves		.10	1.59	1.61	.41	Na	.21	Dzens-Litovskaya, 1960[1]
									S	.01	
									Mn	.06	
									Fe	tr.	
									Al	tr.	
			Stem+large branches		.02	.17	.46	.11	Na	.02	
									S	.003	
									Mn	.004	
									Fe	.01	
									Al	.02	
			Small branches		.04	.63	1.08	.07	Na	.03	
									S	.02	
									Mn	.05	
									Fe	.02	
									Al	.02	
			Roots		.05	.76	1.23	.11	Na	.11	
									S	.02	
									Mn	.001	
									Fe	.06	
									Al	.06	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
UK	Quercus rubra	20	Leaves	2.87	.17	.79	.67	.20	.01	Ovington, 1956a
Southeast USA	Quercus rubra				0.10	0.38	0.88	0.14	Lignin 16.7	Sharpe et al. 1980
USA	Quercus rubra		Leaves	1.731	.131	.825	1.282	.288	Cu 10.2[1] Fe 116[1] Mn 1575[1] Na 375[1] Zn 24.8[1]	Stark, 1973
UK	Quercus sp.	43	Leaves	2.59	.23	1.09	.74	.14	.02	Ovington, 1956a
UK	Quercus sp.		Leaves		.19	.92	.83	.20	.03	Ovington, 1956a
New York, USA	Quercus spp.		Leaves							
	May 27			3.75	.34	1.47	.54			Tryon, 1936
	June 26			2.76	.17	1.21	.65			
	July 26			2.63	.15	1.04	.75			
	Aug 26			2.47	.15	1.00	.91			
	Sept 25			2.40	.15	1.00	.95			
Southeast USA	Quercus stellata				0.10	0.38	0.88	0.14	Lignin 16.7	Sharpe et al. 1980
USA	Quercus velutina		Leaves	2.004	.255	.587	.487	.113	Cu 11.2[1] Fe 93[1] Mn 3000[1] Na 329[1] Zn 34.3[1]	Stark, 1973
Southeast USA	Quercus velutina				0.10	0.38	0.88	0.14	Lignin 16.7	Sharpe et al. 1980
Southeast USA	Rhododendron maxi.				0.03	0.24	1.28	0.19	Lignin 15.7	Sharpe et al. 1980
New York, USA	Robinia pseud.						2.65			Chandler, 1944
Southeast USA	Robinia pseud.				0.35	1.65	3.15	0.35	Lignin 25.1	Sharpe et al. 1980
New York, USA	Thuja occid.						2.48			Chandler, 1944
Montana, USA	Thuja plicata		Wood & bark <15 cm dbh	0.08	0.01	0.03	0.15	0.01	Cu 7.0[1] Fe 31[1] Mn 5[1] Na 30[1] Zn 2[1]	Stark, 1979
			Wood & bark >15 cm dbh	0.09	0.02	0.02	0.10	0.01	Cu 5.2[1] Fe 35[1] Mn 4[1] Na 26[1] Zn 3[1]	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
UK	Thuja plicata	21	Needles	1.22	.10	.38	1.05	.16	.04	Ovington, 1956a
B.C., Canada	Thuja plicata	58	foliage	.73	.13	.52	1.16	.10	S 700[1]	Beaton et al. 1965a
Czechoslovakia	Tilia		Leaves	2.76	.34	1.47	1.75	.24	Ash 9.51	Klimo, 1975
			Annual shoots	1.82	.20	.60	1.97	.25	Ash 8.22	
			Branches <2cm-Bark	1.19	.10	.42	1.85	.11	Ash 5.67	
			-Wood	.94	.10	.29	.30	.07	Ash 1.96	
			Branches 2-5cm							
			-Bark	1.44	.11	.40	1.51	.11	Ash 5.02	
			-Wood	1.15	.06	.22	.24	.06	Ash 1.42	
			Branches >5cm-Bark	1.11	.11	.43	1.53	.12	Ash 5.51	
			-Wood	.67	.04	.21	.30	.03	Ash 1.14	
			Stem - Bark	.82	.08	.49	1.25	.14	Ash 3.49	
			Stem - Wood	.30	.01	.11	.10	.02	Ash .84	
			Underground parts							
			0-0.1cm	1.31	.12	.53	.24	.36	Ash23.46	
			0.1-1cm Bark	1.91	.20	.51	1.41	.25		
			Wood	.63	.12	.40	.22	.24	Ash 1.93	
			1-2cm Bark	1.27	.19	.52	1.96	.24	Ash11.81	
			Wood	.49	.09	.27	.16	.08	Ash 1.35	
			2-5cm Bark	1.07	.11	.52	4.17	.25	Ash14.21	
			Wood	.91	.09	.19	.20	.10	Ash 1.49	
			5-10cm Bark	.84	.14	.61	3.38	.28	Ash20.90	
			Wood	.43	.06	.10	.17	.07	Ash .85	
			>10cm Bark	.79	.12	.70	2.20	.23	Ash15.76	
			Wood	.62	.07	.10	.16	.10	Ash 1.04	
New York, USA	Tilia amer.						2.81			Chandler, 1944
USSR	Tilia cord.		Leaves	2.81	.21	1.72	1.48	.29	S .21	Remezov et al, 1959[1]
			Branches	.31	.03	.24	.41	.04	S .08	
			Roots	.64	.07	.38	.84	.14	S .08	
Maine, USA	Tsuga		Branches	.39	.10	.19	1.39	.08		Young, 1971
			Stem	.24	.05	.12	.83	.04		
			Stump+roots	.31	.06	.11	.54	.04		
New York, USA	Tsuga canadensis						.80			Chandler, 1944
USA	Tsuga canadensis		needles	1.414	.197	.700	.562	.100	Cu 9.8[1]	Stark, 1973
									Fe 340[1]	
									Mn 2625[1]	
									Na 313[1]	
									Zn 62.5[1]	

Table 12 Nutrient Concentrations - Overstory (% of dry weight)

Location	Species	Age	Component	N	P	K	Ca	Mg	Other	Reference
Montana, USA	Tsuga heter.		Wood & bark <15 cm dhb	0.07	0.08	0.04	0.09	0.02	Cu 6.6[1] Fe 29[1] Mn 190[1] Na 33[1] Zn 6[1]	Stark, 1979
			Wood & bark 15-30 cm dbh	0.07	0.05	0.04	0.08	0.02	Cu 6.3[1] Fe 36[1] Mn 153[1] Na 36[1] Zn 6[1]	
B.C., Canada	Tsuga heter.	8-185	current needles	.86-1.17	.11-.19	.28-.57	.18-.27	.08-.12	S 1000-1500[1] B 5-17[1] Cl 75-160[1] Co .05-.17[1] Cu 3.9-4.2[1] Fe 40-68[1] Mn 1580-2000[1] Mo <.05-.05[1] Zn 3-14[1] Al 465-790[1] Si <467[1]	Beaton et al. 1965a & b
Haney, B.C. Canada	Tsuga heter.	climax old growth	Foliage & Twigs	40.0	30.8	12.2	22.4			Kimmmins & Krumlik, 1976
Oregon	Tsuga mert.		Leaves		.16	.64	.33	.08	S .06 B 29[1] Zn 15[1] Fe 60[1] Mn 1780[1]	Will & Youngberg, 1979
B.C., Canada	Tsuga mert.	300+	Wood	.05	.02	.07	.07	.02		Krumlik, 1978
			Bark	.18	.06	.09	.31	.02		
			Large branch	.12	.03	.07	.16	.02		
			Small branch	.17	.04	.09	.18	.03		
			Twigs	.38	.06	.16	.18	.04		
			Foliage	.85	.11	.30	.31	.08		
New York, USA	Ulmus amer.						1.81			Chandler, 1944
USSR	Ulmus laevis		Leaves	1.47	.11	1.09	.30	.34	S .37	Mina, 1955[1]
			Branches	.37	.04	.68	1.19	.07	S .08	
			Stem	.22	.02	.62	.65	.06	S .04	

[1]Cited in Rodin and Bazilevich, 1967.
[2]Maximum values
[3]Parts per million

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other		Reference
Australia	Acacia spp.	Stemwood	.16	.016	.04	.04	.02	Na	.02	Feller 1981
		Stembark	.62	.021	.20	.73	.11		.02	
		Branches	.23	.011	.07	.07	.03		.01	
	Acacia dealbata	Leaves	3.37	.170	.54	.37	.14		.01	
	Acacia obliaquinervia	Leaves	2.08	.111	.53	.23	.17		.05	
USA	Adianthum	Leaves	.83	.14	1.54	.98	.28	S	.24	Van Camp, 1948
	Amphicarpum	Leaves	1.74	.19	1.35	1.91	.45	S	.57	
	Collinsonia	Leaves	.73	.20	1.03	.85	1.27	S	.60	
	Comptonia	Leaves	2.04	.18	.72	.54	.18	S	.23	
	Lindera	Leaves	1.85	.23	1.55	1.56	.49	S	.32	
Oregon, USA	Arctostaphylos patula	Foliage		.18	1.00	.40	.23	S	.06	Will & Youngberg 1979
								B	13[1]	
								Zn	45[1]	
								Fe	30[1]	
								Mn	40[1]	
				.19	1.00	.40	.19	B	14[1]	
								Zn	33[1]	
								Fe	35[1]	
								Mn	80[1]	
				.20	1.10	.41	.16	B	10[1]	
								Zn	32[1]	
								Fe	35[1]	
								Mn	45[1]	
				.20	1.10	.38	.14	S	.08	
								B	19[1]	
								Zn	40[1]	
								Fe	50[1]	
								Mn	35[1]	
USSR	Asarum euro.	Leaves	3.18	.24	5.82	2.17	.46	S	.12	Samoylova[1]
	Aegopodium	Leaves+stem	1.51	.40	6.23	1.09	.32	S	.15	
	Asperula odor.	Leaves+stem	1.91	.24	4.47	2.20	.32	S	.15	
New Hampshire, USA	Athyrium felix.	Above ground	2.53	.18	3.04	.81	.38	S	.19	Siccama et al. 1970
	Dennstaedtia		2.82	.18	2.03	.21	.24		.22	
	Dryopteris nove.		2.38	.17	2.78	.54	.42		.31	
	Dryopteris pheg.		2.25	.15	2.81	.61	.43		.33	
	Dryopteris spin.		2.47	.20	2.58	.37	.43		.22	
	Lycopodium		2.01	.10	1.41	.06	.12		.17	
	Osmundia clay.		2.41	.18	2.88	.29	.13		.21	
	Aralia nudic.		2.32	.22	1.71	.80	.28		.19	
	Arisaema atrs.			.21	1.78	.92	.24		.22	
	Aster acum.		2.14	.19	2.92	.67	.30		.18	
	Carex intum.		2.84	.22	1.90	.18	.14		.29	
	Carex lept.		2.86	.15	3.23	.26	.15		.22	
	Clintonia bore.		2.29	.16	4.47	1.10	.35		.14	
	Cornus cana.		1.79	.25	1.35	3.09	.45		.22	
	Galium trif.		2.83	.20	2.14	1.70	.27		.31	
	Maianthemum		2.40	.22	4.99	.86	.30		.17	
	Medeola virg.		2.30	.13	2.24	.46	.34		.22	
	Mitchella rep.			.11	1.15	1.14	.35		.15	
	Oxalis mont.			.25	2.92	.60	.40		.33	
	Polygonatum			.32	5.45	.52	.14			

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other		Reference
	Smilacina rac.		2.26	.13	2.73	.99	.20		.17	
	Solidago macr.		2.58	.31	5.38	.98	.41		.18	
	Streptopus ros.		2.00	.15	3.39	.81	.28		.15	
	Trientalis bore.		2.02	.17	3.03	1.16	.44		.13	
	Trillium erec.		2.47	.15	3.21	.77	.22		.15	
	Trillium undu.			.16	7.41	1.31	.47		.32	
	Uvularia sess.		2.54	.20	2.22	.85	.24		.18	
	Viola incog.		3.22	.22	3.68	.78	.83		.26	
	Viola rotum.		2.76	.12	4.69	.64	.47		.23	
Nevada, USA	Basidiomycete fungi	Rhizomorphs	1.80-2.50	.14-.32	.02-.32	.66-7.7	.07-2.6	Cu	22-34[1]	Stark 1973
								Fe	670-6800[1]	
								Mn	88-190[1]	
								Na	220-2400[1]	
								Zn	40-215	
		Fruiting bodies	3.6-8.6	.36-.95	.25-8.5	.01-.36	.07-.14	Cu	3-55[1]	
								Fe	25-525[1]	
								Mn	13-63[1]	
								Na	250-900[1]	
								Zn	30-250[1]	
USSR	Bryopogon impl.	Entire	.84	.24	.51	.31	.08	S	.04	Rudreva[1]
								Na	.4	
Oregon, USA	Castanopsis sempervirens	Foliage		.13	70	.38	.12	S	.09	Will & Youngberg 1979
								B	39[1]	
								Zn	16[1]	
								Fe	60[1]	
								Mn	740[1]	
Oregon, USA	Ceanothus velutinus	Foliage		.18	.90	.55	17	S	.06	Will & Youngberg 1979
								B	31[1]	
								Zn	36[1]	
								Fe	55[1]	
								Mn	65[1]	
				.14	.95	.52	.15	S	.06	
								B	21[1]	
								Zn	12[1]	
								Fe	60[1]	
								Mn	120[1]	
				.16	1.00	.46	.16	S	.07	
								B	30[1]	
								Zn	18[1]	
								Fe	50[1]	
								Mn	105[1]	
				.14	.90	.52	.14	S	.12	
								B	20[1]	
								Zn	30[1]	
								Fe	75[1]	
								Mn	290[1]	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other		Reference
USSR	Cladonia alpe.	Entire		.06	.37	.08	.04	S	.05	Rozhnova, 1962'
	Parmelia saxa.	Entire	.79	.05	.16	.28	.11	S	.10	
Alberta, Canada	Epilobium	Leaves	3.22	.21	2.41	.80	.55			Krauler, 1976
		Stems	.67	.12	1.68	.26	.17			
Washington USA	Gaultheria shallon	current	1.15	.20	1.11	.49	.20	Mn	943'	Turner, Long & Backiel 1978
								Fe	268'	
								Zn	20'	
stand age 42 yrs.								Na	51'	
		older						Ash	2.77	
			.85	.08	.65	1.62	.28	Mn	3212'	
								Fe	259'	
								Zn	24'	
								Na	41'	
								Ash	4.89	
	Pteridium aquilinum		1.90	.27	.74	.73	.22	Mn	974'	
								Fe	158'	
								Zn	45'	
								Na	20'	
								Ash	8.50	
	Vaccinium parv.		1.62	.14	1.12	1.33	.19	Mn	5662'	
								Fe	142'	
								Zn	23'	
								Na	21'	
								Ash	6.30	
	Berberis nervosa		1.10	.11	.85	.31	.10	Mn	493'	
								Fe	53'	
								Zn	54'	
								Na	14'	
								Ash	2.27	
	Acer circnatum		2.27	.28	1.15	1.17	.35	Mn	1240'	
								Fe	180'	
								Zn	65'	
								Na	9'	
								Ash	9.17	
	Linnea borealis		1.42	.25	1.70	1.71	.29	Mn	832'	
								Fe	148'	
								Zn	38'	
								Na	20'	
								Ash	8.41	
stand age 95	Gaultheria shallon	current	.099	.13	.97	.49	.20	Mn	1590'	
								Fe	300'	
								Zn	21'	
								Na	48'	
								Ash	3.30	
		older	.091	.09	.63	.98	.23	Mn	3820'	
								Fe	320'	
								Zn	23'	
								Na	52'	
								Ash	4.60	
	Linnea borealis		1.00	.22	1.72	1.17	.28	Mn	450'	
								Fe	310'	
								Zn	23'	
								Na	47'	
								Ash	9.11	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other		Reference
	Vacc. parv.		1.95	.19	1.10	1.25	.23	Mn	2320'	
								Fe	420'	
								Zn	19'	
								Na	47'	
								Ash	6.10	
	Mnium spinulosum		.54	.19	.44	.24	.07	Mn	1090'	
								Fe	870'	
								Zn	29'	
								Na	46'	
								Ash	2.30	
	Mnium insigna		.61	.08	.40	.20	.07	Mn	900'	
								Fe	840'	
								Zn	30'	
								Na	47'	
								Ash	1.72	
	Rhytidiadelphus loreus		.56	.15	.67	.32	.09	Mn	2002'	
								Fe	720'	
								Zn	27'	
								Na	45'	
								Ash	3.27	
	Plageothecium undulatum		.85	.19	.65	.39	.16	Mn	2250'	
								Fe	800'	
								Zn	45'	
								Na	56'	
								Ash	2.87	
	Eurynchium oreganum		.53	.21	.56	.41	.10	Mn	1820@	
								Fe	530'	
								Zn	45'	
								Na	55'	
								Ash	4.20	
New York, USA	Gaylussacia	Stem sap.	.25	.03	.13	.06	.04	S	.05	Woodwell et al. 1975
		Stem bark	.47	.04	.15	.23	.05		.06	
		Live branch	.46	.04	.14	.23	.05		.06	
		Dead branch	.48	.01	.01	.10	.01		.08	
		Twigs	.71	.08	.25	.79	.13		.08	
		Leaves	.75	.08	.67	.84	.32		.24	
		Fruit	.60	.10	.72	.42	.07		.09	
		Flowers	1.73	.24	1.61	.25	.20		.20	
		Roots	.40	.05	.15	.21	.07		.06	
		Rhizome	.32	.06	.20	.21	.05		.06	
	Vaccinium vac.	Stem sap.	.26	.05	.25	.07	.04	S	.10	
		Stem bark	.55	.08	.22	.56	.13		.19	
		Stem wood		.06	.27	.31	.07		.12	
		Live branch	.47	.08	.24	.59	.09		.14	
		Dead branch	.53	.02	.03	.26	.02		.20	
		Twigs	.63	.10	.25	.80	.13		.12	
		Leaves	.60	.08	.47	.88	.33		.28	
		Fruits	.60	.10	.72	.42	.07		.09	
		Flowers	1.73	.24	1.61	.25	.20		.20	
		Small roots		.06	.13	.09	.04		.10	
		Tap root		.07	.13	.13	.04		.10	
		Rhizome	.43	.10	.16	.12	.04		.12	
	Vaccinium ang.	Stem sap.		.08	.18	.33	.06		.11	
		Wood+bark		.08	.18	.33	.06		.11	
		Live branch	.54	.08	.18	.33	.06		.11	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other	Reference
		Dead branch	.65	.02	.02	.14	.01	.16	
		Twigs	.81	.09	.26	.48	.10	.18	
		Leaves	.62	.07	.43	.69	.37	.37	
		Small root		.06	.13	.20	.41	.09	
		Rhizome	.46	.08	.17	.24	.34	.09	
	Kalmia ang.	Stem sap.	.34	.02	.11	.05	.02		
		Stem bark	.43	.03	.11	.32	.06		
		Stem wood		.02	.11	.11	.03		
		Live branch	.47	.03	.17	.18	.06		
		Dead branch	.36	.01	.02	.08	.01		
		Twigs	.60	.05	.32	.38	.07	.02	
		Leaves	.93	.04	.32	.83	.14	.29	
		Small roots		.03	.23	.20	.06	.03	
Moravia, Czechoslovakia	Glecoma	above-ground	1.660	.279	4.773	1.351	.338	Ash14.774	Klimo E. 1975
								Fe .086	
								S .148	
								Al .077	
								Si .332	
								Cu .0005	
								Zn .004	
								Pb .0005	
		under-ground parts	1.030	.22	2.117	1.325	.379	Ash23.066	
								Fe .843	
								S .201	
								Al .809	
								Si 4.840	
								Cu .0014	
								Zn .0096	
								Pb .0008	
	Impatiens parviflora	above-ground	1.770	.451	5.122	1.590	.365	Ash16.020	
								Fe .061	
								S .346	
								Al .041	
								Si .279	
								Cu .0006	
								Zn .006	
								Pb .0003	
		under-ground parts	.940	.398	4.632	1.457	.241	Ash11.790	
								Fe .339	
								S .316	
								Al .316	
								Si 2.192	
								Cu .0010	
								Zn .0078	
								Pb .0008	
	Aguga reptans	above-ground	1.860	.398	4.781	1.669	.348	Ash26.359	
								Fe .108	
								S .200	
								Al .106	
								Si .507	
								Cu .0097	
								Zn .0007	
								Pb .0005	
		under-ground	1.140	.208	2.839	1.033	.265	Ash11.506	
								Fe .227	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other	Reference
								S .156	
								Al .288	
								Si .941	
								Cu .0021	
								Zn .0187	
								Pb .0008	
	Urtica dioica	above-ground	2.280	.349	3.337	2.544	.434	Ash15.356	
								Fe .103	
								S .401	
								Al .078	
								Si .872	
								Cu .0007	
								Zn .005	
								Pb .0003	
		under-ground	1.720	.310	1.718	1.590	.303	Ash12.168	
								Fe .320	
								S .159	
								Al .219	
								Si 1.430	
								Cu .0009	
								Zn .0072	
								Pb .0005	
	Circata lutetiana	above-ground	1.410	.292	2.806	1.590	.417	Ash11.922	
								Fe .120	
								S .142	
								Al .103	
								Si .659	
								Cu .0010	
								Zn .0006	
								Pb .0006	
		below-ground	.870	.221	1.826	1.192	.281	Ash 9.749	
								Fe .200	
								S .128	
								Al .184	
								Si .875	
								Cu .0010	
								Zn .0116	
								Pb 0	
	Lysimachia nummularia	above-ground	1.710	.256	2.897	1.232	.414	Ash10.946	
								Fe .255	
								S .063	
								Al .053	
								Si .461	
								Cu .0005	
								Zn .004	
								Pb .0003	
	Brachypodium	above-ground	.960	.265	2.291	.715	.200	Ash14.402	
								Fe .136	
								S .197	
								Al .107	
								Si 3.316	
								Cu .0006	
								Zn .006	
								Pb .0005	
		under-ground	1.020	.137	.813	.477	.131	Ash 7.318	
								Fe .239	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other	Reference
								S .104	
								Al .190	
								Si 1.564	
								Cu .0010	
								Zn .0076	
								Pb .0008	
	Deschampsia	above-ground	1.520	.263	2.880	.596	.213	Ash14.890	
								Fe .097	
								S .153	
								Al .074	
								Si 3.167	
								Cu .0004	
								Zn .004	
								Pb .0005	
		under-ground	1.100	.172	.614	.874	.362	Ash31.092	
								Fe 1.211	
								S .156	
								Al 1.084	
								Si 9.703	
								Cu .0027	
								Zn .0189	
								Pb .0006	
	Carex acutiformis	above-ground	1.480	.252	2.897	.556	.213	Ash12.674	
								Fe .239	
								S .186	
								Al .120	
								Si 2.215	
								Cu .0006	
								Zn .004	
								Pb .0003	
		under-ground	1.230	.287	1.668	.715	.293	Ash14.474	
								Fe .717	
								S .192	
								Al .485	
								Si 2.759	
								Cu .0029	
								Zn .0012	
								Pb .0006	
	Pulmonaria officinalis	above-ground	1.730	.394	6.724	1.590	.282	Ash20.730	
								Fe .125	
								S .156	
								Al .114	
								Si 2.199	
								Cu .0016	
								Zn .0036	
								Pb .0003	
		under-ground	1.420	.292	3.179	1.113	.224	Ash35.08	
								Fe .266	
								S .164	
								Al .292	
								Si 1.864	
								Cu .0019	
								Zn .0019	
								Pb .0005	
	Iris	above-ground	.960	.296	3.644	2.147	.407	Ash15.302	
								Fe .089	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other	Reference
								S .142	
								Al .054	
								Si .231	
								Cu .0004	
								Zn .003	
								Pb .0005	
		under-ground	.810	.155	1.037	1.351	.227	Ash11.628	
								Fe .539	
								S .096	
								Al .155	
								Si 1.847	
								Cu .0014	
								Zn .0014	
								Pb .0008	
	Iris	above-ground	.860	.135	2.590	2.465	.396	Ash13.482	
								Fe .239	
								S .123	
								Al .142	
								Si .402	
								Cu .0004	
								Zn .0006	
								Pb 0	
		under-ground	1.180	.250	1.843	1.431	.300	Ash14.604	
								Fe .672	
								S .192	
								Al .269	
								Si 2.095	
								Cu .0017	
								Zn .0017	
								Pb .0005	
	Rubus caesius	above-ground	1.100	.223	1.369	1.073	.407	Ash 6.630	
								Fe .078	
								S .255	
								Al .049	
								Si .204	
								Cu .0008	
								Zn .0006	
								Pb .0003	
		under-ground	.760	.243	.431	.715	.272	Ash11.070	
								Fe .394	
								S .120	
								Al .377	
								Si 2.451	
								Cu .0018	
								Zn .0018	
								Pb .0003	
	Average	above-ground	1.484	.296	3.547	1.471	.341	Ash14.883	
								Fe .133	
								S .193	
								Al .086	
								Si 1.114	
								Cu .0014	
								Zn .0007	
								Pb .0004	
		under-ground	1.017	.223	1.747	1.021	.252	Ash14.888	
								Fe .459	

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other		Reference
								S	.152	
								Al	.359	
								Si	2.505	
								Cu	.0015	
								Zn	.0069	
								Pb	.0005	
N. Stradbroke Island, Australia	Hibbertia vestita	Current leaves	2	.08	.9	.97	.44	Na	.1	Westman & Rogers 1977
								S	.26	
		Older leaves	1.30	.04	1.40	1.300	.400	Na	.192	
	Imperata cylindrica	Current leaves	.6	.06	.5	.14	.07	Na	.06	
								S	.07	
	Lepidosperma laterale	Current leaves	.3	.02	.4	.22	.07	Na	.07	
								S	.1	
	Leucopogon margarodes	Current leaves	1.6	.07	.5	.58	.15	Na	.08	
								S	.12	
		Older leaves	.93	.043	.44	.550	.080	Na	.060	
	Lomandra longifolia	Current leaves	1.8	.06	.7	1.07	.11	Na	.10	
								S	.23	
	Monotoca scoparia	Current leaves	1.2	.04	.6	.39	.13	Na	.07	
								S	.11	
		Older leaves	.95	.023	.78	.620	.194	Na	.200	
		Stem wood	.31	.005	.21	.350	.039	Na	.096	
	Persoonia virgata	Current leaves	1.3	.08	.5	.28	.16	Na	.13	
								S	.12	
		Older leaves	.96	.095	.50	.225	.090	Na	.381	
	Petrophile sessilis	Current leaves	.8	.07	.3	.16	.15	Na	.04	
								S	.07	
		Older leaves	.82	.030	.53	.380	.172	Na	.044	
		Stem wood	.30	.034	.25	.750	.020	Na	.052	
	Pteridium esculentum	Current leaves	1.7	.10	.9	.12	.13	Na	.07	
								S	.13	
	Pultenaea villosa	Current leaves	2.6	.09	.6	.55	.28	Na	.13	
								S	.17	
	Tristania conferta	Current leaves	1.6	.08	.8	.73	.25	Na	.1	
								S	1.2	
		Older leaves	1.7	.07	.7	.87	.29	Na	.09	
								S	.14	
*Alaska, USA	Hylacomium splendens	Green	0.59-0.83							Weber and Van Cleve, 1981
		Brown	0.52-0.72							
	Pleurozium schreberi	Green	0.57-0.76							
		Green	0.54-0.58							

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other	Reference
Sweden	Hylocomium sple.	Entire	.77	.17	.47	.18		Na .01	Tamm, 1954
Germany	Hypnum shreb.	Entire	1.18	.23	.60	.59	.17	S .06 Na .07	Wolff, 1871[1]
Florida, USA	Ilex glabra	Wood	0.31	0.03	0.09	0.48	0.11		West et al. 1981 (prelim. data)
		Foliage	0.95	0.05	0.21	0.57	0.20		
USSR	Juniperus com.	Needles < 1 yr	1.34	.18	.62	1.02	.21	Na .02	Rudneva et al[1]
		> 2 yr	1.11	.12	.46	1.42	.20	.01	
	Vaccinium vitis	Leaves < 1 yr	1.21	.14	.61	.56	.14	.01	
		> 1 yr	.90	.10	.42	.36	.10	.02	
Oregon, USA	Mosses+Lichens	Entire-min	.61	.07	.13	.21	.05		Abee, 1973
		max	1.84	.15	.47	1.56	.13		
Florida, USA	Myrica cerifera	Wood	0.55	0.01	0.08	0.55	0.08		West et al. 1981 (prelim. data)
		Foliage	1.46	0.03	0.22	0.82	0.19		
USA	Osmunda cin.	Leaves	2.18	.23	3.88	1.22	.59		Scott, 1955
USSR	Oxalis acet.	Leaves	2.61	.38	2.98	1.30	.20	S .16	Remezov et al. 1959[1]
USSR	Peltigera apht.	Entire	2.87	.10	.38	.32	.10	S .03	Yerdokimova, 1957[1]
Ontario	Pinus banksiana 65	Ground veg.	4	<1	2	1	<1	Biomass 310	Morrison & Foster 1979
Florida, USA	Pinus elliottii	Bole	0.11	0.01	0.02	0.17	0.02		West et al. 1981 (prelim. data)
		Branches	0.23	0.02	0.06	0.29	0.04		
		Foliage	0.80	0.03	0.24	0.24	0.12		
Belgium	Polygonatum	Leaves	3.0	.21	3.8	1.4	.37		Duvigneaud & Denaeyer-de Smet, 1967
	Arum macu.	Leaves	3.9	.40	3.6	.62	.21		
	Ornithogalum	Leaves	5.3	.49	3.5	.40	.20		
	Allium urs.	Leaves	4.6	.37	3.4	.70	.17		
	Narcissus psu.	Leaves	4.3	.30	2.8	.36	.18		
	Pulmonaria	Leaves	2.2	.17	6.6	2.4	.17		
	Ficaria ran.	Leaves	2.1	.40	6.6	1.9	.20		
	Lamium gal.	Leaves	2.5	.25	5.9	1.4	.36		
	Primula elat.	Leaves	2.5	.19	4.9	.64	.30		
	Viola reich.	Leaves	2.1	.28	4.4	1.1	.50		
	Geum rivale	Leaves	3.0	.20	3.5	1.5	.50		
	Anemone nem.	Leaves	2.8	.18	3.0	2.2	.38		
	Circea lut.	Leaves	2.6	.16	3.0	2.0	.50		
	Hedera helix	Leaves	1.7	.10	1.1	1.2	.24		
	Rosa arve.	Leaves	1.8	.13	1.9	1.8	.35		
		Stems	.8	.10	1.2	.9	.30		
	Rubus sp.	Leaves	2.5	.15	1.5	1.1	.43		
		Stems	1.0	.10	1.0	.6	.40		

Table 13 Nutrient Concentrations - Understory

Location	Species	Component	N	P	K	Ca	Mg	Other		Reference
B.C., Canada	Pseudotsuga-seed	Total	.33	.04	.16	.43	.07			Webber, 1977[1]
	dead		.26	.03	.12	.34	.04			
	Thuja - seedling		.44	.04	.22	.74	.05			
	Gaultheria - live		.60	.04	.40	.91	.16			
	dead		.37	.03	.05	.66	.06			
	Berberis nerv.		.93	.11	.77	.89	.11			
	Rosa spp.		.51	.11	.31	.82	.11			
	Polystichum mun.		.25	.15	1.38	.58	.21			
Oregon, USA	Purshia tridentata	Foliage		.20	.95	.40	.15	B	27[1]	Will & Youngberg 1979
								Zn	31[1]	
								Fe	50[1]	
								Mn	25[1]	
				.18	.95	.38	.16	B	19[1]	
								Zn	13[1]	
								Fe	55[1]	
								Mn	30[1]	
				.20	.95	.37	.14	B	18[1]	
								Zn	29[1]	
								Fe	50[1]	
								Mn	20[1]	
Germany	Sphagnum cusp.	Entire		.03	.08	.20	.04	S	.02	Wolff, 1871[1]
								Na	.13	
	Sphagnum sp.	Peat	1.44	.07	.03	.13	.05	S	.05	
								Na	.002	
USSR	Sphagnum fusc.	Current	1.24	.07	.32	.27	.15	S	.06	Bazilevich[1]
								Na	.07	
		Previous	1.00	.07	.27	.44	.25	S	.06	
								Na	.03	
	Sphagnum recu.	Current	1.00	.09	.56	.24	.08	S	.10	
								Na	.04	
	Sphagnum medi.	Current	1.03	.08	.47	.30	.08	S	.12	
								Na	.03	
Oregon, USA	Stokesiella oreg.	Current	1.04	.20	.36	.88	.07	Na	.04	Binkley & Graham 1981
								S	.05	
		1-yr.	.89	.18	.49	.77	.09	Na	.02	
								S	.03	
		2-yr.	.65	.18	.44	.87	.08	Na	.03	
								S	.05	
	Hylacomium splendens	Green	.91	.19	.43	.44	.08	Na	.02	
								S	.02	
		Yellow	.88	.16	.29	.60	.06	Na	.03	
								S	.06	
		Brown	.83	.16	.29	.86	.06	Na	.03	
								S	.02	

Table 13 Nutrient Concentrations - Understory

Location	Species		Component	N	P	K	Ca	Mg	Other	Reference
B.C., Canada	Tsuga, Abies	300	Hygric							
			Shrub & herb	3.71	0.36	4.35	0.70	0.29	Mn 602 ppm Zn 52 ppm Cu 15 ppm	
			Bryophyte	2.33	0.17	1.32	0.55	0.14	Mn 1084 ppm Zn 70 ppm Cu 23 ppm	
			Mesic							
			Shrub & herb	2.54	0.25	3.46	0.51	0.30	Mn 418 ppm Zn 41 ppm Cu 9 ppm	
			Bryophyte	2.48	0.20	0.91	0.28	0.08	Mn 532 ppm Zn 49 ppm Cu 27 ppm	
			Xeric							
			Shrub & herb	2.08	0.18	1.22	0.37	0.24	Mn 272 ppm Zn 42 ppm Cu 11 ppm	
			Bryophyte	2.26	0.20	1.15	0.27	0.09	Mn 226 ppm Zn 36 ppm Cu 24 ppm	
Florida, USA	Vaccinium fuscatum		Wood	0.37	0.03	0.13	0.60	0.06		West et al. 1981 (prelim. data)
			Foliage	1.09	0.05	0.18	0.85	0.19		
USSR	Vaccinium myrt.		Leaves	1.46	.12	.45	.45	.13	S .07	Marchenko-Karlov, 1962[1]
	Vaccinium vitis		Leaves	1.27	.11	.47	.48	.18	S .06	
	Vaccinium ulig.		Leaves	1.28	.13	.38	.24	.13	S .06	
	Empetrumm nigr.		Leaves	1.26	.10	.39	.39	.16	S .06	

[1]Cited in Rodin and Bazilevich, 1967
[2]Maximum values
[3]parts per million

Table 14 Annual Outputs

Location	Dom. Veg.	Output type	kg/ha/yr N	P	K	Ca	Mg	Na	Others		Reference
Japan		Total output	5.39	.51	8.3	23.3	4.50	60.8			Tsutsumi, 1978
				.40	11.6	17.0	4.80	63.6			
				.50	11.2	10.6	3.3	62.5			
						21.4	6.0	88.6			
			5.5	.12	2.3	5.0	2.3				
Japan	"Hinki"	Surface runoff	1.2	.07	2.2	4.2	.7				Iwatsubo & Tsutsumi,
	Broad-mix		1.6	.13	11.8	6.7	2.0				1968
Carnation Creek, B.C. Canada	Abies, Tsuga, Thuja	Stream-water	1.1	.05	4.8	57.7	10.4	38.4	SO4-S	28.	Scrivner (1975)
Washington, USA	Alnus rubra	Lysimetry									Bigger & Cole, 1983
	High productivity										
	Control		114	0.03	42	250	470	44	SO4	50	
	Bole harvest		4	0.01	9	120	39	15	SO4	7	
	Whole tree		14	0.01	20	113	31	14	SO4	10	
	Complete		1	0.01	3	120	28	9	SO4	4	
	Low productivity										
	Control		22	.08	5	72	20	12	SO4	16	
	Bole harvest		7	.08	4	88	19	24	SO4	15	
	Whole tree		0.3	.08	7	71	18	25	SO4	11	
	Complete		4	.08	5	70	15	31	SO4	17	
Oregon, USA	Alnus, Conifer	Stream-water	5-74								Miller & Newton, 1982
New Zealand	Beech - Hardwood	Streamflow	1.58	.35	7.29	13.88	4.18	35.12			Neary et al. 1978
Birkenes Watershed, Norway	Betula, Pinus, Picea	Stream-water	2.2		1.5	14.1	5.0	30.3	SO4-S	26.9	Gjessing et al. 1976
Pago Catchment, Australia	Eucalyptus	Stream-water		.26		7.1	4.5	15.9			P.M. Hallam, cited in Likens et al. 1977
Stewarts Cl. Victoria, Australia	Eucalyptus obliqua	Stream-water			2.1	0.2	3.6	19.8			Guthrie et al. 1978
			(NO3+NH4)-N								
Maroondah, Victoria, Australia	Eucalyptus regnans	Stream-water	3.7	.12	7.7	11.8	6.1	26.0			Feller, unpublished
W. Germany	Fagus sylv.	Leaching	7.7	.019	2.5	15.9	3.40	14.5			Ulrich et al. 1979
									Al	15.5	
									Cl	32.1	
									S	34.7	
	Picea abies	Leaching	17.0	.009	10.9	10.0	4.30	16.0	Al	27.0	
									Cl	33.9	
									S	43.9	

Table 14 Annual Outputs

Location	Dom. Veg.	Output type	kg/ha/yr N	P	K	Ca	Mg	Na	Others		Reference
Storsjon, Sweden	Mixed conifer	Stream-water	2.3	.02	4.0	12.2	8.7	37.5	SO4-S	25.3	W. Dickson, cited in Likens et al. 1977
B.C., Canada	Mixed conifer	Stream-water	NH4 .54 NO3 .82	.73	2.6	42.	8.8	26.	SO4 Cl SiO2	9. 38. 92.	Zeman, 1973
Hubbard Brook, N.E. U.S.	Mixed hardwood	Stream-water	4.0	.020	2.4	13.9	3.3	7.4	Al H SO4 Cl SiO2 HCO3	2.0 0.10 52.8 4.6 37.7 7.77	Likens et al. 1977
Tanghannock Creek, N.E. U.S.	Mixed hardwoods	Stream-water	5.6	.20	5.6	182.	34.8	18.9			Likens 1974
New Hampshire, USA	Mixed Hardwoods	Stream-water	NO3-N-6.6 NH4-N-0.4		-	3.4	23.0	3.4	SO4-S-	16.1	Martin, 1979
Silverstream, New Zealand	Nothofugus	Stream-water	1.8	.03	13.	26.	13.	62.	SO4-S	13.	Miller 1963
Blue Range Catchment Australia	Pinus	Stream-water		.42		5.5	8.7	16.2			P.M. Hallam, cited in Likens et al. 1977
New Zealand	Pinus radiata	Leaching	n.d'	.01	4.2	5.7	1.6	12.5	Si Cl	39.0 5.6	Knight & Will 1977
S. Carolina, USA	Pinus taeda	Stream-water	(NH4-N) 0.04- 0.08 (NO3-N) 0.03- 0.07	0.004- 0.026	0.7- 1.4	0.4- 0.6	0.3- 1.3	0.5-			West et al 1981 (prelim. data)
Velen, Sweden	Pinus, Picea	Stream-water	0.4		2.5	11.1	3.2	9.2	SO4-S	9.4	Eriksson 1974
ELA, Ontario, Canada	Pinus, Picea		0.9	.05	1.2	6.0	2.4	3.7	SO4-S	3.2	Schindler et al. 1976
Finland	Pinus, Picea		2.	.3	4.6	12.	4.	6.	SO4-S	4.7	Viro 1953
Washington, USA	Pinus, Pseudo.	Stream-water	1.3	.13	4.4	20.8	4.6	11.4			Tiedeman et al. 1978
Michigan, USA	Populus (good site)	Leaching	NH4-N 0.1 NO3-N 0.3	.3	7.6	38.8	17.7	6.7	Fe	0.3	Richardson & Lund, 1975
	Clearcut plot (good site)	Leaching	NH4-N 0.1 NO3-N 0.2	.5	9.6	65.2	26.6	15.3	Fe	0.4	
	Populus tremuloides (med. site)	Leaching	NH4-N 0.2 NO3-N 0.1	.3	7.4	28.6	7.0	10.6	Fe	0.2	
	Clearcut plot (med. site)	Leaching	NH4-N 0.2 NO3-N 0.2	.4	11.2	36.2	6.6	14.2	Fe	0.4	
	Populus	Leaching	NH4-N 0.1	.3	5.3	19.4	3.9	11.2	Fe	0.2	

Table 14 Annual Outputs

Location	Dom. Veg.	Output type	kg/ha/yr N	P	K	Ca	Mg	Na	Others		Reference
	tremuloides (poor site)		NO3-N 0.1								
	Clearcut plot (poor site)	Leaching	NH4-N 0.1 NO3-N 0.1	.3	7.6	19.8	4.9	12.0	Fe	0.2	
Tesuque Watersheds, S.W. U.S.	Populus,	Stream-water			3.2	13.1	4.2	10.0			Gosz 1977, cited in Likens et al. 1977
	Mixed Conifer,				2.1	10.1	3.4	6.5			
	Pinus, Juniperus				1.2	22.3	10.8	4.9			
Washington, USA	Pseudotsuga										Bigger and Cole 1983
	High productivity										
	Control		0.02	0.04	5	50	21	5	SO4	7.5	
	Bole harvest		0.22	0.02	8	75	6	17	SO4	6.2	
	Whole tree		0.14	0.30	8	82	20	10	SO4	6.7	
	Complete		0.04	0.14	14	60	16	12	SO4	3.2	
	Low productivity										
	Control		0.08	0.07	11	34	15	14	SO4	24	
	Bole harvest		0.33	0.02	4	22	6	14	SO4	8	
	Whole tree		3.26	0.01	8	38	7	10	SO4	7	
	Complete		4.66	0.02	14	32	10	2	SO4	10	
Oregon, USA	Pseudotsuga menziesii	Soil leaching	1.5	.8	9.5	123	9			53	Sollins et al. 1980
Cascade Mtns. W. U.S.	Pseudotsuga	Stream-water	1.2	.51							Fredriksen 1975
Cedar River, N.W. U.S.	Pseudotsuga	Soil Leaching	0.6	.02	1.0	4.5					Cole et al. 1967
Andrews Forest, Ore., U.S.	Pseudotsuga	Stream-water	.38	.52	2.25	50.32					Fredriksen 1975
Walker Branch, S.E. U.S.	Quercus, Carya	Stream-water	1.8	.02	6.8	148.	77.1	4.5	SO4-S	11.3	G. Henderson, cited in Likens et al. 1977
Coweeta, N.C. U.S.	Quercus, Carya	Stream-water	.08	.02	5.6	8.7	4.3	12.4	SO4	9.1	Swank & Douglas 1977
									Cl	8.9	
									SiO2	97.3	
		Denitrification	18.								Todd et al. 1975
Long Island, NY, N.E. U.S.	Quercus, Pinus	Stream-water			3.9	9.6	7.3	23.			Woodwell and Whittaker 1967
S.E. U.S.	Quercus, Pinus	Stream-water	1.		6.	19.	6.	26.	SO4-S	7.	Gambell & Fisher 1966

Table 14 Annual Outputs

Location	Dom. Veg.	Output type	kg/ha/yr N	P	K	Ca	Mg	Na	Others		Reference
Haney, B.C., Canada	Tsuga, Pseudo., Thuja	Stream-water	(NO3+NH4)-N 1.0	.0	1.6	16.9	3.4	10.8	Cl SO4-S	10.8 7.3	Feller & Kimmins 1979

[1] none detected

Table 15 Outputs - Denitrification

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
Finland (all potentials)	Calluna pine		Organic layers (0-5 cm)	3.5×10^{-2} nmoles $g^{-1}hr^{-1}$	Muller & Sundman, 1980
			A layer (5-7)	4.0×10^{-1} nmoles $g^{-1}hr^{-1}$	
			B layer (7-30)	18.54 nmoles $g^{-1}hr^{-1}$	
	Calluna spruce		Organic layers (0-5)	7.56×10^{-1}	
			B layer (5-30)	8.96	
	Vaccinium pine		Organic layer (0-3)	1.6×10^{-2}	
			A (3-5)	6.0×10^{-1}	
			B (5-30)	15.0	
	Vaccinium spruce		Organic layer (0-5)	3.5×10^{-1}	
			B layer (5-30)	20.6	
	Mrytillus spruce		Organic layer (0-10)	2.0×10^{-1}	
			A (10-15)	1.4	
			B (15-30)	10.6	
	Oxalis-Mrytillus Spruce		Organic 0-5	10.6	
			A 5-40	12.6	
	Oxalis-Mrytillus Spruce		Organic 0-5	6.6	
			A 5-30	8.1	
	Melica lathyrus		Organic 0-10	12.2 nmoles $g^{-1}hr^{-1}$	
	Deciduous forest		A 10-20	18.0	
	Oxalis Maianthemum Deciduous forest		Organic 0-20	11.3	
	Oxalis Maianthemum Deciduous forest		Organic 0-5	25.5	
			A 10-20 cm	12.8	
New Hampshire, USA	Hardwoods	2	Soil+Forest floor		Melillo et al. 1983
			Aerobic scenario	0.4	
			Anaerobic scenario	52	
		50	Soil+forest floor		
			Aerobic scenario	1.4	
			Anaerobic scenario	9.0	
Georgia	Lowland pine Deciduous forests		Total	8 kg N $ha^{-1}yr^{-1}$	Hendrickson, 1981
	Downslope from cornfields		Total	24-36	
	Downslope from hogpens		Total	295	
NE USA	Mix dec.		FF+M5 (0-20 CM)		Melillo et al. 1983
	2 year old clearcut		anaerobic	51.6 kg n $ha^{-1}yr^{-1}$	
			aerobic	0.4 kg N $ha^{-1}yr^{-1}$	
	50+ year old stand		anaerobic	9.0 kg N $ha^{-1}yr^{-1}$	
			aerobic	1.5 kg N $ha^{-1}yr^{-1}$	
N. Carolina, USA	Mix dec.		Twigs	- kg N $ha^{-1}yr^{-1}$	Todd et al. 1975
			Branches	.17, .05	
			Logs	1.61, 1.63	
			Soil L	-	
			H	.08	
			0-10 cm	11.90	
			10-20 cm	2.47	
			20-40 cm	0.25	
			Total	18.16	

Table 15 Outputs - Denitrification

Location	Dominant Veg.	Age	Source	Amt (kg/ha/yr)	Reference
N. Carolina, USA	Mix dec.		Twigs		Todd et al, 1975
			Branches	.17	
				.05	
			Logs	1.61	
				1.63	
			Soil L		
			H	.08	
			0-10 cm	11.90	
			10-20 cm	2.47	
			20-40 cm	.25	
			Total	18.16	
NE USA	Mix. dec.		M.5 (0-5cm) anaerobic, $NO^{-}3$ (i.e. potentials)	9.02 nmoles $g^{-1}hr^{-1}$	Limmer & Steele, 1982
Harrad forest NE USA	Pines		Forest floor + M.S.	22 kg N $ha^{-1}yr^{-1}$	Aber et al. 1983
Trenched plots 1st year after clearcutting	Hardwoods		Forest floor + M.S.	10 kg N ha^{-1} yr^{-1}	
Michigan, USA	Successional sere		Soil+forest floor	<1 (most sites) 8-50 (highest sites)	Robertson & Tiedje, 1984

Table 16 Water Chemistry Profiles

Location	Dom. Veg.	Age	Stage	Collector No.	Concen. u equiv./l H	NO3	NH4	H2PO4	K	Ca	Mg	Other		Reference
New Hampshire, USA	Abies balsamea	Old	Precip.	3	83	21	13		3	9	3	Cl	7	Cronan and Schofield, 1979
												SO4	75	
												HCO3	0	
	Duration 2 years											Org. Anions	12	
												Na	4	
			Throughfall	12-57	95	12	6		37	36	14	Cl	13	
												Al	5	
												SO4	143	
												Fe	1	
												HCO3	0	
												Mn	4	
												Org Anions	33	
												Na	3	
			A horiz. Leachate	15	91	8	5		16	25	15	Cl	16	
												Al	54	
												SO4	137	
												Fe	4	
												HCO3	0	
												Mn	2	
												Org Anions	58	
												Na	7	
			Springs	1	22	15	3		10	26	19	Cl	7	
												Al	67	
												SO4	132	
												Fe	2	
												HCO3	0	
												Mn	1	
												Org Anions	9	
												Na	13	
Findley Lake, Washington	Abies amabilis	300	Precip.		3	Tr			Total Cations		106	Cl	Tr	Johnson, 1975
												HCO3	66	
												SO4	35	
	Duration ?		Throughfall		45	Tr			Total Cations		116	Cl	Tr	
												HCO3	0	
												SO4	64	
			Forest Floor		25	Tr			Total Cations		205	Cl	35	
												HCO3	21	
												SO4	58	
			A2 Horiz.		40	Tr			Total Cations		170	Cl	22	
												HCO3	9	
												SO4	49	
			111 B2 hir hor.		13	Tr			Total Cations		123	Cl	21	
												HCO3	44	
												SO4	43	
			111 B3 Horiz.		Z	Tr			Total Cations		321	Cl	35	
												HCO3	238	
												SO4	48	

Table 16 Water Chemistry Profiles

Location	Dom. Veg.	Age	Stage	Collector No.	Concen. u equiv./l H	NO3	NH4	H2PO4	K	Ca	Mg	Other		Reference
UBC Res. For., B.C.	Alnus rubra, Pseudotsuga	18	Precip.	1	32	11	0.5	0.1	2	10	5	Cl	17	Binkley et al. 1982
												SiO2[1]	2	
												Cond.[2]	17	
												HCO3	5	
												SO4	28	
	Duration 8 months		Throughfall	14	1.3	4	1.6	1.8	106	60	52	Cl	34	
												SiO2	2	
												Cond.	35	
												HCO3	151	
												SO4	108	
			Forest Floor leachate	14	2.5	270	1.4	0.4	69	275	117	Cl	50	
												SiO2[1]	62	
												Cond.[2]	77	
												HCO3	75	
												SO4	78	
			B horiz. leachate	14	1.6	136	1.4	0.2	35	160	79	Cl	35	
												SiO2[1]	73	
												Cond.[2]	73	
												HCO3	103	
												SO4	64	
			Saturated zone	10	2.0	50	1.4	0.1	24	81	35	Cl	36	
												SiO2[1]	95	
												Cond.[2]	27	
												HCO3	131	
												SO4	59	
			Stream	1	0.3	63	0.2	0.0	5	83	33	Cl	23	
												SiO2[1]	111	
												Cond.[2]	21	
												HCO3	128	
												SO4	36	
Northern	Aspen		Precip.	3		18			3	18	3	SO4	34	Graustein (unpub. data
												Na	3	
												SiO[1]	0.5	
	Duration 2 years		Throughfall	4-28		8			29	39	11	HCO3	40	may be revised
												SO4	35	before
												Na	1.4	publication)
												SiO2	1.4	
			Soil leachate 30cm	1	.5	13			45	184	68	HCO3	92	
												SO4	51	
												Na	30	
												SiO2[1]	122	
			90cm		.4	12			11	80	34	HCO3	62	
												SO4	52	
												Na	56	
												SiO2[1]	189	
			150cm		.2	8			10	64	38	HCO3	125	
												SO4	58	
												Na	136	
												SiO2[1]	290	
			Stream			2			16	158	91	SO4	50	
												Na	124	
												SiO2[1]	243	

Table 16 Water Chemistry Profiles

Location	Dom. Veg.	Age	Stage	Collector No.	Concen. u equiv./l H	NO3	NH4	H2PO4	K	Ca	Mg	Other		Reference
UBC Res. For. B.C.	Mixed Con. Duration 1 year	70-90	Precip.	1	32	11	0.5	0.1	2	10	5	Cl	17	Feller 1977
												HCO3	5	
												SO4	28	
												SiO2[1]	2	
												Cond.[1]	17	
												Na	13	
												Fe	0	
												Mn	0	
			Throughfall	42	40	17	0.2	1.3	28	50	25	Cl	48	
												HCO3	21	
												SO4	102	
												SiO2[1]	2	
												Cond.[1]	35	
												Na	28	
												Fe	0.1	
												Mn	1.7	
			Forest Floor leachate	19	4.0	3	0.3	1.0	42	145	150	Cl	76	
												HCO3	98	
												SO4	290	
												SiO2[1]	62	
												Cond.[1]	50	
												Na	45	
												Fe	3.5	
												Mn	2.4	
			B horiz.	19	0.6	5	0.3	0.3	9	90	53	Cl	45	
												HCO3	81	
												SO4	104	
												SiO2[1]	53	
												Cond.[1]	28	
												Na	37	
												Fe	0.1	
												Mn	0.1	
			Saturated zone	2	0.5	1	0.1	0.0	2	65	21	Cl	25	
												HCO3	77	
												SO4	35	
												SiO2[1]	47	
												Cond.[1]	19	
												Na	38	
												Fe	0	
												Mn	0.1	
			Stream	2	0.2	4	0.1	0.1	2	75	26	Cl	23	
												HCO3	129	
												SO4	43	
												SiO2[1]	78	
												Cond.[1]	20	
												Na	44	
												Fe	0	
												Mn	0	

Table 16 Water Chemistry Profiles

Location	Dom. Veg.	Age	Stage	Collector No.	Concen. u equiv./l H	NO3	NH4	H2PO4	K	Ca	Mg	Other		Reference
Petersburg, Alaska	Picea sitchensis-Tsuga heterophylla	Old	Precip.		2.3				Total Cations		58	Cl	30	Johnson 1975
												HCO3	48	
												SO4	Tr	
			Throughfall		5.6						287	Cl	140	
	Duration ?											HCO3	84	
												SO4	38	
			Forest Floor		25.7						513	Cl	303	
												HCO3	27	
												SO4	51	
			A2 Horizon		5.6						390	Cl	213	
												HCO3	93	
												SO4	35	
			B2 hir Horizon		2.0						308	Cl	197	
												HCO3	98	
												SO4	29	
			C horizon		1.0						324	Cl	221	
												HCO3	155	
												SO4	23	
Northern New Mexico	Picea-Abies		Precip.	3		18			3	18	3	SO4	34	Graustein (unpublished Data may be revised before publication)
												Na	3	
	Duration 2 years											SiO2[1]	0.5	
			Throughfall			3			72	121	31	HCO3	43	
												SO4	122	
												Na	13	
												SiO2	6.5	
			Soil leachate 30cm	1	2.6				83	449	93	HCO3	160	
												SO4	152	
												Na	45	
												SiO2[1]	339	
			90cm	1	1.2				97	60	28	HCO3	46	
												SO4	127	
												Na	45	
												SiO2[1]	193	
			150cm	1	1.1				12	107	29	HCO3	29	
												SO4	139	
												Na	70	
												SiO2[1]	254	
			Stream	1		8			28	178	129	HCO3	256	
												SO4	123	
												Na	82	
												SiO2[1]	167	

Table 16 Water Chemistry Profiles

Location	Dom. Veg.	Age	Stage	Collector No.	Concen. u equiv./l H	NO3	NH4	H2PO4	K	Ca	Mg	Other		Reference
Nevada, USA	Pinus jeffreyi		Precip.		3.2	Only total N measured		3.4	25	15	9.5	Na	18	Stark, 1973
			Throughfall		6.3			15.5	133	93	82	Na	78	
			Forest floor leachate		.5			3.0	115	42	33	Na	5.2	
			Min. Soil leachate 50cm		16.0			5.2	151	252	107	Na	139	
			Stream		6.3			9.1	51	197	16	Na	113	
												Kjel-N	(ug/l)	
Oregon, USA	Pseudotsuga	450	Precip.	?		1						49		Sollins and
			Throughfall	?		0.2						147		McCorrison, 1981
			Litter leachate	?		0.2						322		
			Soil 0.1 m	?		1.4						165		
			0.3 m	?		0.2						238		
			1.0 m	?		1.2						162		
			2.0 m	?		1.9						115		
			Seeps	?		0.1						70		
			Stream	1		0.07						47		
		3	Precip.	?		0.5						76		
			Throughfall	?		1.3						184		
			Litter leachate	?		23.0						980		
			Soil 0.1 m	?		6.7						514		
			0.3 m	?		8.4						495		
			1.0 m	?		19.6						312		
			Seeps	?		5.6						61		
			Streams	1		2.4						79		
Thompson site, Washington	Pseudotsuga	45	Precip.		12	4		Total Cations	95			Cl	28	Johnson, 1975
	Duration 1 year											HCO3	41	
												SO4	15	
			Throughfall		6.9	Tr		Total Cations	100			Cl	50	
												HCO3	56	
												SO4	24	
			Forest Floor		1.4	Tr		Total Cations	429			Cl	126	
												HCO3	131	
												SO4	144	
			A horiz.		0.7	Tr		Total Cations	252			Cl	67	
												HCO3	114	
												SO4	47	
			B horiz. (50cm)		0.8	Tr		Total Cations	239			Cl	74	
												HCO3	117	
												SO4	43	

Table 16 Water Chemistry Profiles

Location	Dom. Veg.	Age	Stage	Collector No.	Concen. u equiv./l H	NO3	NH4	H2PO4	K	Ca	Mg	Other		Reference
H.J.Andrews, Forest, Oregon	Pseudotsuga Duration 1-3 years	450	Precip.	1	6.3	0.9		0.2	1	7	4	Cl HCO3 SO4 Na	44 7 5 10	Sollins et al. 1980
			Throughfall	54	5.2	Tr		1.9	18	18	12	Cl HCO3 SO4 Na	52 11 9 14	
			Forest Floor	2	1.5	Tr		3.0	33	58	23	HCO3 SO4 Na	18 28 16	
			Soil Solutions 30cm		4.1	0.4		2.2	24	372	36	Cl HCO3 SO4 Na	40 160 - 292	
			100cm		4.4	0.1		1.5	16	398	46	Cl HCO3 SO4 Na	104 147 258 149	
			200cm		4.3	0.5		1.8	14	324	53	Cl HCO3 SO4 Na	41 72 54 193	
			Springs		7.0	0.4		2.7	8	159	74	Cl HCO3 SO4 Na	- 62 - 91	
			Stream		1.2	1.4		1.7	9	160	69	Cl HCO3 SO4 Na	- 68 - 85	
La Selva, Costa Rica	Tropical Forest Duration 1 month	?	Precip.		30.2	Tr			Total Cations		30	HCO3 SO4	0. 20.	Johnson, 1975
			Throughfall		2.0	10			Total Cations		130	HCO3 SO4	80 48	
			A11 Hor. (15cm)		1.9	11			Total Cations			HCO3 SO4	263 15	
			A12 Hor. (45cm)		0.1	11			Total Cations			HCO3 SO4	285 18	
			A12 Hor. (60cm)		2.1	9			Total Cations			HCO3 SO4	140 15	

' u mol/l
' u S/cm

Table 17 Fire Nutrient Outputs

Location	Dom. Veg.	Age	Output Fire type	kg/ha N	P	K	Ca	Mg	Other	Reference
Florida, USA	Pinus	0-42 yr	Periodic ground fires for 42 yr.	1270						Barnette and Hester, 1930
Minnesota, USA	Pinus banksiana	?	Forest floor burning	500-1700						Alway, 1928, cited in Ahlgren and Ahlgren, 1960
Oregon, USA	Pinus ponderosa	Old	Prescribed broadcast fire	110						Nissley et al. 1980
Arizona, USA	Pinus ponderosa	50	Thinning residue piled and burned	58						Klemmedson, 1976
California, USA	Pinus ponderosa		Prescribed broadcast fire	124						Klemmedson et al. 1962
South Carolina, USA	Pinus taeda	?	Prescribed	11-40					S 1.4-8.0	Richter et al. 1982
N. Carolina, USA	Pinus taeda	55	Prescribed Broadcast	0-12						Schoch 1983
Washington, USA	Pseudotsuga	Clearcut	Broadcast slash fire	490						Isaac and Hopkins, 1937
Washington, USA	Pseudotsuga	300	Wildfire	900						Grier, 1975
B.C., Canada	Tsuga, Pseud.	Clearcut	Broadcast Slashfire	550						Kimmins and Feller, 1976
B.C., Canada	Tsuga,Pseud., Thuja	Clearcut	Slash fire hot	980	15	40	150	30		Feller (unpublished)
			medium	500	10	20	80	10		
Boreal	Various	?	Wildfire	320						Viro, 1974
Lake States, USA	Various		Wildfires	1800						Lovejoy, 1920, cited in Ahlgren and Ahlgren, 1960

ACKNOWLEDGMENT/REMERCIEMENT

We would like to thank Mrs. Patsy Quay who has been responsible for the secretarial work on these tables.

Nous aimerions remercier Mme Patsey Quay qui a dactylographié ces tableaux.

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