1974

Study on Generality of Desert Simulation Model by Using of Tundra Data

F. E. Wielgolaski

J. Radford

W. G. Valentine

1973 PROGRESS REPORT

STUDY ON GENERALITY OF A DESERT SIMULATION MODEL BY USE OF TUNDRA DATA

F. E. Wielgolaski
University of Oslo, Norway

J. Radford and W. G. Valentine
Utah State University

US/IBP Desert Biome
Research Memorandum 74-54

in

REPORTS OF 1973 PROGRESS
Volume 1: Central Office, Modelling
General-Purpose Model Section, pp. 187-216

MAY, 1974

Ecology Center, Utah State University, Logan, Utah 84322

INTRODUCTION

There are several viewpoints on development of simulation models in the field of ecology. The models can be very simple and use only constant coefficients and linear relationships in transfers from one state variable to another. The flows can be dependent on or independent of external factors. More or less of the physiology behind the processes between state variables may be included.

In total ecosystem studies the model often begins with a very simple flow diagram (or diagrams) between the main components (Fig. 1). The boxes represent amounts at a certain time and the arrows show the physical movement of matter between compartments. This concept is developed to more complicated compartment models (e.g., as proposed in the "Ustaoset" diagram in the IBP Tundra Biome; Dahl and Gore, 1968) and is increasingly used in ecology (Gore and Olson, 1967; Kelley et al., 1969). A set of equations concerned only with intrinsic factors of the system and with steady-state situations is typical for these relatively simple models. In its classical form, this type of model is purely descriptive or empirical, based on measured compartments at a specific site without inclusion of the physiology involved in the changes. This type of model is usually very site-specific although use of various values of different parameters may make it possible to compare various sites in a macroscale. This type of model is often the most useful in dealing with a total ecosystem. However, Goodall (1967, 1969), Van Dyne (1969), Milner (1972), and Timin et al. (1972) have also included the influence on flows and compartments of extrinsic variables.

This could be a step towards more mechanistic models for "total" ecosystems. In a typical mechanistic model the flows should fully express the physiology behind the processes in the model. Therefore, most mechanistic models are developed fractionally; e.g., a photosynthetic system (de Wit et al., 1970) or a plant-mineral uptake system (Miller, 1972). However, some attempts have been made to use a partly mechanistic approach for a total ecosystem. One model of this type is the ELM model being developed by the US/IBP Grassland Biome (Anway et al., 1972). It presently consists of five sections (abiotic, production, mammalian consumption, decomposition, and nutrient), most of which have some submodels.

Another partly mechanistic ecosystem model is under development by the US/IBP Desert Biome (Dr. D. W. Goodall and co-workers). One important difference distinguishes this model from others. It is made up of several versions of plant, animal and climate-soil submodels within a main program. A simple version of one or more of the submodels may be combined with various numbers of higher resolution versions of the other submodels, thus making the model very flexible. A high-resolution total model may be used or, e.g., a high-resolution animal submodel, according to the interests of the users. The same high flexibility is possible in the use of the model on single species of the system (plant or animal) or on small or large groups of species. These might again be subdivided into more or fewer compartments, depending on the interest of resolution. A special feature of this model is its ability to consider simultaneously, within each of the compartments, the amounts of nitrogen, ash elements (subdivided into anions and cations if actual), protein carbon, reserve carbon (soluble carbohydrates and fats), and structural carbon (partly subdivided into cellulose and lignin along with other slow-decomposing elements if actual). This subdivision into the building stores of plant and animal material enables the model to more readily handle the physiological processes going on in flows between the state variables. The disadvantage of including such biochemical variables is that the functions describing their flows are not completely known.

This paper describes the use of data from two different sites of the Norwegian IBP Tundra Biome studies on a relatively low-resolution version of the Desert Biome model.

The desert and the tundra have some characteristics in common even though the temperatures and precipitation are normally quite different. Both desert and tundra are usually virtually treeless and the ground vegetation cover is usually sparse in both areas. Very often the amount of organic matter is very low in both areas, although often for different reasons (it may be caused by low productivity in both). The idea that a desert and tundra have many characteristics in common (as well as dissimilarities) was one of the reasons for using the Norwegian tundra data in the desert model.

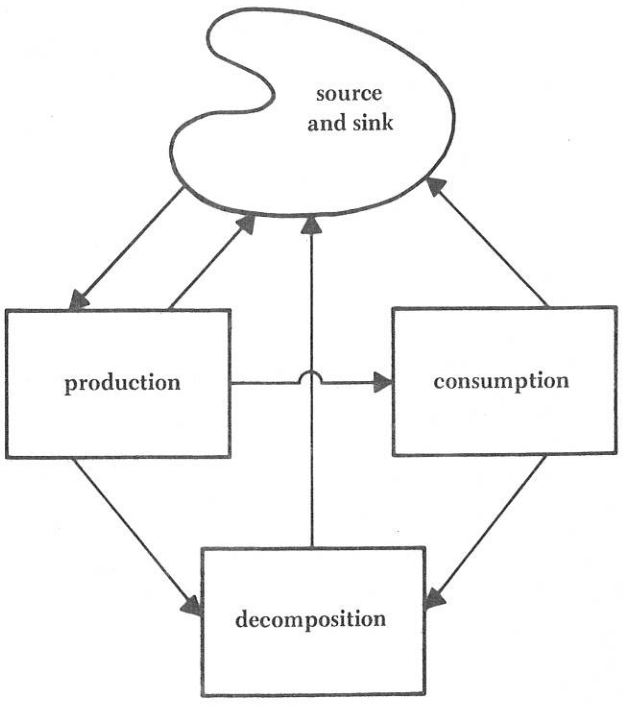


Figure 1. Flow diagram between main compartments.

SITE DESCRIPTION -- WORD MODEL

The two Norwegian tundra sites used in the desert model are situated at a distance from each other of about 1 km at the Hardangervidda mountain plateau in the southern part of the country, latitude 60° 16′ N, longitude 7° 30′ E and altitude 1200-1300 m above sea level (200-300 m above the treeline). The yearly precipitation is quite high, normally 800-1000 mm a year, and the cloud cover and relative humidity are also relatively high. Therefore, the area is more oceanic regarding the humidity than most tundra areas of the world. The yearly temperature is about -3 C, slightly different at the two sites. The mean summer temperature in July and August was about 7 C in 1970. The winter temperature may be rather low, as a mean of January and February, about -15.5 C measured at 2-m height in 1970 (Skarveit, pers. comm., 1972). Detailed data are available for climate, mechanical, physical, and chemical analyses of the soil, plant biomass and growth as well as organic and organic constituents of plants at different times of the year (see initial values in computer output, Appendix 1). Some data are also available for animals (most invertebrate groups, reindeer and sheep), decomposition and microbes.

LICHEN HEATH

The site most like a desert is a lichen heath with only about 25% cover of higher plants (maximum dry weight green biomass about 35 g/m²; total living about 135 g/m²), consisting mostly of dwarf shrubs but including a few monocotyledons. The height of the plants is seldom above 10 cm. Most of the dwarf shrubs at this site are evergreens (*Vaccinium vitis-idaea* and *Empetrum hermaphroditum*). In addition to the vascular plant cover, about 75% of the ground is covered with cryptogams (maximum about 350 g/m² dry weight live biomass), mostly fruticose lichens (*Cladonia* and *Cetraria* species). The average total plant growth is found to be about 1 g/m² per day when compensated for decomposition. The typical dry vegetation type at the site is caused by the soil type. The site is situated on glacifluvial sandy soil on an escher. About 95% of the material is sand several meters down (Veum, pers. comm., 1972). The content of organic matter is very low (less than 2% mean of the upper 35 cm of the soil) except for the uppermost 1-2 cm (about 25%). The low content of organic matter is caused by the sparse vascular plant vegetation, the very slow growth and death rate of lichens, and the relatively high decomposition rate at and just below the soil surface, compared to the growth rate (weight loss from litter bags found to be 15-20% the first year after death as a mean for vascular plants and cryptogams; Veum, pers. comm., 1972). The very coarse material in the soil results in a strong downward drainage and, although precipitation is relatively high, the site is very much like a desert.

The release of nutrients is slow from the mostly granitic material in the sand and most of the easily soluble nutrients are leached out of the soil. The plants get their nutrients for growth by decomposition of organic material and by precipitation. There is no other input of water to the system other than by precipitation as the site is situated on the top of the escher. The cation content in precipitation may be considerable (more than 13 mg per liter have been measured, but it is usually less than 1 mg per liter). The nitrogen content in precipitation is usually very low (0-0.6 mg per liter), as is the phosphorous content. This indicates that the total site is very oligotropic, and nutrients, along with precipitation, strongly limit growth. The snow cover at Hardangervidda is, on an average, about 2-m maximum in late April. At the lichen heath, however, much of the snow is blown away (50-60 cm maximum remaining). Therefore, insolation through the snow is not sufficient to prevent the soil temperature from going below 0 C (-5 to -8 C from 0-20 cm between November and April). Only plants tolerant to these low temperatures will survive, therefore limiting the number of vascular plants at the site. Because of the thin cover, the snow melts early in the spring compared to the parts of the Hardangervidda plateau which have thicker snow cover. The snow-free period usually lasts from early June to late September. This provides a long growing season for the cryptogams and also possibly for the evergreen shrubs.

The thin snow cover can be penetrated by reindeer during the winter (maximum penetration is about 50 cm). During this period lichens are the most important food for these animals (about 90% according to fistula studies). The total food intake per reindeer is about 1240 g/day during winter (Gaare, pers. comm., 1972). Because of the slow growth of the lichens (less than 0.5 cm per year according to American and Finnish studies, although measured up to 50-60 g/m² dry weight increase per year at the Norwegian lichen heath site), the reindeer population has to be restricted to keep the system in a steady state.

Other animals at the lichen heaths of Hardangervidda are mostly invertebrates, although there may be some birds and small mammals. The invertebrate population of the vegetation and litter layer may be surprisingly high, with a minimum in a summer dry period (about 6500 per m² or 40 mg per m² in early August), and a maximum in fall (more than 25,000 per m² or about 175 mg per m² in mid-September). The two main groups are Acari and Collembola, as in other vegetation types at the plateau. The soil fauna is, however, considerably smaller than at sites with more water and organic material in the soil. The Enchytraeidae, which are very common at other sites, are practically nonexistent in the soil at the lichen heath.

The microbial activity in the soil at the lichen heath is less than at most other vegetation types in the area. Soil respiration is about half the magnitude of that at eutrophic sites -- about 50 mg CO_2 (m² hr). Both bacteria and soil fungi

decrease rapidly with soil depth (more rapidly than at other sites). The maximum is in mid-September because of higher soil moisture. Based on rough estimates from one species in laboratory studies, the bacteria biomass in the upper 15 cm is approximately 6 mg/m² (Lid Torsvik, pers. comm., 1972) and the fungi biomass in the upper 5 cm is 15-20 g/m² (Hansen, pers. comm., 1972).

The symbiotic N-fixation at the site is estimated to be 0.8 g/m² per year (Lid Torsvik, pers. comm., 1972) and is caused mostly by aerobic bacteria, although some autotrophic N-fixation (photosynthetic blue-green algae) took place (about 0.1 g/m²). There were no legumes at the site but some of the lichens were nitrogen-fixing (about 0.8/m² per year, according to Lid Torsvik, pers. comm., 1972).

WET MEADOW

This site has nearly 100% plant cover. During the summer higher plants cover about 70% (maximum dry weight green biomass about 130 g/m²; total living roughly 750 g/m²); about half of which are monocotyledons (mostly the sedge, *Carex nigra*). Low willows (mostly *Salix lapponum*) and dwarf shrubs (mostly *Salix herbacea*) are also important (about one-fourth of the cover is shrubs). The mean height of the plants is 15-20 cm. The most important cryptogam group at this wet site is bryophytes (dominated by three to four species) which cover 90-95% of the ground (175 g/m² dry-weight biomass, about one-third of which is green). The average daily total plant growth is difficult to calculate from biomass measurements because of difficulties in separating live and dead roots. However, according to recent photosynthesis-respiration measurements it is calculated at about 5-6 g/m² per day.

The soil type, which is about 75-cm peat, is flooded frequently (especially in spring) with nutritious water from schisty phyllitic rocks. This has had a strong influence on the development of the existing dominant plant community. The water table in spring and fall is close to the surface (often at -10 cm) while in drier periods (mid-summer) it may drain (evapotranspiration) down to -30 to -40 cm. The water content in the upper layers (10-15 cm) may then be somewhat below field capacity, but is generally between field capacity and saturation, even at this depth. The content of organic matter is very high in the peat (above 80%; Veum, pers. comm., 1972). The radioisotope technique has shown that the peat accumulation has been 0.9-1 cm per 100 years. The decomposition rate may be rapid in the litter layer because of adequate moisture (up to about 40% weight decrease the first year after death of green material; Veum, pers. comm., 1972), but is very slow deeper in the profile because of anaerobic conditions.

The plant growth at the site is usually not limited by lack of water, but may be limited by O_2 shortage in the soil. In spring, soil surface temperature may be 5 C lower at the wet meadow than at the lichen heath. Even in August a temperature difference of 2-3 C may be found. This indicates that plant growth possibly is more limited by summer temperature at the wet meadow than at the lichen heath. In addition to nutrients from precipitation and those released by decomposition, the plants use nutrients from flooding water. Analyses have shown a high amount of iron in the peat and especially in the roots of plants; possibly a luxury uptake. The amounts of nitrogen, phosphorous and cations (sum of Ca, Mg, K, and Na) in different organs of the plants are 1.5-2 times higher at the wet meadow than at the lichen heath, indicating that nutrients are less limiting to growth at the wet meadow than at the lichen heath.

The snow cover is relatively heavy at the wet meadow, up to 2 m in early May. This gives good insolation, and the soil temperature during winter is seldom much below 0 C (minimum -0.3 to -0.4 C at the surface during the November to April period, increasing to a minimum of 0 C at -20 cm). More plants tolerate these soil temperatures than the low temperatures at the lichen heath. The vegetation period is, however, shorter. The snow does not usually melt until mid- or late June and new snow may be found in mid- to late September. Although the mosses can start their assimilation by snow melt (and even before), none of the vascular plants is evergreen and new leaf has to be produced before effective photosynthesis occurs. However, translocation of reserves has occurred before effective photosynthesis and before snow melt and leafing-out; thus beginning before all the ground was snow-free.

The wet meadow might be used for summer grazing by sheep, although a study has shown that the dominating sedge was not favored by the animals. A daily herbage intake per m² by sheep at the site was found to be about 0.7 g. During early summer this type of vegetation is also used by reindeer. In early July about 25-30% of the forage is woody plants and about 20% graminous plants, while later in the summer forbs from other vegetation types are preferred (about 45% of the total intake, although 10% of the intake is still woody plants and a similar percentage of graminous plants in August; Gaare, pers. comm., 1972). The site seems to be too wet for strong influence of small mammals although some have been found; more than at the lichen heath which is too dry. Birds are also more frequent at this site than at the lichen heath, but their influence could possibly also be neglected in a relatively low-resolution model.

The number of invertebrates in the vegetation and litter layer at the wet meadow is about the same as at the lichen heath. The minimum in summer (caused by a decrease, especially in Dollenbola) is, however, less obvious (about 13,000 individuals per m² or 65 mg per m² in early August) because more water is available. The amounts were high in early summer (late June) and in fall (above 15,000

individuals per m^2 or 240 mg per m^2 in early September) giving two maximum peaks. The wet meadow has a much higher number of invertebrates in the soil than does the lichen heath, mostly because of high populations of both Enchtraeidae Acari and Collembola. The lowest total of invertebrates in soil was found at snow melt (a very rough estimate of about 125,000 individuals per m^2 or 1 g per m^2) and the highest in late August (roughly about 24,000 individuals per m^2 or 1.6 g per m^2).

The soil respiration at the wet meadow is roughly estimated at about 90 mg CO_2(m^2 hr). Both the bacteria and fungi rapidly decrease with soil depth as at the lichen heath. One reason for this at the wet meadow is the anaerobic conditions existing relatively close to the soil surface. The highest numbers of bacteria are found in the middle of the summer at all depths, and the minimum, even by anaerobic incubation, in fall (Lid Torsvik, pers. comm., 1972), possibly because of the water conditions. Rough estimates of the bacteria biomass in the upper 30 cm of the soil give values of the order of 20 mg/m_2 (Lid Torsvik, pers. comm., 1972). A similar rough estimate of the fungi biomass is about 70 g/m^2 (Hansen, pers. comm., 1972).

The nonsymbiotic N-fixation at the wet meadow is about twice as high as the lichen heath, about 1.3 g/m^2 per year (Lid Torsvik, pers. comm., 1972), half of which is caused by anaerobic bacteria. The blue-green algae at the site fixed about 0.25 g N/m^2 per year. No symbiotic N-fixation has so far been found at this site.

DESCRIPTION OF THE DESERT MODEL USED

The Desert Biome modeling programs are written in such a way that the structure of the ecosystem in question can largely be specified at execution time. The numbers of plant and animal species groups to be treated separately, the number of plant organ types to be distinguished, the number of different size categories or stages of development, the number of litter classes, and the chemical constituents to be traced during the simulation are all flexible and may be determined by the program user. Likewise, the time scale and time unit for simulation may be varied freely. Naturally, the parameters of the system are special to the biological and chemical components modeled, and information about these is required at execution time, as well as the biological inventory of the system at the starting point of the simulation, and meteorological data during its course. The large measure of freedom given to and reliance placed upon the user at execution time make it practicable to apply the model programs to a wide variety of ecosystems.

The models are based upon rate functions which, in principle, can be studied quite independently of the operation of the model, and can all be determined experimentally. It would, of course, also be possible to fit the parameters for the model by a process of successive approximation, though the large number of parameters involved would make this a lengthy and uncertain procedure; this would, of course, prevent the use of the same data in a validation test of the model. In the present work, a combination of these approaches has been used (prior and independent estimation of parameters, followed by improvement by successive approximation in certain cases), and it cannot be claimed that the extent of agreement attained is any measure of the agreement to be expected if the model (including parameters) were applied to other sets of data -- even for the same sites.

The model used is a somewhat modified Version III model of the desert ecosystem model (Valentine, 1973). Each of the Version III submodels is intended to be used primarily in conjunction with more sophisticated models of other parts of the ecosystem, when these are the main focus of interest. These versions, however, were generally not yet developed at the time of this work.

PLANT SUBMODEL

The submodel consists of parts for gas exchange, translocation and death and handles both carbon and mineral flows (Valentine, 1973).

Compared to Version III of the plant submodel, two conceptual changes were carried out in the present simulation study, both dealing with the gas exchange part of the model. The most important change was to make the photosynthesis dependent on environmental parameters and not only on seasons. It was also made optional to have photosynthesis simultaneously with leafing-out in spring and with the rapid downwards translocation in fall, as well as concurrently with germination. For gas exchange only net assimilation is treated in the present version of the model. The amount of carbon fixed is a proportion of the protein carbon in leaves at various seasons of the year defined by phenological stages. In the present simulation the year was subdivided into a spring period, a summer period, a fall period (each of them divided into two subperiods), and a dormancy period (Table 1).

Net carbon fixation by photosynthetic organs during daylight hours is assumed to depend on irradiation, air temperature and relative humidity. The rate of fixation is related to irradiation by the Michaelis-Menton function.

$$R = (R_{max} I)/(K_s + I)$$

where R_{max} is the rate of fixation at optimum levels of light, temperature, and relative humidity, I is the irradiation and K_s is the value of irradiation which causes R to equal $R_{max}/2$.

Table 1. Phenological stages for the plant submodel

	WET MEADOW						
	Spring		Summer		Fall		Dormancy
Plant type	Leaf-out	Photosyn.	Early	Late	Pre-leaf fall	Leaf	
Woody plants	Jun 10	Jun 20	Jul 10	Aug 25	Sep 1	Sep 15	Sep 25
Herbaceous dicots	Jun 10	Jun 20	Jul 10	Aug 25	Sep 1	Sep 15	Sep25
Monocotyledons	Jun 10	Jun 20	Jul 10	Aug 25	Sep 1	Sep 15	Sep 25
Lichens	—	—	—	—	—	—	—
Mosses	—	Jun 5	Jul 10	Aug 25	Sep 1	Sep 15	Oct. 1
	LICHEN HEATH						
Woody plants	Jun 1	Jun 5	Jul 5	Aug 25	Sep 13	Sep 15	Sep 25
Herbaceous dicots	—	—	—	—	—	—	—
Monocotyledons	Jun 1	Jun 10	Jul 5	Aug 25	Sep 13	Sep 15	Sep 25
Lichens	—	Jun 1	Jul 5	Aug 25	Sep 13	Sep 15	Sep 25
Mosses	—	Jun 1	Jul 5	Aug 25	Sep 13	Sep 15	Sep 25

The maximum fixation is also modified by factors for temperature and relative humidity, each varying from zero to one. The factor for relative humidity increases linearly from zero to one as the relative humidity increases from a lower threshold to an upper threshold. Below the lower threshold the factor has a value of zero; above the upper threshold the factor has a value of one. Saturation deficit may probably be a better parameter for the air humidity and this or other values for tension of water in the air may be used in the model in later versions for modifications of the photosynthesis.

The temperature factor increases following a sigmoid function from zero to one as the temperature increases from a lower threshold to an optimal temperature, and decreases linearly to zero as the temperature increases to some upper threshold. The environmental values used in the simulations reported here are given in Table 2. Most of the optimum values are known for short-term experiments (Kjelvik and Wielgolaski, 1972; Wielgolaski and Kjelvik, unpublished manuscript); the optimum values on a daily basis are only rough estimates.

Specified percentages of the carbon fixed are allocated to the plant organs, and specified percentages of amounts of carbon are then allocated to each of three carbon fractions (protein carbon, reserve carbon and structural carbon). The percentages may vary with plant organ, species and phenological stage. This allocation procedure occurs at the same time the carbon is fixed and is equivalent to translocation from photosynthetic organs to other organs. If the nitrogen level in the photosynthetic organs becomes depressed below a threshold amount, the percentage of newly fixed carbon which is allocated to the protein fraction will be multiplied by the complement with respect to one of a negative exponential function. The amount of carbon allocated to the reserve fraction is correspondingly increased.

In the present simulation, it is said that the allocation to organs other than leaves is rather slow during the growth season, up to 9% per day in woody plants, up to 2% per day in herbaceous dicotyledons, up to 1.5% per day in monocotyledons, and up to 0.1% per day in cryptogams.

It is assumed that when soil nutrients are not limiting, plant growth is specified by constant mineral to total-carbon ratios for each mineral, organ, species, and phenological stage. The amounts of nutrients taken up from the soil are then equal to the amount of carbon fixed multiplied by these specified ratios. The uptake will, however, be limited by the mineral soil nutrients available below a threshold value, and decreases to zero at an accelerating rate as nutrients become more scarce. Especially at the lichen heath, values strongly below the threshold might often be found.

Translocation of carbon from storage organs to leaves during leafing-out occurs at a constant rate, which might be relatively high in the tundra. The protein and reserve carbon fractions are summed (structural carbon is not translocated) and specified percentages of this amount are allocated to the three carbon fractions. The translocation rate is therefore expressed as weight of protein and reserve carbon translocated per weight of protein and reserve carbon in the storage organ per unit of time. Up to 2-3% of the available amounts in storage organs are in the simulations said to be translocated upwards per day; the amounts of nitrogen and ash elements translocated are

Table 2. Values of environmental parameters used in the plant submodel for photosynthesis calculations

Parameters	WET MEADOW			
	Woody dicots	Herbaceous dicots	Monocotyledons	Mosses
Lower temperature threshold	0	0	0	—2.5
Optimum temperature	22	22	22	18
Upper temperature threshold	28	28	28	25
Lower relative humidity threshold	40	40	40	75
Upper relative humidity threshold	70	70	70	85
Maximum carbon fixation rate (mg CO_2/g dry matter per ha)	10.0	11.5	10.0	1.0
Irradiance at half-max. fixation rate	200	200	200	100
	LICHEN HEATH			
Lower temperature threshold	0	0	—2.5	—2.5
Optimum temperature	22	22	14	18
Upper temperature threshold	28	28	22	25
Lower relative humidity threshold	40	40	75	75
Upper relative humidity threshold	70	70	90	85
Maximum carbon fixation rate (mg CO_2/g dry matter per ha)	7.5	9.5	0.72	1.0
Irradiance at half-max. fixation rate	200	200	100	100

specified proportions of the total carbon translocated, these proportions being, respectively, the nitrogen:carbon ratio and the ash elements:carbon ratio in leaves.

Allowance is made for a constant rate of translocation from leaves to storage organs during the pre-leaf abscission period. This rate, which may be different for each storage organ, is expressed as weight of chemical constituent translocated per weight present in leaves per unit of time. Protein and reserve carbon are summed, and specified percentages of this sum are allocated to the three carbon fractions in the recipient organs. Structural carbon is not translocated; nitrogen and ash elements are. In tundra conditions where the pre-leaf abscission and death periods are usually short (Table 1), the translocation rate during this period might be very high, often above 10% per day.

The transfer rate of material from living to dead compartments (weight transferred per weight present per unit of time) may vary with species, organ and phenological stage, but not with chemical constituent and not with environmental factors within each stage. The recipient dead organic matter compartments are specified as input to the model. The same dead organic matter compartment can receive material from several sources, but the material from a single organ of one species cannot be transferred to more

Table 3. Soil characteristics*

Site	Depth (cm)	Organic matter %	Volume % soil water			
			Saturation	Field capacity	Wilting point	Actual
Wet meadow	0-12	80.9	85.2	58.4	11.1	76.7
	12-35	82.1	82.2	66.4	10.1	75.3
Lichen heath	0-2	28.5	54.1	29.3	6.0	27.4
	2-8	2.7	46.0	16.8	3.9	18.7
	8-18	1.9	36.6	9.5	3.0	12.8
	18-35	0.8	36.1	3.1	1.0	5.8

*Veum, pers. comm., 1973.

than one compartment. The death rate in the tundra is usually low in periods other than in late fall. Then the death rate of herbaceous green may be 10-40% per day. Woody material and roots, as well as cryptogams, are said to have a low, relatively constant death rate during the year, as an average 0.01 per day.

The sensitivity of some estimated factors in the model, e.g., the lower optimum 24-hourly temperatures for net photosynthesis and the upwards translocation rates in spring were tested by special sensitivity tests. It was found that the model was very sensitive, especially to maximum photosynthesis under optimal conditions and death rates, while less sensitive to the optimum temperatures and upward translocation rates. Except for necessary debugging, especially of the new parts of the model and the data, no serious problems arose in using the tundra data in the plant submodel of Version III of the desert ecosystem model.

SOIL SUBMODEL

The submodel, Version III, consists of two main parts, the hydrology and decomposition sections. The hydrology section handles snow melt, inflitration, water flows in and on the soil, evapotranspiration, and erosion. The decomposition section deals with changes in dead organic material caused by microorganisms and with leaching. Mineralization of organic material is handled as is nutrient cycling, especially nitrogen (see Radford, 1973, for description).

The various factors in the soil are studied by soil horizon, and the processes modelled with respect to these horizons. The rate of processes in the soil is in Version III of the submodel; said to be dependent only on precipitation of the exogenous variables, and only for the hydrology section. To use the submodel for tundra conditions it was necessary in some cases to allow variations with temperature and sometimes (indirectly) with wind as well. Most of the parameters and rates in Version III, however, are allowed to vary between seasons, which are the same for all soil processes. This implies a thermally defined partition of the year, sometimes split into relatively small units (e.g., to handle litter fall). The seasons may thus vary somewhat from those used in the plant submodel (Table 1).

Horizons for the submodel were determined by considering natural "limits" if present. For both of the tundra sites studies, these horizons (Table 3) included essentially all of the rooting zone.

HYDROLOGY

Simulation of soil moisture changes required certain environmental input (daily rain or snow; daily pan evaporation) run on water and daily 24-hourly air temperature and extremes. Daily snow melt varied directly with daily average air temperature above a minimum temperature (1 C). Snow blowing, important for the lichen heath, was made a seasonally variable fraction of unmelted new snow. About 80% of new snow is blown away from the lichen heath, 5% from the wet meadow. In order to simulate infiltration, average rainfall rates were assumed to vary with size and season of storm (e.g., 5 mm/hr for total daily storm of 10-20 mm during the summer season).

Snow melts, runon, rain, free (pooled) water were all summed as "total precipitation" subject to infiltration and/or runoff. Infiltration calculation was based on an average infiltration rate (mm/hr) variable with soil water content in a roughly inversely exponential manner from a maximum 10 mm/hr to a constant minimum of 0. Infiltration into and water flow within frozen soil (assumed when air temperature and snow depth are below minima) were set to zero. Also, "total precipitation" was assumed to saturate snow cover before being available for other flow. Thus, during further snow melt, "snow water" would be

released (melted) along with new melting. Runoff from the sites took place mostly during snow melt (at the lichen heath only during this period) with a maximum when the snow depth remaining was between 15 and 5 cm.

Downward movement of water became impossible when the calculated water content of a horizon exceeded full saturation. Otherwise soil water in excess of field capacity moved downward after one day. Further drainage, however, was a rapidly exponentially decreasing function of the difference between water content and field capacity. The points for water saturation, field capacity and wilting were known in different soil horizons and sites from pF studies (Table 3).

Evaporation and transpiration were both modelled for the top horizons, while only transpiration was said to take place from deeper layers, in proportion to live root distribution in the horizons. Pan evaporation was used as a measure of potential evapotranspiration in the present study. Evaporation from the top layer and successively lower layers continued until depletion of the layers (maximal evaporation = potential evapotranspiration times the percentage of bare soil) or until the soil water started to reduce the actual evaporation rate below the potential rate (of no concern for the wet meadow). Transpiration from the various horizons occurred at the potential evapotranspiration rate times the percentages of plant cover and of live roots in the horizons. The limits to actual transpiration from a given horizon were soil water reduction (as above) and the potential transpiration for that horizon. Total water loss was, however, not allowed to exceed certain minima, the permanent wilting points of the various layers.

Problems in adapting the soil model to tundra conditions arose mostly in the handling of soil moisture. Thus, snow melting and blowing and water flow with a lower barrier present were necessarily modelled for the first time or largely changed. The high water content and the low bulk density of the soil at the wet meadow (0.2 g/cm^3) were unusual conditions for a desert and made some changes necessary. The strong shrinkage effect at drought of the peaty soil was also uncommon for desert soil, but is not covered in the present sophistication of the model. Other and considerable changes were partly inspired by the present exercise. All changes forced welcome generalizations needed even for desert conditions (cold deserts, at least).

DECOMPOSITION

The soil submodel deals with the transfers of standing dead to litter and further to soil organic matter (non-recognizable) and to mineralized nutrients. These values could be obtained by respiration measurements of microbes attacking the various organic material and by measured weight loss of the material caused by leaching and microbial activity. The biological process rates in the soil are said to be zero at extreme water conditions, above water saturation and below wilting point. Between these limits the decomposiiton-respiration rates were said to occur at average seasonal rates, given as a mean for the horizons at the site. These rates were applied to various horizons by the use of seasonal horizon-specific multiplying constants. The rates were given as percentage of decomposition (loss) per day of, respectively, protein carbon, reserve carbon and structural carbon. The highest decomposition rate was found for herbaceous litter at the wet meadow during the summer, up to 6.6% per day of protein carbon, 2.6% of reserve carbon and 1.8% of structural carbon. Lowest decomposition rates were used for cryptogams, down to 0.01% for structural carbon for the growing season.

The nitrogen fixation and losses are, in the present version of the model, treated similarly as mentioned for breakdown of litter. This means that the same water limitations occur, and that constant values are given for each season as grams gain or loss of nitrogen per day per gram total carbon soil organic matter.

In the present run of the submodel the other processes handled are minor, e.g., erosion, and are therefore neglected.

RESULTS

The computer output reports on changes in the input variables to different times of the year (output for lichen heath and wet meadow appears in Appendix 1). The changes in plant cover of the various types of plants are expected with most changes for the herbaceous vascular plants. The differences in dry matter of plants as well as the various constitutents in the plants seem to be as validated from observed values. The reduction was stronger for protein and reserve carbon in the soil than for structural carbon. As expected, the mineral fractions increased during the winter. Because of input by precipitation there was some increase in nitrogen, phosphorous and cations to the system during the winter, while the amount of total carbon was strongly reduced during the same period. The variation in total carbon, soil water and snow cover during the year is given in the graphical output. The lower biomasses shown generally in the second year were caused by extremely low temperatures in July of that year.

Even if the model seems to run for the parameters used it might be that minor changes in the estimated data may give a still more realistic output. By sophistication of the model, exact values for all input parameters and flows may be still more important than in the present version of the model.

ACKNOWLEDGEMENTS

This study has been made possible by financial support from the US/IBP Desert Biome and the authors want to extend their appreciation for this support. Dr. David W. Goodall has offered many helpful suggestions and we wish to thank him for his interest and help. Data were provided by field scientists in Norway and the senior author thanks his colleagues in Norway for their supply of these data.

LITERATURE CITED

ANWAY, J. C., E. G. BRITTAIN, H. W. HUNT, G. S. INNIS, W. J. PARTON, C. F. RODELL, and R. H. SAUER. 1972. ELM: Version 1.0. US/IBP Grassland Biome Tech. Rep. No. 156. Colo. State. Univ. Ft. Collins. 285 pp.

DAHL, E., and A. J. P. GORE. 1968. Proceedings of working meeting on analysis of ecosystems: Tundra Zone, Ustaoset, Norway, September 1968. (Mimeo.)

DE WIT, C. T., R. BROUWER, and F. W. T. PENNING DE VRIES. 1970. The simulation of photosynthetic systems. *In* Prediction and measurement of photosynthetic productivity. Proc. of IBP/PP Tech. Meeting, Trebon, Czechoslovakia, Sept. 1969. Centre for Agr. Publ. and Doc., Wageningen, The Netherlands. 632 pp.

GOODALL, D. 1967. Computer simulation of changes in vegetation subject to grazing. J. Ind. Bot. Soc. 46:356-362.

GOODALL, D. 1969. Simulating the grazing situation, pp. 211-236. *In* F. Heinmets (ed.), Concepts and models of biomathematics: simulation techniques and methods. Marcel Dekker, New York.

GORE, A. J. P., and J. S. OLSON. 1967. Preliminary models for accumulation of organic matter in an *Eriophorum/Calluna* ecosystem. Aquilo, Ser. Bot. 6:297-313

KELLEY, J. M., P. A. OPSTRUP, J. S. OLSON, S. I. AUERBACH, and G. M. VAN DYNE. 1969. Models of seasonal primary productivity in eastern Tennessee *Festuca* and *Andropogon* ecosystems. Oak Ridge Nat. Lab. (Tennessee) TM-4310. 296 pp.

KJELVIK, S., and F. E. WIELGOLASKI. 1972. Photosynthesis at Hardangervidda, Norway, measured by ^{14}C-method, pp. 91-100. *In* F. E. Wielgolaski (ed.), IBP in Norden. No. 8. 111 pp.

MILLER, P. C. 1972. A model to incorporate minerals into tundra plant production, pp. 51-54. *In* Proc. US/IBP 1972 Tundra Biome Symp., Seattle.

MILNER, C. 1972. The use of computer simulation in conservation management, pp. 249-275. *In* J. N. R. Jeffers (ed.), Mathematical models in ecology; the 12th Symp. of the Brit. Ecol. Soc., March 1971. Blackwell Sci. Publ., London. 398 pp.

RADFORD, J. 1973. Terrestrial models: Soil processes (Versions I, II, III). US/IBP Desert Biome Res. Memo. 73-56. 196 pp.

TIMIN, M. E., B. D. COLLIER, F. ZICH, and D. WALTERS. 1972. A computer simulation of the arctic tundra ecosystem near Barrow, Alaska, pp. 71-79. *In* Proc. 1972 US/IBP Tundra Biome Symp., Seattle.

VALENTINE, W. 1973. Terrestrial models: Plant processes (Version I, II, III). US/IBP Desert Biome Res. Memo. 73-54. 119 pp.

VAN DYNE, G. M. 1969. Grassland management, research, and training viewed in a systems context. Range Sci. Ser. No. 3. Colo. State Univ., Ft. Collins.

WIELGOLASKI, F. E. 1972. IBP Grassland/Tundra International Modelling-Synthesis Workshop: Summary of output workbook. US/IBP Grassland Biome Tech. Rep. No. 197. Colo. State Univ., Ft. Collins. 34 pp.

WIELGOLASKI, F. E., K. P. HAYCOCK, and D. J. CONNOR. 1972. A grazing lands plant-decomposition, carbon-mineral simulation model. US/IBP Grassland Biome Tech. Rep. No. 203. Colo. State Univ., Ft. Collins. 75 pp.

APPENDIX 1

OUTPUT EXAMPLE

Lichen Heath

```
NORWEGIAN IBP  -- 1972 DATA FOR LICHEN HEATH --  STIGSTUV HARDANGERVIDDA, NORWAY

INITIAL REPORT ON AUG  2 1972                                          2.233 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE
                          NITROGEN    ANIONS     CATIONS     PROTEIN C   RESERVE C.  STRUCT C     TOTAL C    DRY MATTER
WOODY PLANTS
  GREEN PARTS              3495.00     233.00     2503.00    17013.00    26840.00   52590.00    92447.00    229229.50
  NON-GREEN ABOVE GROUND   1729.00     173.00     1152.00     5941.00    16278.00   85709.00   107928.00    268833.12
  ROOTS 0-2 CM              165.00      15.00      105.00      569.00     1699.00    8946.00    11212.00     27931.20
  ROOTS 2-8 CM             1379.00     126.00      878.00     4737.00    14159.00   74549.00    93445.00    232773.34
  ROOTS 8-18 CM             982.00      80.00      561.00     3032.00     9061.00   47711.00    59804.00    148971.24
  ROOTS 18-35 CM            331.00      30.00      210.00     1137.00     3398.00   17892.00    22427.00     55865.24
      TOTAL                7979.00     657.00     5469.00    37428.00    71435.00  288397.00   397260.00    963603.94
MONOCOTYLEDONS
  GREEN PARTS              2160.00     130.00     1620.00     7425.00     9920.00   27302.00    44647.00    110478.50
  NON-GREEN ABOVE GROUND      .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 0-2 CM               91.00      12.00       65.00      313.00     1385.00    3666.00     5364.00     13365.10
  ROOTS 2-8 CM              760.00      98.00      543.00     2610.00    11540.00   30559.00    44704.00    111386.20
  ROOTS 8-18 CM             486.00      62.00      347.00     1671.00     7385.00   19559.00    28610.00     71283.72
  ROOTS 18-35 CM            182.00      23.00      130.00      627.00     2770.00    7333.00    10730.00     26733.64
      TOTAL                3679.00     325.00     2705.00    12646.00    33000.00   88419.00   134055.00    333247.21
LICHENS
  GREEN PARTS             17600.00    1600.00    12800.00    85512.00   392960.00  826528.00  1290000.00   3190851.81
  NON-GREEN ABOVE GROUND      .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 0-2 CM                .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 2-8 CM                .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 8-18 CM               .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 18-35 CM              .00         .00        .00         .00         .00        .00         .00          .00
      TOTAL               17600.00    1600.00    12800.00    85512.00   392960.00  826528.00  1290000.00   3190851.81
MOSSES
  GREEN PARTS              321.00      39.00      225.00     1104.00     2106.00    9630.00    12840.00     31934.29
  NON-GREEN ABOVE GROUND   534.00      47.00      337.00     1835.00     4095.00   17790.00    23720.00     58870.20
  ROOTS 0-2 CM                .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 2-8 CM                .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 8-18 CM               .00         .00        .00         .00         .00        .00         .00          .00
  ROOTS 18-35 CM              .00         .00        .00         .00         .00        .00         .00          .00
      TOTAL                855.00      86.00      462.00     2939.00     6201.00   27420.00    36560.00     90804.48

ALL SPECIES
  GREEN PARTS             23576.00    2002.00    17128.00    31054.00   431826.00  917050.00  1429930.00   3562494.22
  NON-GREEN ABOVE GROUND   2262.00     220.00     1489.00     7776.00    20373.00  103499.00   131648.00    327703.32
  ROOTS 0-2 CM              256.00      27.00      170.00      881.00     3084.00   12612.00    16577.00     41296.42
  ROOTS 2-8 CM             2138.00     224.00     1421.00     7347.00    25699.00  105103.00   138149.00    344159.54
  ROOTS 8-18 CM            1468.00     142.00      908.00     4703.00    16446.00   67265.00    88414.00    220254.96
  ROOTS 18-35 CM            513.00      53.00      340.00     1764.00     6169.00   25225.00    33157.00     82598.98
      TOTAL                30113.00    2668.00    21436.00    53525.00   503596.00 1230754.00  1837875.00   4578507.37

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.
                  WOODY PLANTS                          22.932
                  MONOCOTYLEDONS                        12.144
                  LICHENS                               85.339
                  MOSSES                                12.971
          TOTAL                                         91.361
                                  PERENNIALS    22.932 ANNUALS       .000

CONSTITUENTS OF SHED SEEDS
                          NITROGEN    ANIONS     CATIONS     PROTEIN C   RESERVE C   STRUCT C    TOTAL C    DRY MATTER
WOODY PLANTS                 .00         .00        .00         .00         .00        .00         .00          .00
MONOCOTYLEDONS               .00         .00        .00         .00         .00        .00         .00          .00
LICHENS                      .00         .00        .00         .00         .00        .00         .00          .00
MOSSES                       .00         .00        .00         .00         .00        .00         .00          .00
      TOTAL                  .00         .00        .00         .00         .00        .00         .00          .00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE
    TYPE OF MATERIAL      NITROGEN    ANIONS     CATIONS     PROTEIN C   RESERVE C   STRUCT C    TOTAL C    DRY MATTER
WOODY NON-GREEN STD.        3080.00     168.00     700.00     10587.00     613.00   100800.00   112000.00    276748.84
WOODY EX-GREEN STD.          700.00      37.00     200.00      2407.00    4593.00    13000.00    20000.00     49300.24
MONOCOT STD.                1170.00      59.00     534.00      4023.00    4401.00    78376.00    86800.00    216027.36
LICHEN DEAD                 2500.00     250.00    1500.00      8595.00   47405.00   144600.00   200000.00    498405.40
MOSS DEAD                    358.00      40.00     224.00      1232.00    2710.00    17978.00    19920.00     49584.24
WOODY LITTER                 946.00      52.00     220.00      3252.00     188.00    30960.00    34400.00     85006.64
HERBACEOUS LITTER          14320.00     755.00    3800.00     49230.00   84450.00   314320.00   448000.00   1105398.50
DEAD ROOTS 0-2 CM            217.00      12.00      44.00       745.00     387.00     7440.00     8568.00     21186.40
DEAD ROOTS 2-8 CM           1807.00     100.00     369.00      6210.00    3191.00    61999.00    71400.00    176552.20
DEAD ROOTS 8-18 CM          1156.00      63.00     235.00      3975.00    2042.00    39679.00    45696.00    112991.00
DEAD ROOTS 18-35 CM          477.00      24.00      89.00      1490.00     766.00    14880.00    17136.00     42372.80
GREEN LICHENS              17600.00    1600.00   12800.00     85512.00  392960.00  826528.00  1280000.00   3190851.81
      TOTAL                44287.00    3160.00   20714.00    152258.00  543702.00 1605960.00  2301920.00   5719425.37

SOIL VARIABLES
                          NITROGEN    ANIONS     CATIONS     PROTEIN C   RESERVE C   STRUCT C    TOTAL C    ORG.D.M.
ORGANIC MATTER CONSTITUENTS
  FROM   0. TO   20. MM.   956377.00   31140.00   166080.00   3287550.00   864450.00  16608000.00  20760000.00  41520000.00
  FROM  20. TO   80. MM.   387928.00   14040.00    74880.00   1733500.00   257700.00   7768800.00   9360000.00  18720000.00
  FROM  80. TO  180. MM.   797237.00   28800.00   153600.00   2740500.00   523500.00  15976000.00  19200000.00  38400000.00
  FROM 180. TO  350. MM.   266667.00   16320.00    87040.00    915980.00   172020.00   9792000.00  10980000.00  21760000.00
      TOTAL               2408009.00   90300.00   481600.00   8677530.00  1817670.00  50104900.00  60200000.00  120400000.00
TN MINERAL FRACTION
  FROM   0. TO   20. MM.   3637.00    3000.00    77800.00
  FROM  20. TO   80. MM.   2072.00    3100.00    28900.00
  FROM  80. TO  180. MM.   2767.00    16000.00   27200.00
  FROM 180. TO  350. MM.   3537.00    27200.00   40800.00
      TOTAL                11981.00   49300.00   174700.00

TOTAL, SOIL AND DEAD
    ORGANIC MATERIAL       2464287.00  142760.00  677014.00   8467988.00  2361372.00  51710760.00  62501920.00  126119425.00

TOTAL IN ECOSYSTEM         2494400.00  145429.00  693450.00   8533313.00  2864968.00  52941514.00  64337795.00  130697932.00

SOIL WATER POTENTIAL, ATM.
  FROM   0. TO   20. MM.     -10.00
  FROM  20. TO   80. MM.     -10.00
  FROM  80. TO  180. MM.     -10.00
  FROM 180. TO  350. MM.     -10.00

                                                                                        .456 SECONDS ELAPSED
```

NORWEGIAN IBP — 1972 DATA FOR LICHEN HEATH -- STIGSTUV HARDANGERVIDDA, NORWY

REPORT NO. 1 ON AUG 25 1972 (I.E., AFTER 23 DAYS OF SIMULATION) 1.394 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	3256.10	208.57	2294.24	15718.70	35102.18	70123.80	120944.69	297431.91
NON-GREEN ABOVE GROUND	1729.23	172.36	1151.74	5963.98	16341.11	80040.90	108345.89	266862.15
ROOTS 0-2 CM	165.24	15.00	104.99	579.71	1730.91	9113.31	11429.93	28449.00
ROOTS 2-8 CM	1380.02	125.97	877.80	4826.23	14424.92	75943.27	95194.41	237087.98
ROOTS 8-18 CM	893.29	79.38	560.87	3089.11	9231.19	48603.37	60923.63	151732.62
ROOTS 18-35 CM	331.48	29.99	209.95	1159.41	3461.82	18276.62	22845.85	56900.95
TOTAL	7744.36	630.47	5198.57	43335.14	80292.13	308051.14	419678.41	1041464.52
MONOCOTYLEDONS								
GREEN PARTS	2020.89	116.37	1450.13	11174.47	14935.38	41132.90	67242.75	164095.61
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	90.82	11.97	64.95	313.60	1387.67	3673.09	5374.36	13390.29
ROOTS 2-8 CM	758.47	97.77	541.75	2614.97	11562.25	30613.08	44790.29	111595.55
ROOTS 8-18 CM	485.02	61.86	346.20	1674.18	7399.24	19591.81	28665.27	71417.71
ROOTS 18-35 CM	181.63	22.95	129.70	628.19	2775.34	7347.18	10750.71	26783.88
TOTAL	3536.83	310.92	2532.63	16405.40	38059.88	102358.06	156823.33	390783.04
LICHENS								
GREEN PARTS	17436.03	1578.54	12628.31	86577.82	399952.68	841246.96	1302777.45	3246713.56
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	17436.03	1578.54	12628.31	86577.82	399952.68	841246.96	1302777.45	3246713.56
MOSSES								
GREEN PARTS	323.02	38.72	223.39	1146.92	2187.85	10004.30	13339.07	33152.89
NON-GREEN ABOVE GROUND	533.39	46.95	236.73	1832.89	4090.29	17769.56	23692.75	58802.56
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	856.40	85.67	460.11	2979.81	6278.14	27773.86	37031.82	91955.45
ALL SPECIES								
GREEN PARTS	23036.03	1942.19	16596.06	113617.91	452178.09	962507.96	1504303.94	3741393.94
NON-GREEN ABOVE GROUND	2261.61	219.91	1388.46	7796.87	20431.40	103810.36	132078.64	328664.71
ROOTS 0-2 CM	255.06	26.97	169.83	892.30	3118.58	12786.40	16797.29	41839.30
ROOTS 2-8 CM	2138.49	223.75	1419.55	7441.19	25987.17	106556.35	139984.71	348683.54
ROOTS 8-18 CM	1378.31	141.84	907.07	4763.28	16630.43	68195.14	89598.86	223150.33
ROOTS 18-35 CM	513.12	52.94	339.65	1786.60	6237.16	25573.80	33597.57	83684.74
TOTAL	29573.62	2607.60	20820.63	122298.17	524582.82	1279430.02	1916311.00	4767416.50

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	25.641
MONOCOTYLEDONS	17.463
LICHENS	95.840
MOSSES	13.130
TOTAL	92.451

PERENNIALS 25.641 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
LICHENS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY NON-GREEN STD.	3065.95	167.25	696.98	10538.72	613.86	100346.97	111499.55	275512.73
WOODY EX-GREEN STD.	749.20	43.07	334.01	2767.52	5652.80	13873.23	22293.55	54978.32
MONOCOT STD.	1300.75	67.45	654.30	4686.37	5360.04	39062.93	49109.33	121609.10
LICHEN DEAD	2645.99	262.45	1616.83	9107.36	51023.05	150080.77	210211.18	523860.20
MOSS DEAD	357.71	39.97	223.87	1231.13	2705.80	13943.49	17880.42	44485.45
WOODY LITTER	951.92	52.32	221.30	3272.36	189.19	31153.90	34615.46	85538.98
HERBACEOUS LITTER	14472.42	764.19	3911.78	49822.54	85610.89	317375.85	452809.27	1117292.23
DEAD ROOTS 0-2 CM	213.61	12.07	45.09	733.42	423.62	7345.41	8502.44	21028.15
DEAD ROOTS 2-8 CM	1793.81	99.28	365.45	6164.68	3170.43	61552.81	70887.92	175286.35
DEAD ROOTS 8-18 CM	1133.30	61.77	230.47	3896.95	2003.63	38903.93	44804.52	110786.92
DEAD ROOTS 18-35 CM	424.50	23.53	87.28	1460.74	751.61	14589.34	16801.69	41546.74
GREEN LICHENS	17600.00	1600.00	12800.00	90512.00	392960.00	826528.00	1280000.00	3190851.81
TOTAL	44709.25	3193.35	21187.37	184193.78	550464.91	1614756.61	2319415.31	5762776.37

SOIL VARIABLES

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	ORG.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 20. MM.	956691.41	31153.68	166154.69	3297055.25	865835.87	16613312.12	20766207.25	41533906.50
FROM 20. TO 80. MM.	387883.34	14030.22	74826.61	1332523.48	257518.72	7768449.37	9358491.50	18716983.00
FROM 80. TO 180. MM.	796941.15	28743.70	153297.76	2735063.91	522474.26	15933207.37	19190745.50	38381491.00
FROM 180. TO 350. MM.	266369.08	16287.87	86867.96	1414164.62	171683.90	9790190.50	10976039.00	21752078.00
TOTAL	2407884.91	90215.48	481146.92	8268807.12	1817512.73	50105159.00	60191478.50	120382958.00
IN MINERAL FRACTION								
FROM 0. TO 20. MM.	3590.58	3072.86	78402.77					
FROM 20. TO 80. MM.	2115.04	3140.29	29194.28					
FROM 80. TO 180. MM.	2949.11	16048.41	27433.85					
FROM 180. TO 350. MM.	3430.01	27238.10	41017.80					
TOTAL	12084.74	49499.67	176048.78					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	2464678.84	142908.50	678787.09	8490300.87	2367977.62	51719915.50	62510893.50	126145734.00
TOTAL IN ECOSYSTEM	2490252.44	145516.09	699207.69	8533299.00	2892500.44	52999745.50	64427209.50	130911150.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	99812776.00	.00	-129.49	99.13	842.00	87407.80
BY RUN-OFF OR RUN-ON	.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-44159080.50	.00	-27.00	-11.04	-88.72	.00
TOTAL	55653695.00	.00	-146.56	88.09	753.69	87407.80

SOIL WATER POTENTIAL, ATM.

FROM 0. TO 20. MM.	-.10
FROM 20. TO 80. MM.	-.80
FROM 80. TO 180. MM.	-7.60
FROM 180. TO 350. MM.	-10.00

ACCUMULATED PRECIPITATION TO AUG 25 1972 INCLUSIVE IS 30.2 MM. - THAT IS 302.0 TONS PER HECTARE .475 SECONDS ELAPSED

NORWEGIAN IBP -- 1972 DATA FOR LICHEN HEATH -- STIGSTUV HARDANGERVIDDA, NORWY

REPORT NO. 2 ON SEPT 8 1972 (I.E., AFTER 38 DAYS OF SIMULATION) .841 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	1525.56	97.05	1077.50	7716.21	17230.48	73248.50	98195.20	242931.19
NON-GREEN ABOVE GROUND	2702.78	209.48	1553.75	8874.84	22841.75	86058.24	117774.83	292468.19
ROOTS 0-2 CM	165.21	14.99	104.93	580.22	1735.41	9176.91	11452.54	28521.97
ROOTS 2-8 CM	1955.02	162.51	1273.95	7748.48	20959.77	76139.91	104848.15	260248.89
ROOTS 8-18 CM	1266.63	104.34	828.99	5036.94	13586.76	48779.18	67352.87	167157.00
ROOTS 18-35 CM	527.18	42.18	344.04	2131.32	5636.60	18273.82	26041.74	64564.44
TOTAL	7738.37	630.54	5179.21	32088.00	81990.78	311586.55	425665.33	1055891.50
MONOCOTYLEDONS								
GREEN PARTS	866.25	49.48	616.54	5112.54	6873.52	43761.67	55707.72	137325.05
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	205.54	19.50	146.50	991.77	2291.04	7661.55	6944.32	17056.04
ROOTS 2-8 CM	1330.89	130.25	949.14	6002.36	16064.55	70516.86	52583.77	129788.10
ROOTS 8-18 CM	829.36	81.33	590.55	3706.28	10099.17	19530.23	33335.68	82319.19
ROOTS 18-35 CM	296.00	29.43	211.09	1305.34	3674.34	7324.09	12303.77	30408.31
TOTAL	3527.04	308.99	2513.82	19118.25	38962.61	104794.39	160875.25	396897.57
LICHENS								
GREEN PARTS	17394.70	1571.45	12571.60	92248.56	404344.07	850489.03	1317081.66	3281912.84
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	17394.70	1571.45	12571.60	92248.56	404344.07	850489.03	1317081.66	3281912.84
MOSSES								
GREEN PARTS	321.84	38.37	291.38	1156.60	2206.29	10088.66	13451.55	33523.99
NON-GREEN ABOVE GROUND	532.99	46.91	236.55	1831.52	4087.23	17756.24	23674.99	58758.48
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	854.83	85.28	457.93	2988.12	6293.52	27844.91	37126.54	92282.47
ALL SPECIES								
GREEN PARTS	20108.35	1756.35	14477.10	76233.91	430614.36	977587.85	1484436.11	3695593.00
NON-GREEN ABOVE GROUND	2835.76	256.39	1790.30	10706.36	26928.98	103814.48	141449.82	351226.69
ROOTS 0-2 CM	370.75	33.49	251.42	1571.95	4026.45	12798.45	18396.86	45578.88
ROOTS 2-8 CM	3285.91	292.76	2229.09	13750.83	37024.32	106656.77	157431.92	390036.98
ROOTS 8-18 CM	2094.99	185.67	1419.53	8743.21	23685.92	68259.42	100688.55	249476.20
ROOTS 18-35 CM	819.18	71.61	555.13	3436.66	9310.94	25597.90	38345.51	94972.76
TOTAL	29514.94	2596.27	20722.57	114442.92	531590.97	1294714.86	1940748.77	4826884.44

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	24.649
MONOCOTYLEDONS	15.259
LICHENS	86.107
MOSSES	13.156
TOTAL	92.296

PERENNIALS 24.649 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
LICHENS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY NON-GREEN STD.	3043.96	166.09	692.39	10463.33	618.24	89637.37	110718.93	273584.71
WOODY EX-GREEN STD.	366.26	21.17	168.14	1378.29	2833.54	6967.98	11179.81	27567.85
MONOCOT STD.	1136.14	59.01	575.15	4132.40	4746.08	34070.45	42948.93	106332.60
LICHEN DEAD	2580.23	255.26	1585.22	8889.58	50044.81	145729.27	204663.66	510034.95
MOSS DEAD	357.08	39.92	223.59	1229.34	2698.91	13894.10	17822.35	44340.51
WOODY LITTER	964.29	57.99	224.06	3314.87	191.70	31558.74	35065.32	86650.52
HERBACEOUS LITTER	14584.09	771.85	4056.61	50349.12	86634.68	319943.17	456926.97	1127492.56
DEAD ROOTS 0-2 CM	212.14	12.40	48.66	733.03	509.41	7267.54	8509.98	21049.69
DEAD ROOTS 2-8 CM	1781.16	98.61	363.21	6121.45	3154.81	61128.49	70404.75	174092.27
DEAD ROOTS 8-18 CM	1125.32	61.35	229.07	3869.67	1993.86	38676.03	44499.56	110033.26
DEAD ROOTS 18-35 CM	421.52	23.37	86.76	1450.57	748.05	14488.87	16687.49	41263.99
GREEN LICHENS	17600.00	1600.00	12800.00	90512.00	392960.00	826528.00	1280000.00	3190851.81
TOTAL	44172.19	3162.01	21052.85	192443.66	547174.08	1599849.98	2299427.72	5713794.62

SOIL VARIABLES

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C MHPVG.D.M.	
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 20. MM.	957235.41	311177.82	1662290.73	3276366.62	868205.97	16622163.37	20776735.75	41553471.50
FROM 20. TO 80. MM.	387838.50	140720.45	747773.25	1331547.59	257337.52	7768097.31	9356982.37	18713964.75
FROM 80. TO 180. MM.	796830.17	287722.62	1531884.57	2783029.12	522090.06	15932159.25	19187277.25	38374554.50
FROM 180. TO 350. MM.	266332.32	16275.83	86807.39	213484.75	171558.00	978511.75	1074554.50	2174909.00
TOTAL	2408236.47	901196.72	4810951.94	8264427.06	1819191.53	50111931.00	60195549.50	120391099.00
IN MINERAL FRACTION								
FROM 0. TO 20. MM.	3670.47	3148.17	79011.64					
FROM 20. TO 80. MM.	2147.35	3149.61	29240.76					
FROM 80. TO 180. MM.	3110.46	16085.55	27673.49					
FROM 180. TO 350. MM.	3436.67	27268.26	41226.60					
TOTAL	12364.91	49651.59	177152.49					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	2464773.56	1430010.32	6789257.27	8416670.62	2366325.59	51711780.50	62494977.00	126104393.00
TOTAL IN ECOSYSTEM	2494288.50	1456606.59	6999979.84	8531313.50	2897916.56	53006495.00	64435725.50	130930277.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	241277460.00	.00	-50.30	204.79	1739.40	95926.08
BY RUN-OFF OR RUN-ON	.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-104792093.00	.00	-60.40	-26.20	-209.58	.00
TOTAL	136481368.00	.00	-111.70	178.59	1529.82	95926.08

SOIL WATER POTENTIAL, ATM.
FROM 0. TO 20. MM. -1.30
FROM 20. TO 80. MM. -1.30
FROM 80. TO 180. MM. -1.70
FROM 180. TO 350. MM. -2.90

ACCUMULATED PRECIPITATION TO SEPT 9 1972 INCLUSIVE IS 47.1 MM. - THAT IS 471.0 TONS PER HECTARE .474 SECONDS ELAPSED
STATE(1621) PERMITS ONLY .9999999851 OF THE PROPOSED UNIT CHANGE AT 268 + .000 DAYS
STATE(1621) PERMITS ONLY .9999999851 OF THE PROPOSED UNIT CHANGE AT 273 + .000 DAYS

NORWEGIAN IBP -- 1972 DATA FOR LICHEN HEATH -- STIGSTUV HARDANGERVIDDA, NORWY

REPORT NO. 4 ON JULY 5 1973 (I.E., AFTER 337 DAYS OF SIMULATION) 3.488 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	745.94	39.73	434.59	7449.34	16627.01	70557.15	94633.50	232738.47
NON-GREEN ABOVE GROUND	2506.43	222.10	1696.22	9899.09	25103.16	85752.67	120754.92	299580.68
ROOTS 0-2 CM	164.18	14.90	104.23	575.27	1720.62	9104.45	11400.35	28392.99
ROOTS 2-8 CM	2160.48	175.35	1427.82	8782.27	23237.02	75868.55	107887.84	267507.30
ROOTS 8-18 CM	1403.34	112.92	925.05	5727.22	15108.21	48555.44	69390.87	172024.48
ROOTS 18-35 CM	592.46	46.53	392.54	2479.77	6407.20	18208.64	27095.61	67084.31
TOTAL	7573.34	611.53	4979.46	34912.97	98203.22	308046.89	431163.09	1067328.20
MONOCOTYLEDONS								
GREEN PARTS	632.88	35.70	429.34	4763.65	6370.66	17562.48	28696.78	69599.60
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	178.83	15.92	126.08	834.34	1769.58	3196.93	5800.85	14255.60
ROOTS 2-8 CM	1105.87	100.26	779.82	4879.07	11971.95	26644.18	43495.18	107415.12
ROOTS 8-18 CM	569.01	60.80	395.88	2312.46	5780.35	17051.76	25144.57	62314.64
ROOTS 18-35 CM	241.90	29.47	170.55	1046.89	2707.13	6394.61	10148.63	25096.61
TOTAL	2728.49	246.15	1900.67	13836.40	28599.67	70849.93	113286.00	278681.56
LICHENS								
GREEN PARTS	15764.54	1408.24	11265.92	98972.87	389060.78	818365.33	1267298.97	3155972.56
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	15764.54	1408.24	11265.92	98972.87	389060.78	818365.33	1267298.97	3155972.56
MOSSES								
GREEN PARTS	246.11	28.17	162.54	953.87	1819.52	8320.16	11097.55	27522.07
NON-GREEN ABOVE GROUND	521.17	45.87	231.31	1790.91	3996.62	17362.61	23150.14	57455.87
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	767.28	74.04	393.85	2744.79	5816.13	25682.77	34243.69	84977.93
ALL SPECIES								
GREEN PARTS	17389.47	1511.84	12291.40	73039.72	413877.96	914805.12	1401722.78	3485832.69
NON-GREEN ABOVE GROUND	3027.60	267.97	1927.53	11690.01	29099.77	103115.28	143905.06	357036.55
ROOTS 0-2 CM	343.01	30.82	230.31	1409.61	3490.20	12301.38	17201.20	42648.59
ROOTS 2-8 CM	3266.35	284.61	2203.63	13661.34	35208.97	102512.70	151383.01	374922.42
ROOTS 8-18 CM	1972.85	173.72	1320.93	8039.68	20888.56	65607.20	94535.44	234339.12
ROOTS 18-35 CM	834.37	71.00	563.09	3526.66	9114.33	24603.25	37244.23	92180.91
TOTAL	26833.66	2339.97	18536.89	111367.02	511679.80	1222944.92	1845991.73	4586960.19

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS		24.369
MONOCOTYLEDONS		7.887
LICHENS		85.036
MOSSES		12.205
TOTAL		90.847
	PERENNIALS	24.369 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
LICHENS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY NON-GREEN STD.	2936.35	160.52	671.88	10097.96	683.06	96128.24	106909.28	264175.29
WOODY EX-GREEN STD.	30.08	1.83	20.10	191.57	427.61	2605.46	3224.64	7983.35
MONOCOT STD.	305.73	16.40	176.30	1340.39	1653.90	14932.90	17927.19	44405.00
LICHEN DEAD	3073.12	290.27	2049.04	10941.49	26459.42	164068.58	241469.49	601644.93
MOSS DEAD	436.78	49.07	275.99	1523.24	3256.32	16353.11	21132.66	52557.70
WOODY LITTER	977.33	57.67	226.64	3359.74	196.40	31986.17	35542.31	87828.79
HERBACEOUS LITTER	13362.68	711.33	4166.80	47949.61	80220.44	333361.67	461031.73	1138554.39
DEAD ROOTS 0-2 CM	537.96	43.43	293.29	2289.54	4489.73	13476.83	20256.10	49958.06
DEAD ROOTS 2-8 CM	1757.06	97.47	361.79	6043.44	3181.18	60307.73	69532.35	171937.63
DEAD ROOTS 8-18 CM	1109.56	60.62	228.13	3818.68	2010.82	38096.55	43926.06	108616.74
DEAD ROOTS 18-35 CM	415.64	23.09	86.51	1431.92	756.65	14279.46	16468.02	40721.60
GREEN LICHENS	17600.00	1600.00	12800.00	90512.00	392960.00	826528.00	1280000.00	3190851.81
TOTAL	42542.27	3107.76	21355.47	148993.59	556295.51	1612124.69	2317419.78	5759235.19

SOIL VARIABLES

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	MHG4G.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 20. MM.	961429.40	31413.08	167777.39	329683.06	889304.45	16695844.37	20872131.75	41744263.50
FROM 20. TO 80. MM.	387467.44	13940.49	74791.97	132496.34	256031.34	7764607.94	9345335.50	18690671.00
FROM 80. TO 180. MM.	795998.99	28570.50	152371.50	271841.62	519322.97	15923998.87	19161803.25	38323606.50
FROM 180. TO 350. MM.	266052.93	16189.62	86337.58	90879.05	170641.30	9784367.37	10863587.62	21727175.25
TOTAL	2410948.81	90171.69	480878.45	823740.00	1835300.05	50168818.00	60242858.00	120485716.00
IN MINERAL FRACTION								
FROM 0. TO 20. MM.	3500.51	2895.93	76916.54					
FROM 20. TO 80. MM.	2861.54	3260.76	29936.02					
FROM 80. TO 180. MM.	4793.51	16229.56	28416.85					
FROM 180. TO 350. MM.	3777.70	27354.71	41684.50					
TOTAL	14929.25	49740.97	176957.90					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	2469420.31	142970.42	679187.31	837739.56	2391595.53	51780342.50	62560277.50	126244951.00
TOTAL IN ECOSYSTEM	2495253.94	145310.39	697724.70	940106.50	2903275.31	53003887.00	64406269.00	130831911.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	249309465C.00	.00	1961.74	436.54	3707.77	66460.93
BY RUN-OFF OR RUN-ON	-111079998.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-2216606944.00	.00	-1102.30	-554.15	-4433.21	.00
TOTAL	165407744.00	.00	859.44	-117.61	-725.44	66460.93

SOIL WATER POTENTIAL, ATM.

FROM 0. TO 20. MM.	-.10
FROM 20. TO 80. MM.	-.50
FROM 80. TO 180. MM.	-2.50
FROM 180. TO 350. MM.	-2.90

ACCUMULATED PRECIPITATION TO JULY 5 1973 INCLUSIVE IS 465.7 MM. - THAT IS 4657.0 TONS PER HECTARE .474 SECONDS ELAPSED

NORWEGIAN IBP -- 1972 DATA FOR LICHEN HEATH -- STIGSTUV HARDANGERVIDDA, NORWY

REPORT NO. 5 ON AUG 2 1973 (I.E., AFTER 365 DAYS OF SIMULATION) 1.742 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	730.48	38.53	377.60	9067.79	20240.90	72897.28	102205.97	250491.51
NON-GREEN ABOVE GROUND	2506.13	222.04	1695.75	9909.10	25131.22	85913.16	120953.48	300069.47
ROOTS 0-2 CM	164.32	14.90	109.20	580.80	1737.10	9190.80	11508.69	28660.21
ROOTS 2-8 CM	2161.39	175.30	1473.42	8827.19	23371.83	76588.12	108787.13	269725.44
ROOTS 8-18 CM	1404.41	112.89	924.79	5755.94	15194.42	49015.96	69966.32	173443.80
ROOTS 18-35 CM	592.66	46.51	392.43	2490.45	6439.32	18381.33	27311.10	67515.85
TOTAL	7559.39	606.17	4918.29	36631.26	92114.78	311986.65	440732.68	1090006.28
MONOCOTYLEDONS								
GREEN PARTS	607.94	31.02	772.25	6568.46	8784.33	24216.36	39569.14	95467.52
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	178.34	15.98	125.73	832.72	1767.78	3196.34	5796.84	14245.81
ROOTS 2-8 CM	1102.92	108.96	777.64	4871.33	11964.74	26639.28	43475.35	107365.37
ROOTS 8-18 CM	567.51	60.63	398.77	2309.77	5780.99	17048.64	25139.41	62300.79
ROOTS 18-35 CM	241.20	24.40	170.07	1045.38	2705.86	6393.44	10144.68	25086.58
TOTAL	2697.98	240.89	1840.46	15627.65	31003.71	77494.06	124125.42	304466.07
LICHENS								
GREEN PARTS	15679.07	1384.77	11078.18	92633.66	407127.76	856387.65	1326149.06	3300923.75
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	15679.07	1384.77	11078.18	92633.66	407127.76	856387.65	1326149.06	3300923.75
MOSSES								
GREEN PARTS	251.87	27.94	161.18	1022.66	1950.68	8920.01	11893.35	29478.96
NON-GREEN ABOVE GROUND	520.44	45.81	230.98	1789.41	3991.03	17338.33	23117.76	57375.52
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	772.31	73.74	392.16	2811.07	5941.71	26258.34	35011.11	86854.47
ALL SPECIES								
GREEN PARTS	17269.36	1479.26	11989.30	79292.56	438103.66	962421.29	1479817.50	3676361.69
NON-GREEN ABOVE GROUND	3026.57	267.85	1926.73	11697.50	29122.25	103251.48	144071.24	357444.95
ROOTS 0-2 CM	342.66	30.77	229.93	1413.51	3504.88	12387.15	17305.54	42906.02
ROOTS 2-8 CM	3264.31	284.26	2201.05	13698.52	35336.56	103227.40	152262.48	377090.81
ROOTS 8-18 CM	1971.93	173.52	1319.56	8065.71	20975.41	66064.60	95105.73	235744.65
ROOTS 18-35 CM	833.92	70.92	562.51	3535.82	9145.18	24774.77	37456.78	92702.43
TOTAL	26708.75	2305.58	18229.08	117703.63	536187.95	1272126.67	1926018.27	4782250.50

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	25.010
MONOCOTYLEDONS	10.443
LICHENS	86.336
MOSSES	12.459
TOTAL	91.967

PERENNIALS 25.010 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
LICHENS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY NON-GREEN STD.	2928.84	160.13	670.47	10072.50	688.17	95883.46	106644.13	263520.46
WOODY EX-GREEN STD.	122.03	6.45	70.61	1224.78	2733.78	11549.86	15508.42	38137.29
MONOCOT STD.	383.34	20.61	226.75	2057.50	2616.74	17300.68	21974.92	54167.90
LICHEN DEAD	3001.36	287.09	2011.31	10768.72	65823.30	160190.00	236782.02	589927.06
MOSS DEAD	425.35	47.77	269.67	1484.32	3171.47	15916.33	20572.12	51162.75
WOODY LITTER	953.63	52.37	221.12	3278.29	191.90	31210.72	34680.91	85700.16
HERBACEOUS LITTER	12665.55	674.24	3959.01	45043.76	76184.08	316874.11	438101.95	1081919.91
DEAD ROOTS 0-2 CM	487.25	39.45	266.52	2074.08	4079.15	12209.88	18363.12	45290.63
DEAD ROOTS 2-8 CM	1727.85	95.59	755.01	5926.15	3124.61	59134.09	68184.84	168605.77
DEAD ROOTS 8-18 CM	1080.38	59.04	222.30	3718.50	1961.41	37094.69	42774.60	105769.63
DEAD ROOTS 18-35 CM	404.32	22.47	84.23	1393.05	737.52	13890.03	16020.60	39615.25
GREEN LICHENS	17600.00	1600.00	12800.00	105112.00	392960.00	826528.00	1280000.00	3190351.81
TOTAL	41773.89	3060.21	21152.02	194753.64	554272.14	1597781.80	2299707.59	5714568.56

SOIL VARIABLES

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C MG#$G.O.M.	
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 20. MM.	962377.80	31456.27	168088.30	3285442.94	894427.93	16713424.75	20893295.50	41786591.00
FROM 20. TO 80. MM.	397347.33	13923.55	74250.50	1321209.44	255551.30	7763653.25	9341313.87	18682627.75
FROM 80. TO 180. MM.	795598.94	28495.07	151966.73	2711202.50	517949.46	15920209.37	19149361.25	38298722.50
FROM 180. TO 350. MM.	255915.52	16144.00	86098.56	906058.33	170174.63	9781827.27	10858060.25	21716120.50
TOTAL	2411235.50	90018.88	480404.09	8224813.19	1838103.30	50179114.00	60242030.00	120484061.00
IN MINERAL FRACTION								
FROM 0. TO 20. MM.	3422.21	3124.79	19871.26					
FROM 20. TO 80. MM.	2845.63	3288.51	30087.63					
FROM 80. TO 180. MM.	4933.80	16330.62	29019.90					
FROM 180. TO 350. MM.	3699.72	27432.21	42183.78					
TOTAL	14901.36	50176.12	121158.56					

TOTAL, SOIL AND DEAD ORGANIC MATERIAL	2467910.79	143255.21	681714.66	937386.81	2392375.44	51776895.50	6254637.50	126198729.00
TOTAL IN ECOSYSTEM	2494617.50	145560.79	699947.74	940070.37	2928563.37	53049022.00	6446765.50	130930979.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	34487440640.00	.00	1701.18	877.95	7422.93	177843.54
BY RUN-OFF OR RUN-ON	-1110729998.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-29646960160.00	.00	-1489.34	-741.17	-5929.36	.00
TOTAL	3729784512.00	.00	211.84	132.78	1493.57	177843.54

SOIL WATER POTENTIAL, ATM.

FROM 0. TO 20. MM.	-.50
FROM 20. TO 80. MM.	-.60
FROM 80. TO 180. MM.	-.80
FROM 180. TO 350. MM.	-1.30

ACCUMULATED PRECIPITATION TO AUG 2 1973 INCLUSIVE IS 565.8 MM. - THAT IS 5659.0 TONS PER HECTARE .477 SECONDS ELAPSED

NORWEGIAN IBP -- 1972 DATA FOR LICHEN HEATH -- STIGSTUV HARDANGERVIDDA, NORWAY

REPORT NO. 6 ON AUG 26 1973 (I.E., AFTER 389 DAYS OF SIMULATION) 1.479 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	779.26	30.75	336.39	12159.28	27149.76	83160.87	122468.91	299051.05
NON-GREEN ABOVE GROUND	2506.16	221.99	1695.34	9926.80	25180.43	86182.89	121290.12	300898.57
ROOTS 0-2 CM	164.58	14.89	104.17	589.60	1763.37	9378.49	11691.46	29086.36
ROOTS 2-8 CM	2163.23	175.26	1427.08	8999.58	23588.65	77735.54	110727.77	273269.27
ROOTS 8-18 CM	1405.59	112.87	924.57	5802.25	15333.12	49750.32	70885.69	175711.72
ROOTS 18-35 CM	593.09	46.50	392.34	2507.73	6991.16	18656.72	27655.60	68465.68
TOTAL	7611.89	602.26	4885.89	39884.25	99506.49	324814.82	464205.55	1146482.62
MONOCOTYLEDONS								
GREEN PARTS	645.67	27.63	331.55	10245.91	13703.17	37775.45	61724.53	148348.97
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	177.95	15.84	125.43	832.00	1769.25	3203.79	5805.04	14266.05
ROOTS 2-8 CM	1100.53	108.70	775.77	4870.33	11983.55	26701.34	43555.22	107561.22
ROOTS 8-18 CM	566.32	60.48	393.82	2311.07	5797.53	17088.36	25196.96	62441.50
ROOTS 18-35 CM	240.74	24.34	169.67	1045.43	2710.78	6408.33	10164.54	25135.21
TOTAL	2731.21	236.99	1796.24	19304.74	35964.28	91177.27	146446.29	357752.93
LICHENS								
GREEN PARTS	15551.62	1365.38	10923.03	63725.52	414287.55	871457.80	1349470.86	3358183.78
NON-GREEN ABOVE GROUND	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	15551.62	1365.38	10923.03	63725.52	414287.55	871457.80	1349470.86	3358183.78
MOSSES								
GREEN PARTS	254.85	27.73	159.98	1063.03	2027.66	9272.06	12362.74	30626.55
NON-GREEN ABOVE GROUND	519.82	45.75	230.71	1786.26	3986.24	17317.54	23090.04	57306.73
ROOTS 0-2 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 2-8 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 8-18 CM	.00	.00	.00	.00	.00	.00	.00	.00
ROOTS 18-35 CM	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	774.66	73.48	390.68	2849.29	6013.90	26589.60	35452.79	87933.28
ALL SPECIES								
GREEN PARTS	17231.39	1451.49	11750.95	87192.74	457168.14	1001666.16	1596027.02	3836210.31
NON-GREEN ABOVE GROUND	3025.98	267.74	1926.05	11713.07	29166.67	103500.42	144380.17	358205.29
ROOTS 0-2 CM	342.51	30.73	229.60	1421.60	3532.62	12532.28	17486.50	43352.41
ROOTS 2-8 CM	3263.76	283.95	2198.85	13769.91	35572.20	104436.88	153778.98	380830.49
ROOTS 8-18 CM	1971.90	173.35	1318.39	8113.31	21130.66	66838.68	96082.65	238153.21
ROOTS 18-35 CM	833.83	70.85	562.00	3553.16	9201.93	25065.05	37820.14	93600.89
TOTAL	26669.38	2279.11	17985.84	157763.79	555772.21	1314039.47	1995575.47	4950352.56

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	27.050
MONOCOTYLEDONS	16.153
LICHENS	86.798
MOSSES	12.607
TOTAL	92.944

PERENNIALS 27.058 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
LICHENS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	DRY MATTER
WOODY NON-GREEN STD.	2915.41	159.42	667.67	10026.63	690.89	95444.84	106167.36	262330.30
WOODY EX-GREEN STD.	146.64	7.12	77.88	1737.32	3878.27	14455.17	20070.77	49227.18
MONOCOT STD.	421.72	22.25	247.90	2815.62	3640.80	19363.95	25820.37	63328.27
LICHEN DEAD	2842.87	265.98	1912.29	10295.30	63257.54	152132.32	225686.16	562233.19
MOSS DEAD	412.37	46.30	260.36	1440.17	3075.57	15425.29	19941.03	49592.29
WOODY LITTER	932.87	51.22	216.27	3206.94	188.21	30531.37	33926.52	83835.95
HERBACEOUS LITTER	11937.79	635.26	3751.10	43038.14	73093.30	303861.07	419992.51	1037039.49
DEAD ROOTS 0-2 CM	434.13	35.24	238.21	1848.33	3645.42	10882.27	16376.02	40390.77
DEAD ROOTS 2-8 CM	1687.54	93.64	747.97	5805.06	3065.24	57923.01	66793.30	165164.97
DEAD ROOTS 8-18 CM	1058.25	57.84	217.90	3642.55	1924.27	36335.22	41902.05	103612.17
DEAD ROOTS 18-35 CM	396.06	22.01	82.57	1364.68	723.73	13605.66	15694.06	38807.82
GREEN LICHENS	17600.00	1600.00	12800.00	95012.00	392960.00	826528.00	1290000.00	3190851.81
TOTAL	40785.65	2996.26	20820.20	196732.75	550143.23	1576488.16	2272364.12	5646414.06

SOIL VARIABLES

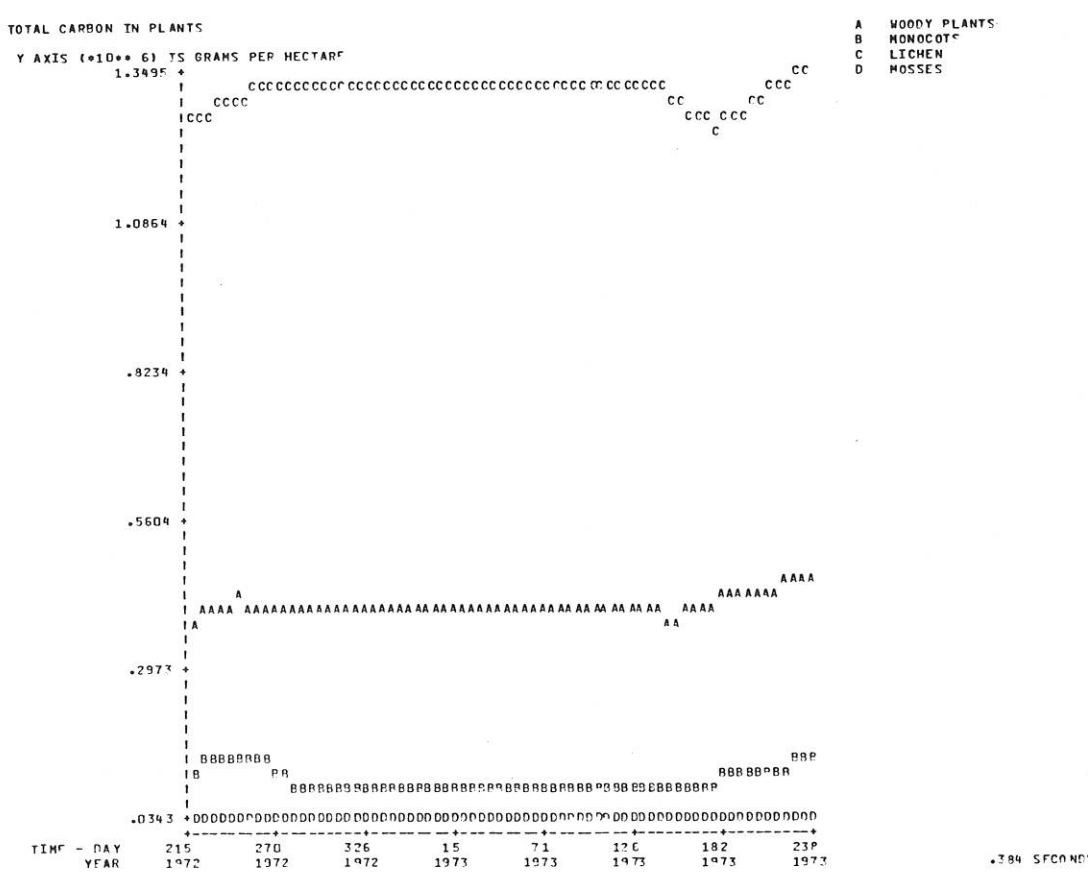
	NITROGEN	ANIONS	CATIONS	PROTEIN C	RESERVE C	STRUCT C	TOTAL C	MJ3SG.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 20. MM.	963434.12	31507.08	169430.86	377352.69	900225.26	16733279.62	20917037.50	41834075.00
FROM 20. TO 80. MM.	797220.56	13896.32	74162.12	131997.56	255047.68	7762678.56	9337083.75	18674167.50
FROM 80. TO 180. MM.	795287.39	28436.52	151652.57	270553.72	516883.29	15917253.87	19139690.75	38279381.50
FROM 180. TO 350. MM.	265817.32	16130.60	85919.70	304172.07	169825.31	9779919.50	10853915.87	21707833.75
TOTAL	2411759.37	89946.52	481105.24	821255.94	1841981.52	50193091.00	60247728.00	120495457.00

IN MINERAL FRACTION								
FROM 0. TO 20. MM.	3561.82	3258.66	79900.69					
FROM 20. TO 80. MM.	2852.06	3327.27	30315.81					
FROM 80. TO 180. MM.	4949.08	16377.58	29204.16					
FROM 180. TO 350. MM.	3520.76	27435.32	42118.30					
TOTAL	14883.73	50394.37	181538.92					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	2467427.72	143337.61	682464.36	8358788.69	2392124.72	51769579.00	62520092.00	126141871.00
TOTAL IN ECOSYSTEM	2484093.09	145615.72	700450.20	8494152.37	2947896.91	53083618.00	64515667.00	131092223.00

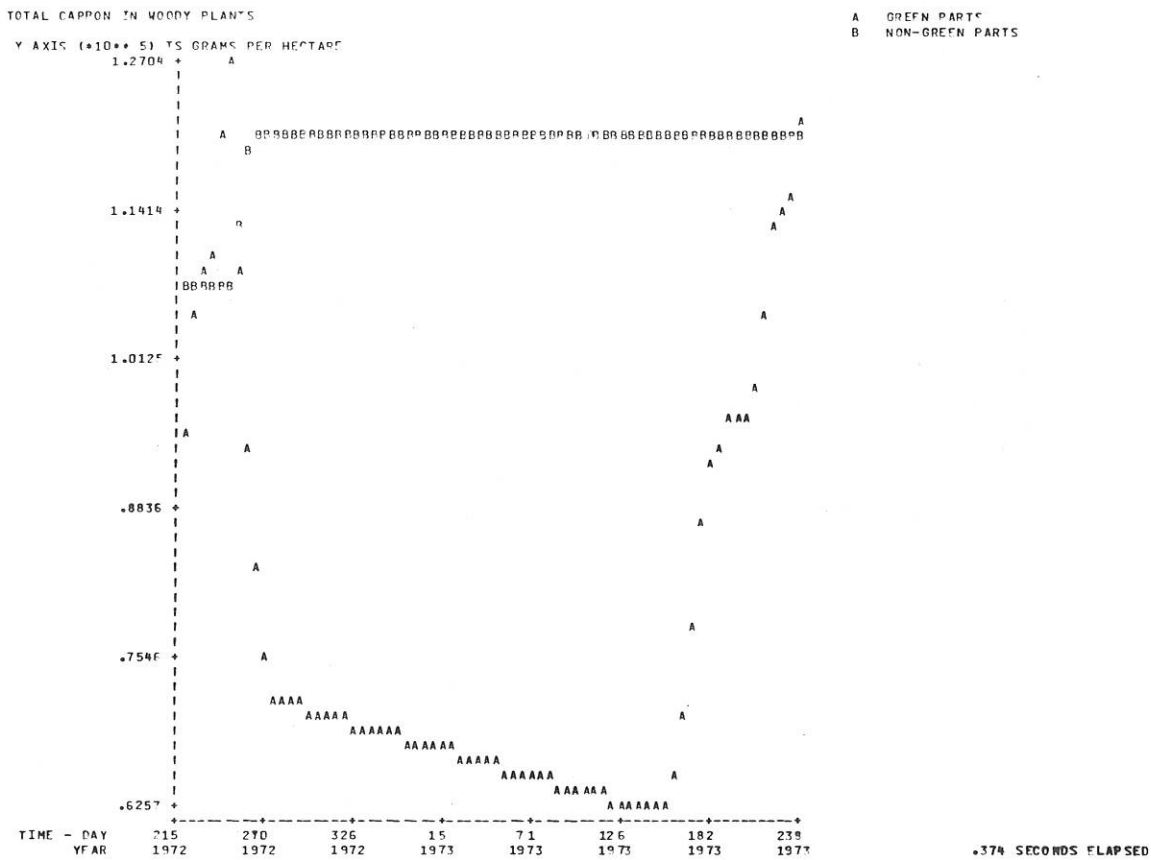
ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM	WATER	MINERAL SOIL	NITROGEN	ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	3450795776.00	.00	1336.05	1009.61	8575.14	175850.84
BY RUN-OFF OR RUN-ON	-111079998.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-3287574240.00	.00	-1643.79	-821.89	-6575.15	.00
TOTAL	52141568.00	.00	-307.74	187.71	2000.00	175850.84

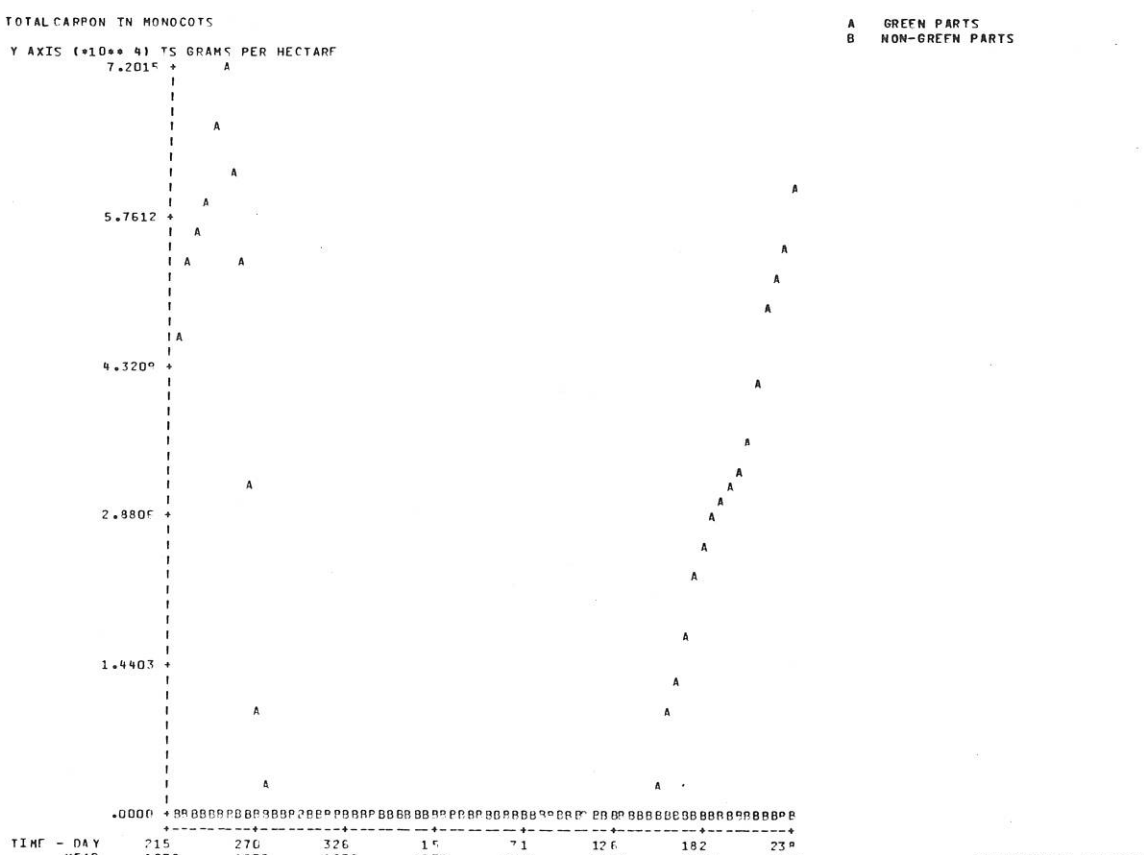
SOIL WATER POTENTIAL, ATM.	
FROM 0. TO 20. MM.	-22.00
FROM 20. TO 80. MM.	-2.50
FROM 80. TO 180. MM.	-1.70
FROM 180. TO 350. MM.	-2.90

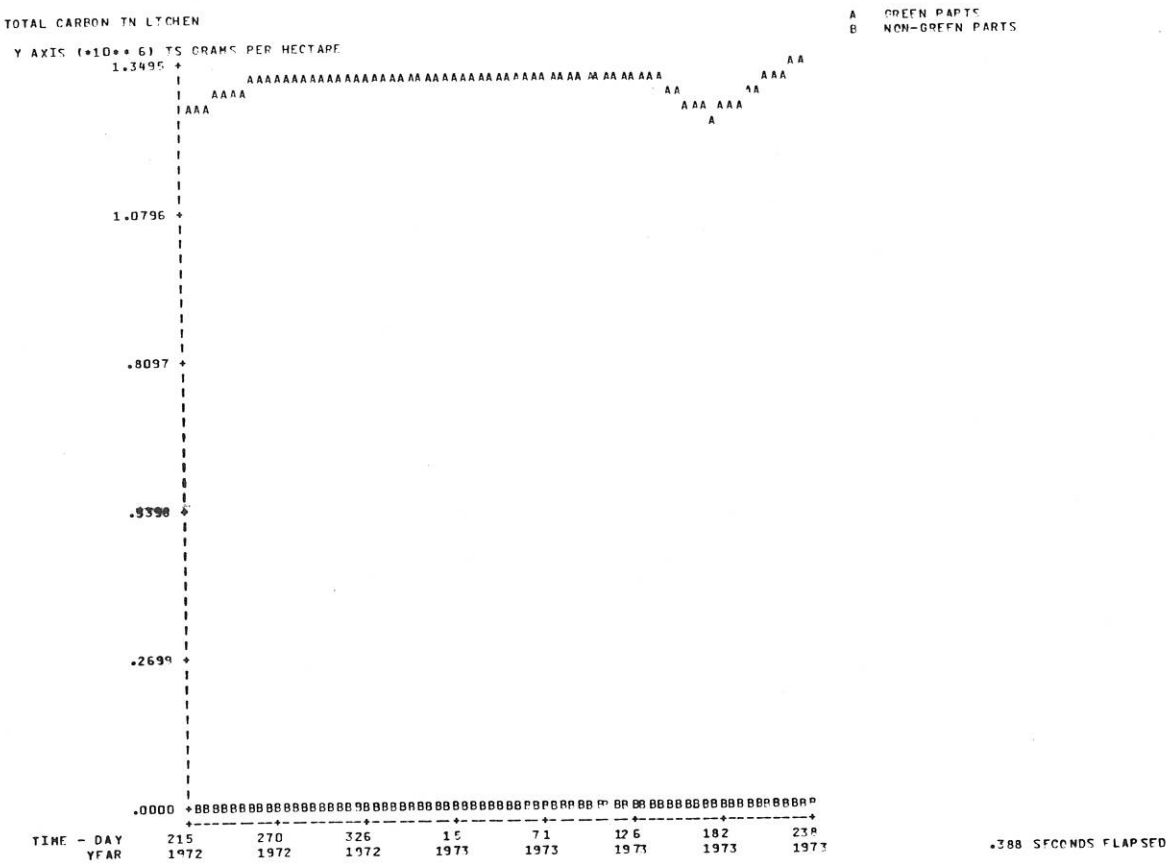
ACCUMULATED PRECIPITATION TO AUG 26 1973 INCLUSIVE IS 597.0 MM. - THAT IS 5970.0 TONS PER HECTARE .478 SECONDS ELAPSED

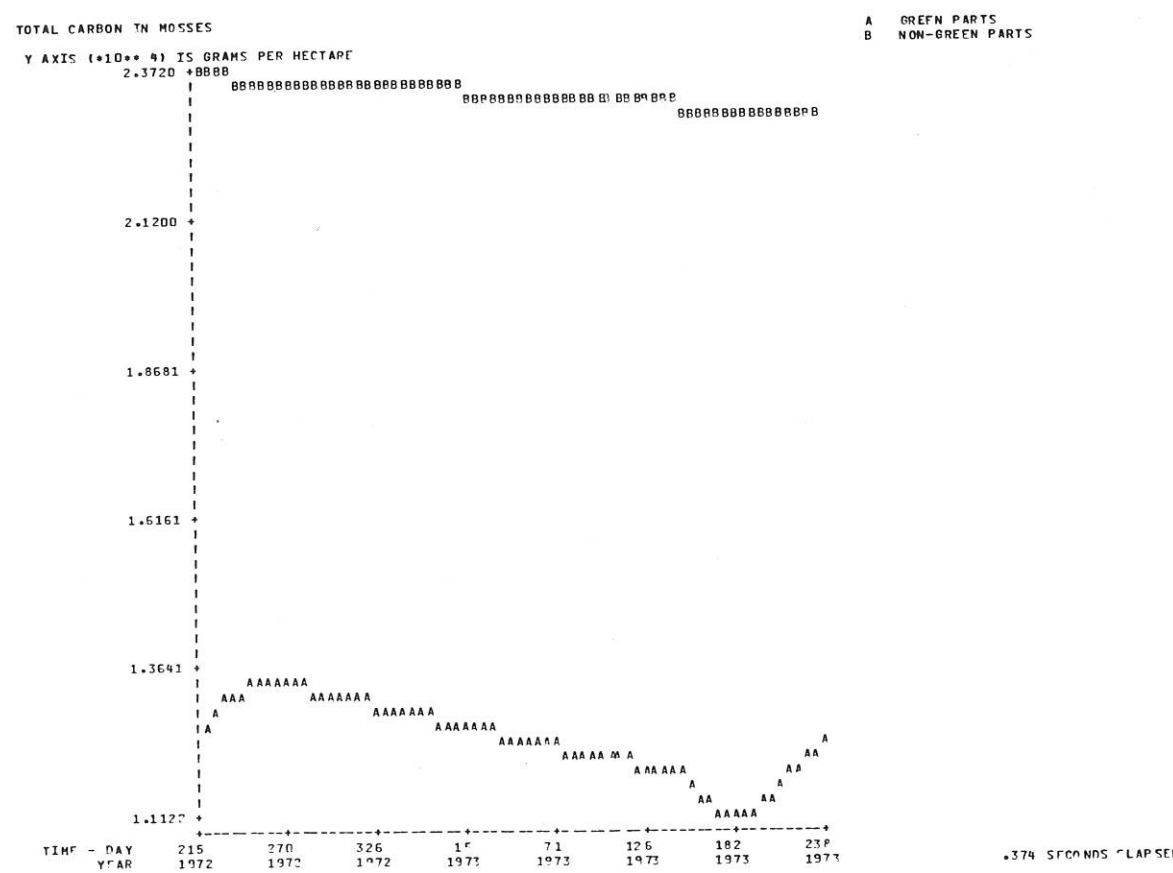


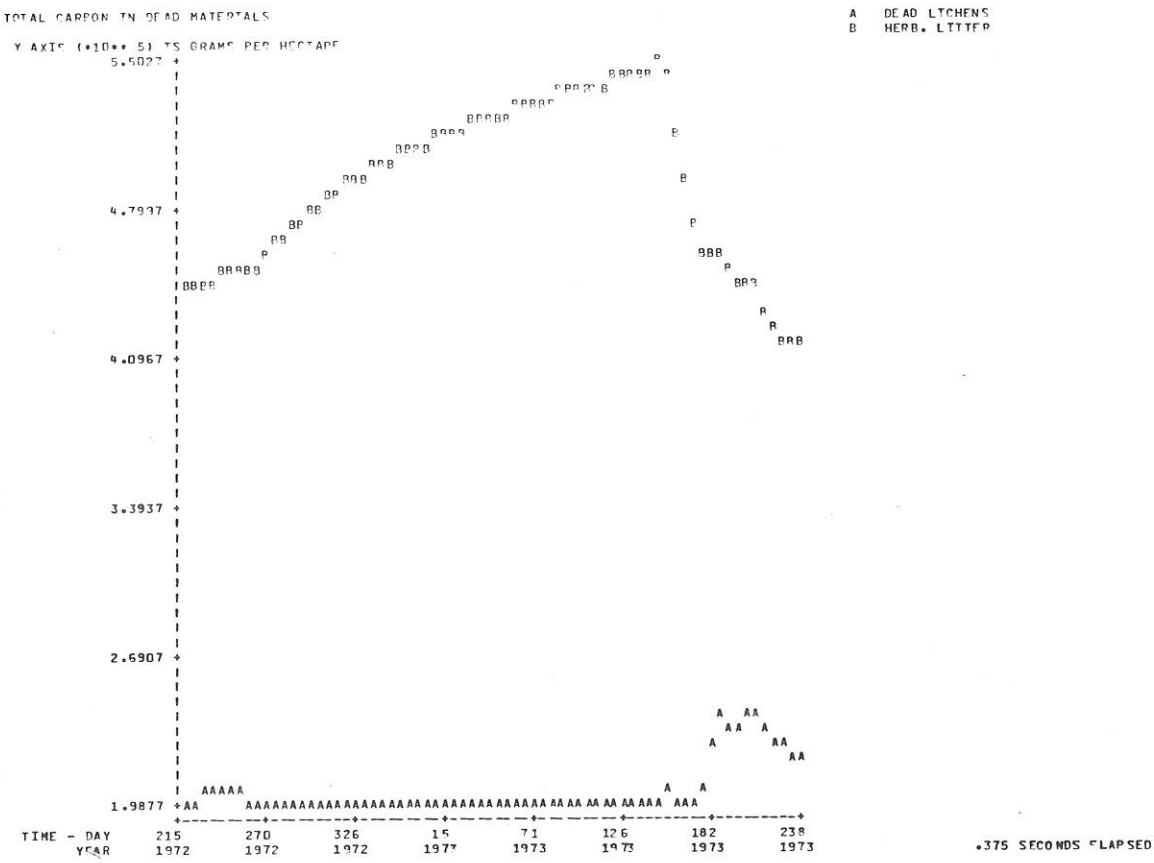
.384 SECONDS ELAPSED

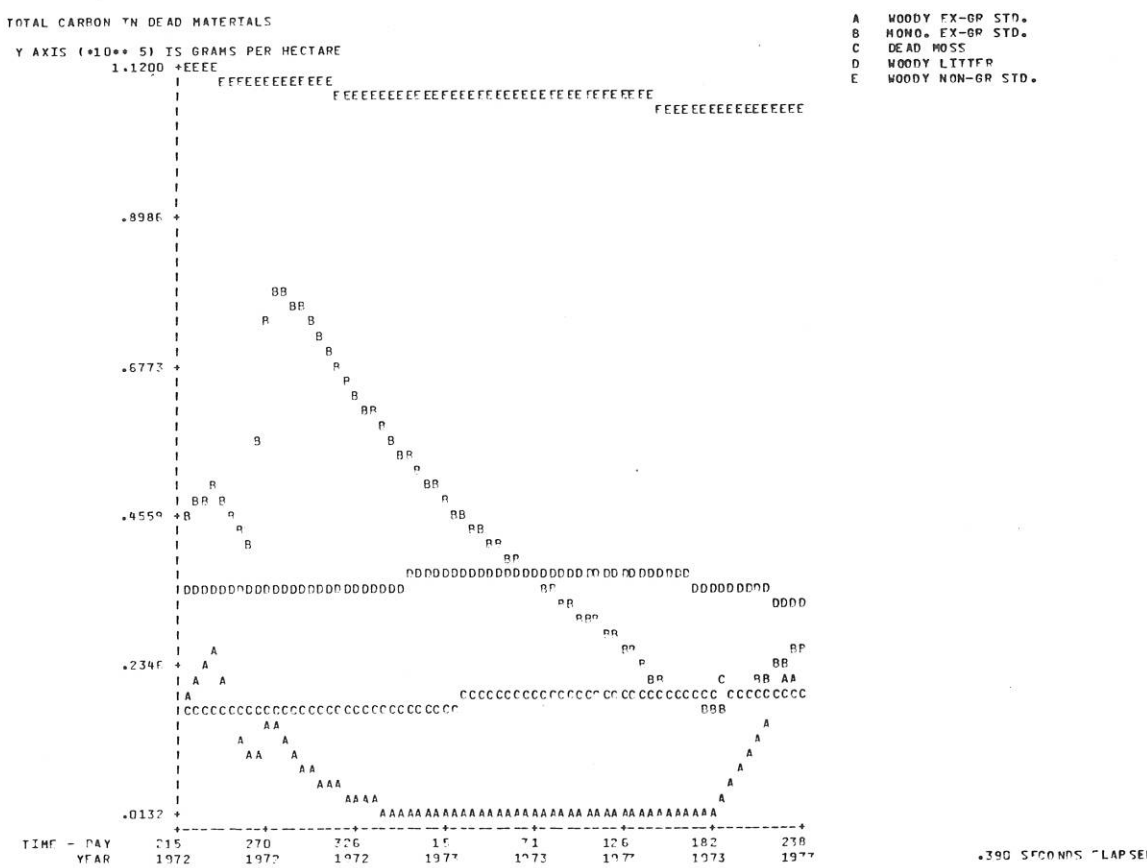

TOTAL CARBON IN WOODY PLANTS
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 5) TS GRAMS PER HECTARE
1.2708
1.1414
1.0125
.8836
.7546
.6257
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.374 SECONDS ELAPSED

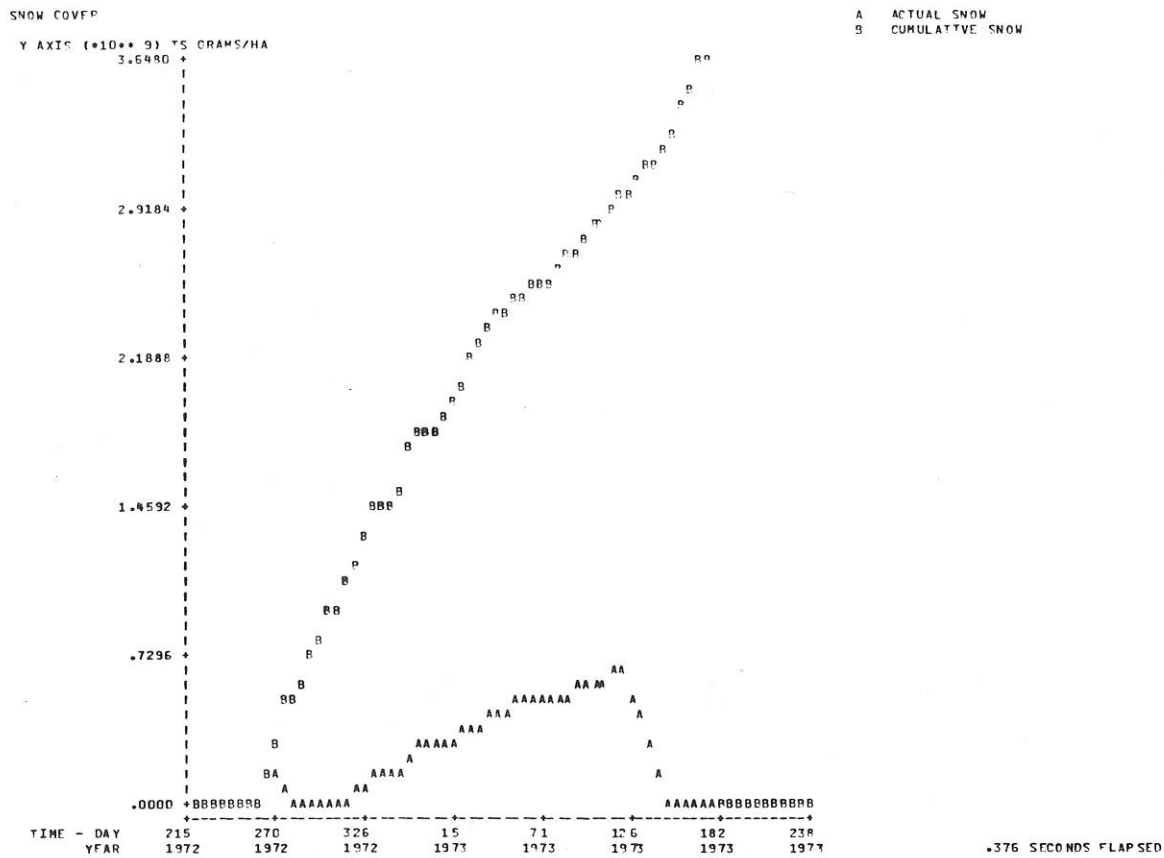

TOTAL CARBON IN MONOCOTS
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 4) TS GRAMS PER HECTARE
7.2015
5.7612
4.3209
2.8806
1.4403
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.376 SECONDS ELAPSED


TOTAL CARBON TN LYCHEN
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 6) IS GRAMS PER HECTARE
1.3495
1.0796
.8097
.5398
.2699
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.388 SECONDS ELAPSED


TOTAL CARBON TN MOSSES
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 4) IS GRAMS PER HECTARE
2.3720
2.1200
1.8681
1.6161
1.3641
1.1122
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.374 SECONDS ELAPSED


TOTAL CARBON IN DEAD MATERIALS
Y AXIS (*10** 5) IS GRAMS PER HECTARE
5.5027
4.7997
4.0967
3.3937
2.6907
1.9877
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1977 1973 1973 1973 1977
A DEAD LICHENS
B HERB. LITTER
.375 SECONDS ELAPSED


TOTAL CARBON IN DEAD MATERIALS
Y AXIS (*10** 5) IS GRAMS PER HECTARE
1.1200
.8986
.6773
.4559
.2346
.0132
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1977 1973 1977 1973 1977
A WOODY EX-GR STD.
B MONO. EX-GR STD.
C DEAD MOSS
D WOODY LITTER
E WOODY NON-GR STD.
.390 SECONDS ELAPSED



Wet Meadow

NORWEGIAN IBP- 1972 DATA FOR WET MEADOW SITE NOR3 --STIGSHIV.HARD.VIDDA,NORWAY

INITIAL REPORT ON AUG 2 1972 2.284 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	15680.00	1127.00	10290.00	53900.00	56400.00	93100.00	203400.00	500562.00
NON-GREEN PARTS	13928.00	2786.00	26000.00	47878.00	171640.00	553386.00	772904.00	1943853.30
TOTAL	29608.00	3913.00	36290.00	101778.00	228040.00	646486.00	976304.00	2444415.20
HERBACEOUS DICOTS								
GREEN PARTS	2882.00	393.00	3144.00	9907.00	10880.00	27300.00	48087.00	120196.95
NON-GREEN PARTS	1661.00	408.00	3322.00	5710.00	11760.00	42280.00	59750.00	151054.50
TOTAL	4543.00	801.00	6466.00	15617.00	22640.00	69580.00	107837.00	271251.45
MONOCOTYLEDONS								
GREEN PARTS	15249.00	1326.00	11934.00	52514.00	60760.00	173176.00	286450.00	710499.90
NON-GREEN PARTS	36945.00	5337.00	36945.00	127000.00	291640.00	1224934.00	1643574.00	4105011.97
TOTAL	52194.00	6663.00	48879.00	179514.00	352400.00	1398110.00	1930024.00	4816111.81
MOSSES								
GREEN PARTS	2633.00	282.00	4326.00	9050.00	9160.00	51163.00	69373.00	174791.00
NON-GREEN PARTS	6640.00	540.00	7885.00	23074.00	28386.00	114540.00	166000.00	415066.90
TOTAL	9273.00	822.00	12211.00	32124.00	37546.00	165703.00	235373.00	589857.89
ALL SPECIES								
GREEN PARTS	36444.00	3128.00	29694.00	125371.00	137200.00	344739.00	607310.00	1506049.97
NON-GREEN PARTS	59174.00	9071.00	74152.00	203662.00	503426.00	1935140.00	2642228.00	6615586.67
TOTAL	95618.00	12199.00	103846.00	329033.00	640626.00	2279879.00	3249538.00	8121636.37

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	24.017	
HERBACEOUS DICOTS	13.017	
MONOCOTYLEDONS	33.989	
MOSSES	92.984	
TOTAL	96.939	
PERENNIALS	96.939 ANNUALS	.000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
HERBACEOUS DICOTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY NON-GREEN DEAD	.00	.00	.00	.00	.00	.00	.00	.00
WOODY SOIL DEAD	.00	.00	.00	.00	.00	.00	.00	.00
HERBACEOUS SOIL DEAD	.00	.00	.00	.00	.00	.00	.00	.00
WOODY HERBACEOUS DEAD	158.00	10.00	166.00	543.00	837.00	1504.00	2980.00	7181.05

DICOT STANDING DEAD	270.00	23.00	730.00	929.00	1730.00	3342.00	6000.00	15019.80
MONOCOT STANDING DEAD	6210.00	455.00	4909.00	31747.00	22040.00	122213.00	165600.00	411757.45
WOODY WOODY STD. DEAD	1366.00	124.00	2111.00	4696.00	1762.00	43222.00	49693.00	124748.60
MOSS DEAD	5472.00	638.00	8564.00	18810.00	26790.00	176800.00	182400.00	458547.50
LITTER ON SURFACE	6944.00	518.00	6746.00	23971.00	30359.00	104490.00	158720.00	394991.85
DEAD ROOTS 0-120MM	7498.00	1194.00	8354.00	25775.00	6020.00	722163.00	253959.00	635187.24
DEAD ROOTS 12-350MM	667.00	107.00	743.00	2291.00	535.00	19965.00	22791.00	57005.35
SUBSOIL DEAD ROOTS	167.00	19.00	186.00	573.00	134.00	2496.00	3207.00	8007.05
TOTAL	28752.00	3089.00	31768.00	98834.00	90207.00	656195.00	845237.00	2112945.81

SOIL VARIABLES

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	ORG.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 120. MM.	5000860.00	340992.00	4262400.00	17131250.00	4121750.00	85248000.00	105560000.00	213120000.00
FROM 120. TO 350. MM.	11895050.00	699200.00	8740000.00	40982234.00	2810766.00	174800000.00	213500000.00	437000000.00
TOTAL	16895850.00	1040192.00	13002400.00	58079484.00	6932516.00	260048000.00	319060000.00	650120000.00
IN MINERAL FRACTION								
FROM 0. TO 120. MM.	19200.00	5300.00	1408600.00					
FROM 120. TO 350. MM.	14950.00	1800.00	1992700.00					
TOTAL	34150.00	7100.00	3401300.00					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	16958752.00	1050380.00	16435468.00	58177831.00	7022719.00	260760494.00	325237240.00	650240000.00
TOTAL IN ECOSYSTEM	17054370.00	1062570.00	16539314.00	58310751.00	7663345.00	262994072.00	329154768.00	660354072.00

SOIL WATER POTENTIAL, ATM.

FROM 0. TO 120. MM.	.00
FROM 120. TO 350. MM.	.00

.307 SECONDS ELAPSED

NORWEGIAN IBP- 1972 DATA FOR WET MEADOW SITE NOR3 --STIGSHIV.HARD.VIDDA,NORWAY

REPORT NO. 1 ON AUG 25 1972 (I.E., AFTER 23 DAYS OF SIMULATION) 1.148 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	20339.67	1237.64	13629.25	71203.94	74481.06	123012.47	268697.46	660667.66
NON-GREEN PARTS	13940.69	2787.02	26025.81	47924.96	171808.08	553928.13	773661.16	1945755.22
TOTAL	34280.36	4024.66	39655.06	119128.89	246289.14	676940.60	1042358.62	2606422.87
HERBACEOUS DICOTS								
GREEN PARTS	3880.85	420.68	4392.93	13871.35	15228.03	38232.62	67332.01	168008.10
NON-GREEN PARTS	1663.71	407.72	3329.00	5721.97	11784.46	42367.62	59874.05	151366.27
TOTAL	5544.56	828.40	7721.93	19593.32	27012.49	80600.24	127206.06	319374.37
MONOCOTYLEDONS								
GREEN PARTS	20037.81	1544.94	15816.17	69372.98	80298.88	228959.43	378631.30	938884.72
NON-GREEN PARTS	36888.71	5327.06	36890.43	126809.71	291203.27	1223103.02	1641115.98	4099469.84
TOTAL	56926.52	6872.00	52706.60	196182.69	371502.15	1452062.44	2019747.28	5038354.56
MOSSES								
GREEN PARTS	2776.26	295.13	4555.31	9539.85	9657.59	53945.30	73142.74	184282.64
NON-GREEN PARTS	6632.54	539.39	7876.14	23048.07	28354.11	114411.31	165813.48	414600.54
TOTAL	9408.80	834.53	12431.45	32587.92	38011.69	168356.61	238956.22	598883.17
ALL SPECIES								
GREEN PARTS	47034.59	3498.40	38393.65	163988.12	179665.56	444149.82	787803.48	1951843.11
NON-GREEN PARTS	59125.65	9061.19	74121.39	203504.71	503149.91	1933810.06	2640069.62	6611191.81
TOTAL	106160.24	12559.59	112515.04	367492.82	682815.47	2377959.87	3428268.16	8563034.87

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	29.671	
HERBACEOUS DICOTS	17.179	
MONOCOTYLEDONS	41.299	
MOSSES	9.900	
TOTAL	97.914	
PERENNIALS	97.914 ANNUALS	.000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
HERBACEOUS DICOTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY NON-GREEN DEAD	.14	.03	.26	.48	1.72	5.54	7.74	19.46
WOODY SOIL DEAD	.13	.03	.25	.46	1.63	5.26	7.35	18.48
HERBACEOUS SOIL DEAD	3.86	.57	4.02	13.25	30.30	126.55	170.10	425.09
WOODY HERBACEOUS DEAD	2015.51	131.54	1396.89	7023.90	7573.62	12615.12	27212.64	67009.00
DICOT STANDING DEAD	634.82	67.36	739.62	2221.84	3121.21	6875.37	12218.41	30542.63
MONOCOT STANDING DEAD	7931.63	596.29	6320.61	27307.42	29048.13	179737.60	196093.14	487331.56
WOODY WOODY STD. DEAD	1384.89	125.94	2139.26	4761.19	1849.87	43482.56	50093.63	125789.38
MOSS DEAD	3477.53	405.00	5499.72	11940.25	17006.75	114188.84	143135.85	359456.77
LITTER ON SURFACE	2992.28	222.34	2837.20	10296.24	22125.81	86763.86	119185.91	297124.04
DEAD ROOTS 0-120MM	4293.26	683.12	4790.64	14758.45	5154.32	200949.58	220862.36	552319.92
DEAD ROOTS 12-350MM	447.71	71.12	498.02	1524.07	488.98	18601.24	20614.29	51553.95
SUBSOIL DEAD ROOTS	168.75	19.26	187.87	579.03	148.03	2553.93	3280.99	8201.99
TOTAL	23342.50	2322.61	24198.44	80426.59	96550.36	625905.44	792882.37	1979792.22

SOIL VARIABLES

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	ORG.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 120. MM.	5001590.44	341163.07	4261762.87	17167796.00	4128045.09	85248010.00	105398510.00	213078702.00
FROM 120. TO 350. MM.	11879589.37	697857.84	8722968.00	40808749.00	2806369.34	174731606.00	218346722.00	436693444.00
TOTAL	16881179.75	1039019.91	12984730.87	57975545.00	6934413.44	259979616.00	323745232.00	649771344.00
IN MINERAL FRACTION								
FROM 0. TO 120. MM.	23950.90	5894.23	1415780.00					
FROM 120. TO 350. MM.	28156.32	2857.96	2002704.61					
TOTAL	52107.22	8752.19	3418484.59					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	16956629.25	1050001.69	16427413.75	58032971.50	7020367.75	260604055.20	325679452.00	651752936.00
TOTAL IN ECOSYSTEM	17062783.25	1062651.27	16539928.75	58407064.00	7703779.19	262983478.00	329197720.00	660315968.00

```
ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM
                              WATER      MINERAL SOIL    NITROGEN    P + ANIONS   CATIONS        TOTAL C
 TO OR FROM ATMOSPHERE     -15734740.00          .00      841 .89       72.24     614.16     -47068.15
 BY RUN-OFF OR RUN-ON              .00          .00         .00         .00       .00           .00
 TO OR FROM SUBSOIL        -11500000.00          .00         .00         .00       .00           .00

       TOTAL               -27234740.00          .00      841 .89       72.24     614.16     -47068.15

SOIL WATER POTENTIAL, ATM.
  FROM   0. TO  120. MM.          -.05
  FROM 120. TO  350. MM.          -.03

ACCUMULATED PRECIPITATION TO AUG  25 1972 INCLUSIVE IS    30.6 MM. - THAT IS     306.0 TONS PER HECTARE          .339 SECONDS ELAPSED



 NORWEGIAN IBP- 1972 DATA FOR WET MEADOW  SITE NOR3 --STIRSHIV.HARD.VIDDA.NORWAY

REPORT NO.  2 ON SEPT  9 1972 (I.E.,AFTER  38 DAYS OF SIMULATION)                  .727 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE
                        NITROGEN    P + ANIONS   CATIONS     PROTEIN C   RESERVE C   OTHER C     TOTAL C    DRY MATTER
WOODY PLANTS
  GREEN PARTS            8185.66      484.52     5487.55     28657.12    29974.45   115850.70   174482.27   431736.28
  NON-GREEN PARTS       25338.58     3459.26    33643.70     87830.28   213377.87   553154.34   854362.48  2141258.06
     TOTAL              33524.24     3943.78    39131.25    116487.40   243352.32   669005.04  1028844.75  2572994.34
HERBACEOUS DICOTS
  GREEN PARTS            1442.74      149.91     1637.66     5160.15     5664.52    36418.46    47239.13   117970.04
  NON-GREEN PARTS        4005.95      650.94     5979.59    14100.23    20974.58    42313.25    77388.06   194941.47
     TOTAL               5448.69      800.85     7613.24    19260.38    26639.10    78727.71   124627.19   312911.50
MONOCOTYLEDONS
  GREEN PARTS            8064.81      611.65     6368.66    27920.23    32319.58   215650.03   275889.83   686621.55
  NON-GREEN PARTS       48059.57     6169.00    45695.63   165485.59   335667.42  1220514.25  1721667.25  4296526.69
     TOTAL              56124.38     6780.65    52064.29   193405.82   367986.99  1436164.28  1997557.08  4983148.19
MOSSES
  GREEN PARTS            2782.04      295.32     4563.11     9558.98     9677.44    54057.05    73293.47   184560.81
  NON-GREEN PARTS        6627.62      538.99     7870.30    23030.97    28333.06   114326.40   165690.43   414292.85
     TOTAL               9409.66      834.31    12433.40    32589.95    38010.51   168383.45   238983.90   598953.66

ALL SPECIES
  GREEN PARTS           20475.25     1541.40    18052.98    71296.48    77635.99   421972.23   570904.70  1420988.66
  NON-GREEN PARTS       84031.72    10818.19    93189.21   310447.07   598352.92  1930308.22  2819108.16  7047019.00
     TOTAL             104506.97    12359.59   111242.18   381743.54   675988.91  2352280.44  3390012.87  8468007.62

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.
                  WOODY PLANTS                    21.855
                  HERBACEOUS DICOTS               13.252
                  MONOCOTYLEDONS                  33.869
                  MOSSES                          93.961
        TOTAL                                     97.293
                                PERENNIALS    97.293 ANNUALS       .000

CONSTITUENTS OF SHED SEEDS
                        NITROGEN    P + ANIONS   CATIONS     PROTEIN C   RESERVE C   OTHER C     TOTAL C    DRY MATTER
WOODY PLANTS                 .00          .00         .00         .00         .00         .00         .00         .00
HERBACEOUS DICOTS            .00          .00         .00         .00         .00         .00         .00         .00
MONOCOTYLEDONS               .00          .00         .00         .00         .00         .00         .00         .00
MOSSES                       .00          .00         .00         .00         .00         .00         .00         .00
     TOTAL                   .00          .00         .00         .00         .00         .00         .00         .00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE
    TYPE OF MATERIAL    NITROGEN    P + ANIONS   CATIONS     PROTEIN C   RESERVE C   OTHER C     TOTAL C    DRY MATTER
WOODY NON-GREEN DEAD        4.89          .68        6.61       16.93       42.01      110.65      169.59      425.15
WOODY SOIL DEAD             4.45          .64        6.15       15.40       39.20      105.14      159.74      400.57
HERBACEOUS SOIL DEAD       10.20         1.35       10.15       35.17       70.48      252.62      359.26      894.49
WOODY HERBACEOUS DEAD    2530.41       155.94     1717.02     8843.95     9355.65    17992.38    36191.98    89134.76
DICOT STANDING DEAD       843.96        89.09      970.27     2982.53     3777.92     9676.47    16436.91    41056.97
MONOCOT STANDING DEAD    7812.89       589.17     6211.77    26936.13    29288.03   130488.75   186712.91   463887.62
WOODY WOODY STD. DEAD    1410.70       128.97     2181.35     4850.04     1987.80    43726.51    50564.36   126979.28
MOSS DEAD                2988.79       348.55     4732.24    10273.99    14640.39   107566.49   132480.87   332593.67
LITTER ON SURFACE        5963.29       434.18     4839.00    20623.05    35338.91   131838.37   187800.32   467332.27
DEAD ROOTS 0-120MM       3519.29       558.80     3920.95    12098.48     5597.84   196618.86   214315.18   535922.98
DEAD ROOTS 12-350MM       362.32        57.96      403.60     1244.59      526.17    18189.05    19959.81    49914.43
SUBSOIL DEAD ROOTS        171.07        19.60      190.50      586.99      166.63     2623.14     3376.76     8441.52
     TOTAL              25622.24      2384.84    25189.59    88507.24   100831.03   659188.42   848526.69  2116983.66

SOIL VARIABLES
                        NITROGEN    P + ANIONS   CATIONS     PROTEIN C   RESERVE C   OTHER C     TOTAL C  **KLG.D.M.
ORGANIC MATTER CONSTITUENTS
  FROM   0. TO  120. MM.  5001410.00   341159.37  4260894.00  17153964.25  4129224.53  8547580.00 1065307 68.00 2130615 36.00
  FROM 120. TO  350. MM. 11872555.12   697240.61  8715222.37  40772194.00  2804367.25 17470052 6.00 2818277086.00 4365541 72.00
     TOTAL               16873965.00  1038399.98 12976116.37  57926158.00  6933591.75 25994810 6.00 3032807852.00 6495615 04.00
IN MINERAL FRACTION
  FROM   0. TO  120. MM.    27310.73     6154.78    141926 4.77
  FROM 120. TO  350. MM.    37967.77     3449.41    200894 7.80
     TOTAL                  65173.49     9604.18    342820 8.56

TOTAL, SOIL AND DEAD
    ORGANIC MATERIAL     16964765.25  1050383.98 16429514.37  58014665.00  7034427.75 26060729 4.00 3078467376.00 6561732 80.00

TOTAL IN ECOSYSTEM       17069272.00  1062748.56 16540756.50  58376408.50  7710411.62 26295957 4.00 3078467376.00 6602006 80.00



ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM
                              WATER      MINERAL SOIL    NITROGEN    P + ANIONS   CATIONS        TOTAL C
 TO OR FROM ATMOSPHERE     -8153485E.50          .00    1490 .82       169.46    1440.72     -10843 0.28
 BY RUN-OFF OR RUN-ON              .00          .00         .00         .00       .00           .00
 TO OR FROM SUBSOIL        -19000000 .00          .00         .00         .00       .00           .00

       TOTAL               -25153485E.00          .00    14900.82       169.46    1440.72     -10843 0.28

SOIL WATER POTENTIAL, ATM.
  FROM   0. TO  120. MM.          -.05
  FROM 120. TO  350. MM.          -.03

ACCUMULATED PRECIPITATION TO SEPT  9 1972 INCLUSIVE IS    56.3 MM. - THAT IS     563.0 TONS PER HECTARE          .342 SECONDS ELAPSED
STATE( 1621) PERMITS ONLY  .9999999553 OF THE PROPOSED UNIT CHANGE AT 268 +  .000 DAYS
```

NORWEGIAN IBP- 1972 DATA FOR WET MEADOW SITE NOR3 --STIOSHIV.HARD.VIDDA,NORWAY

REPORT NO. 4 ON JULY 5 1973 (I.E., AFTER 327 DAYS OF SIMULATION) 2.773 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	7798.60	505.22	5175.74	26803.57	28111.40	40480.25	101485.21	249711.77
NON-GREEN PARTS	23879.60	3263.48	32578.74	90245.54	180498.44	548952.81	809696.79	2031803.19
TOTAL	31677.20	3768.70	37754.49	117139.11	208609.84	589433.05	911182.00	2281514.94
HERBACEOUS DICOTS								
GREEN PARTS	1095.10	113.50	1195.90	3790.09	4158.06	10450.37	18398.52	45937.27
NON-GREEN PARTS	3827.70	601.15	5739.14	11316.77	16163.11	40240.46	67720.34	172112.94
TOTAL	4922.80	714.65	6935.04	15106.85	20321.17	50690.83	86118.85	218050.17
MONOCOTYLEDONS								
GREEN PARTS	4351.75	363.29	3449.04	15027.95	17409.43	49682.61	82119.99	203695.89
NON-GREEN PARTS	46292.58	5851.75	43890.35	151748.98	297512.04	1157066.44	1605927.45	4012476.47
TOTAL	50644.32	6215.04	47339.38	166776.93	314921.47	1206749.05	1688047.44	4216172.31
MOSSES								
GREEN PARTS	2963.77	312.49	4850.46	10178.83	10308.11	57585.23	78072.17	196690.91
NON-GREEN PARTS	6539.66	531.83	7765.86	27225.34	27957.06	112809.20	163991.60	408794.89
TOTAL	9503.43	844.33	12616.32	37904.16	38265.18	170394.43	241563.77	605485.80
ALL SPECIES								
GREEN PARTS	16209.21	1294.50	14671.14	55890.43	59986.99	164198.46	280075.89	696035.80
NON-GREEN PARTS	80538.54	10248.21	89974.09	256536.62	522130.66	1859068.89	2646836.12	6625187.44
TOTAL	96747.76	11542.72	104645.23	312527.06	582117.65	2023267.34	2926912.03	7321223.12

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	12.775
HERBACEOUS DICOTS	5.158
MONOCOTYLEDONS	11.156
MOSSES	98.929
TOTAL	96.271

PERENNIALS 96.271 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
HERBACEOUS DICOTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY NON-GREEN DEAD	.24	.03	.33	.80	1.81	5.49	8.10	20.32
WOODY SOIL DEAD	.23	.03	.31	.78	1.71	5.22	7.69	19.30
HERBACEOUS SOIL DEAD	10.03	1.29	9.93	32.54	62.75	239.51	334.80	837.08
WOODY HERBACEOUS DEAD	317.75	19.07	213.54	1111.20	1165.43	6601.95	8878.58	22024.53
DICOT STANDING DEAD	68.48	7.17	78.03	243.30	286.69	2064.95	2594.94	6482.89
MONOCOT STANDING DEAD	1630.94	123.28	1293.13	5632.43	6287.58	48758.24	60678.25	151081.90
WOODY WOODY STD. DEAD	1265.10	116.35	1938.17	4352.10	2226.92	36907.49	43486.50	109207.01
MOSS DEAD	2491.02	290.62	3940.80	8563.11	12232.58	100091.54	120887.24	303374.52
LITTER ON SURFACE	19118.44	1390.48	15237.85	63992.64	95934.38	569644.64	731971.66	1822520.69
DEAD ROOTS 0-120MM	5074.08	727.22	5370.51	17442.59	22796.97	247735.20	287974.76	719771.02
DEAD ROOTS 12-350MM	597.81	87.40	637.47	2054.29	2203.31	23674.49	27932.10	69817.65
SUBSOIL DEAD ROOTS	233.97	27.61	253.45	803.25	587.91	4028.58	5419.74	13542.27
TOTAL	30808.09	2790.56	28973.53	106629.02	143788.04	1039757.27	1290174.33	3218699.09

SOIL VARIABLES

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	!!VAB.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 120. MM.	5005889.25	341471.23	4263180.19	17392778.25	4134709.97	85263542.00	105475300.00	213095060.00
FROM 120. TO 350. MM.	11871146.75	697117.70	8713671.87	40764884.50	2803967.47	174694310.00	218263160.00	436526320.00
TOTAL	16877036.00	1038588.94	12976852.00	57911462.50	6938677.44	259957852.00	324810688.00	649621376.00
IN MINERAL FRACTION								
FROM 0. TO 120. MM.	29698.37	6354.21	1423800.45					
FROM 120. TO 350. MM.	38144.13	3679.84	2008251.67					
TOTAL	67842.50	10034.05	3432052.12					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	16975686.50	1051413.55	16437877.62	58021791.50	7082465.44	260997608.00	326100860.00	652840072.00
TOTAL IN ECOSYSTEM	17072434.25	1062956.25	16542522.75	58342319.50	7664583.06	263020874.00	329027772.00	660161288.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	P + ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	3361850032.00	.00	18062.59	377.15	3206.43	-127052.91
BY RUN-OFF OR RUN-ON	-2543103288.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-579999984.00	.00	.00	.00	.00	.00
TOTAL	238743760.00	.00	18062.59	377.15	3206.43	-127052.91

SOIL WATER POTENTIAL, ATM.

FROM 0. TO 120. MM.	.00
FROM 120. TO 350. MM.	.00

FREE WATER DEPTH = 4.4 MM.

ACCUMULATED PRECIPITATION TO JULY 5 1973 INCLUSIVE IS 490.6 MM. - THAT IS 4906.0 TONS PER HECTARE .341 SECONDS ELAPSED

NORWEGIAN IBP- 1972 DATA FOR WET MEADOW SITE NOR3 --STIOSHIV.HARD.VIDDA,NORWAY

REPORT NO. 5 ON AUG 2 1973 (I.E., AFTER 365 DAYS OF SIMULATION) 1.408 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	9453.80	556.14	6282.23	26642.94	34121.11	56416.89	123180.95	303026.71
NON-GREEN PARTS	23879.09	3263.31	32581.37	90244.50	180524.60	549046.46	809815.55	2032102.72
TOTAL	33331.99	3819.45	38863.60	116887.44	214645.71	605463.34	932996.50	2335129.41
HERBACEOUS DICOTS								
GREEN PARTS	1384.36	125.87	1518.54	4812.59	5279.83	13269.70	23362.12	58305.89
NON-GREEN PARTS	3810.72	599.34	5727.79	11285.41	16122.73	40155.84	67563.99	171714.28
TOTAL	5201.08	725.20	7247.31	16098.00	21402.57	53425.54	90926.11	230020.17
MONOCOTYLEDONS								
GREEN PARTS	5281.54	415.03	4186.38	18240.66	21131.26	60303.86	99675.77	247215.95
NON-GREEN PARTS	46141.58	5832.46	43747.79	150956.76	296551.64	1153347.33	1600755.72	3999554.22

TOTAL	51423.12	6247.49	47934.17	1690797.42	3176827.89	1713651.19	1700431.48	4246770.12
MOSSES								
GREEN PARTS	3131.55	379.06	5119.13	107252.53	108908.84	60843.54	82486.91	207807.88
NON-GREEN PARTS	6530.72	531.10	7755.23	226794.24	27918.91	112654.84	163267.89	408235.51
TOTAL	9662.27	860.17	12874.36	334046.77	38809.65	173498.38	245754.80	616043.38
ALL SPECIES								
GREEN PARTS	19251.34	1426.10	17105.27	664848.72	71427.04	190833.99	328705.75	816356.42
NON-GREEN PARTS	80367.11	10226.21	89808.17	2650880.91	521117.77	1855204.45	2641403.03	6611606.69
TOTAL	99618.46	11652.31	106914.44	3315729.63	592540.81	2046038.44	2970108.84	7427963.06

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	14.835
HERBACEOUS DICOTS	6.297
MONOCOTYLEDONS	13.026
MOSSES	95.718
TOTAL	97.028

PERENNIALS 97.028 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
HERBACEOUS DICOTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY NON-GREEN DEAD	.24	.03	.33	.80	1.81	5.49	8.10	20.32
WOODY SOIL DEAD	.23	.03	.31	.76	1.71	5.22	7.69	19.30
HERBACEOUS SOIL DEAD	5.00	.64	4.95	16.22	31.27	119.36	166.84	417.16
WOODY HERBACEOUS DEAD	1188.23	72.58	791.30	4113.06	4302.71	11177.04	19592.81	48360.60
DICOT STANDING DEAD	203.11	20.12	225.31	710.15	798.33	3313.69	4822.17	12042.36
MONOCOT STANDING DEAD	2116.67	162.70	1678.11	7309.90	8237.43	53471.41	69018.74	171752.91
WOODY WOODY STD. DEAD	1288.98	118.74	1973.89	4434.47	2329.42	37282.95	44046.84	110616.32
MOSS DEAD	2491.36	230.67	3941.26	8564.23	12235.11	100099.23	120898.57	303402.95
LITTER ON SURFACE	19269.64	1400.84	15352.82	66916.59	96483.99	572497.04	735887.61	1832246.55
DEAD ROOTS 0-120MM	5237.45	708.30	5534.42	17973.46	23826.86	251632.80	293433.12	733420.23
DEAD ROOTS 12-350MM	612.33	89.28	652.04	2101.48	2294.86	24020.95	28417.29	71030.91
SUBSOIL DEAD ROOTS	237.60	28.08	257.10	815.05	610.79	4115.20	5541.04	13845.59
TOTAL	32650.84	2931.98	30411.83	112956.17	151154.29	1057730.34	1321840.80	3297175.12

SOIL VARIABLES

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DOJ78.D.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 120. MM.	5005889.25	341471.23	4263180.19	17149278.25	4134709.97	85263542.00	105475730.00	213095060.00
FROM 120. TO 350. MM.	11871146.75	697117.70	8713671.87	40764884.50	2803967.47	174694310.00	218263160.00	436526320.00
TOTAL	16877036.00	1038588.94	12976852.00	57914162.50	6938677.44	259957852.00	324810688.00	649621376.00
IN MINERAL FRACTION								
FROM 0. TO 120. MM.	27857.62	6501.02	1424879.11					
FROM 120. TO 350. MM.	35499.12	3589.35	2006083.41					
TOTAL	63356.74	10090.36	3430957.50					
TOTAL, SOIL AND DEAD								
ORGANIC MATERIAL	16973043.25	1051611.27	16438221.25	58027118.50	7089831.69	261015582.00	326132528.00	652918544.00
TOTAL IN ECOSYSTEM	17072661.50	1063263.56	16545135.62	58358648.00	7682372.50	263061620.00	329102636.00	660346504.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	P + ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	3858482112.00	.00	18290.28	684.47	5819.17	-52189.68
BY RUN-OFF OR RUN-ON	-2925473664.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-719999984.00	.00	.00	.00	.00	.00
TOTAL	213008464.00	.00	18290.28	684.47	5819.17	-52189.68

SOIL WATER POTENTIAL, ATM.

FROM 0. TO 120. MM.	.00
FROM 120. TO 350. MM.	.00

FREE WATER DEPTH = 1.8 MM.

ACCUMULATED PRECIPITATION TO AUG 2 1973 INCLUSIVE IS 592.2 MM. - THAT IS 5922.0 TONS PER HECTARE .341 SECONDS ELAPSED

NORWEGIAN IBP- 1972 DATA FOR WET MEADOW SITE NOR3 --STIGSHIV.HARD.VIDDA,NORWAY

REPORT NO. 6 ON AUG 26 1973 (I.E., AFTER 389 DAYS OF SIMULATION) 1.173 SECONDS ELAPSED

CONSTITUENTS OF VEGETATIONAL BIOMASS, G. OR KCAL. PER HECTARE

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS								
GREEN PARTS	12391.29	684.60	8581.23	44588.73	46607.34	77062.81	168259.38	413822.90
NON-GREEN PARTS	23883.68	3263.89	32595.11	102684.55	180622.03	549368.62	810255.20	2033208.72
TOTAL	36774.98	3948.49	41176.33	124853.28	227229.87	626431.43	978514.58	2447031.59
HERBACEOUS DICOTS								
GREEN PARTS	2004.50	158.34	2210.92	7006.91	7687.19	19320.04	34014.14	84855.22
NON-GREEN PARTS	3811.40	598.34	5719.04	11272.05	16112.17	40160.37	67544.58	171662.47
TOTAL	5815.90	757.29	7928.96	18278.95	23799.36	59480.41	101558.72	256517.69
MONOCOTYLEDONS								
GREEN PARTS	7217.17	533.22	5718.40	24915.88	28864.70	82372.22	136152.41	337650.49
NON-GREEN PARTS	46049.25	5819.54	43674.71	150534.60	295931.49	1150964.97	1597431.06	3991246.62
TOTAL	53265.42	6352.77	49393.11	175450.48	324795.79	1233337.19	1733583.47	4328897.00
MOSSES								
GREEN PARTS	3313.34	347.06	5410.29	11374.17	11522.24	64373.95	87270.36	219853.37
NON-GREEN PARTS	5523.10	530.48	7746.19	22667.78	27886.25	112523.46	163077.49	407759.45
TOTAL	9836.44	877.54	13156.48	34041.95	39408.49	176897.42	250347.85	627612.82
ALL SPECIES								
GREEN PARTS	25422.31	1727.82	21920.83	87985.69	94681.57	243129.03	425596.27	1056181.98
NON-GREEN PARTS	80260.48	10212.26	89714.05	264738.97	520551.94	1853017.41	2638308.25	6603877.25
TOTAL	105682.90	11939.09	111634.88	352624.66	615233.50	2096146.42	3064004.59	7660059.12

GROUND COVER BY DIFFERENT PLANT SPECIES, PER CENT.

WOODY PLANTS	12.781
HERBACEOUS DICOTS	9.087
MONOCOTYLEDONS	17.433
MOSSES	96.446
TOTAL	97.860

PERENNIALS 97.860 ANNUALS .000

CONSTITUENTS OF SHED SEEDS

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY PLANTS	.00	.00	.00	.00	.00	.00	.00	.00
HERBACEOUS DICOTS	.00	.00	.00	.00	.00	.00	.00	.00
MONOCOTYLEDONS	.00	.00	.00	.00	.00	.00	.00	.00
MOSSES	.00	.00	.00	.00	.00	.00	.00	.00
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00

CONSTITUENTS OF DEAD ORGANIC MATERIAL, G. OR KCAL. PER HECTARE

TYPE OF MATERIAL	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	DRY MATTER
WOODY NON-GREEN DEAD	.24	.03	.33	.80	1.81	5.49	8.10	20.33
WOODY SOIL DEAD	.23	.03	.31	.76	1.72	5.22	7.70	19.31
HERBACEOUS SOIL DEAD	4.99	.64	4.94	16.18	31.21	119.12	166.51	416.32
WOODY HERBACEOUS DEAD	2238.70	129.31	1487.42	7729.94	8082.85	16803.91	32616.60	80368.45
DICOT STANDING DEAD	393.97	35.96	435.39	1376.13	1528.15	5092.63	7996.90	19963.09
MONOCOT STANDING DEAD	2763.99	211.56	2191.26	9545.81	10837.44	59623.98	80007.23	198380.11
WOODY WOODY STD. DEAD	1312.78	121.15	2010.00	4516.41	2430.39	37659.69	44606.49	112024.48
MOSS DEAD	1680.45	196.06	2658.38	5776.67	8253.37	85593.86	99627.90	249839.80
LITTER ON SURFACE	9364.02	605.59	6642.27	32054.22	69249.20	457433.73	555737.15	1386073.50
DEAD ROOTS 0-120MM	3275.78	466.83	3457.16	11225.82	19476.15	230750.61	261452.58	653534.44
DEAD ROOTS 12-350MM	622.35	90.57	667.13	2134.05	2358.13	24259.92	28752.10	71868.17
SUBSOIL DEAD ROOTS	240.10	28.40	259.62	823.19	626.61	4174.94	5624.74	14059.90
TOTAL	20897.59	1886.14	19809.20	72199.99	122877.01	921522.98	1116599.97	2791162.84

SOIL VARIABLES

	NITROGEN	P + ANIONS	CATIONS	PROTEIN C	RESERVE C	OTHER C	TOTAL C	*10**6.0.M.
ORGANIC MATTER CONSTITUENTS								
FROM 0. TO 120. MM.	5012304.19	341886.27	4265706.12	17250568.00	4147704.66	95709413.00	106592185.00	213184370.00
FROM 120. TO 350. MM.	11871146.75	697117.70	8713671.87	40364884.50	2803967.47	174694310.00	218263160.00	436526320.00
TOTAL	16883450.75	1039003.98	12979378.00	57899952.50	6951672.12	260003722.00	324855344.00	649710688.00
IN MINERAL FRACTION								
FROM 0. TO 120. MM.	34349.55	7130.92	1033058.97					
FROM 120. TO 350. MM.	30916.32	3417.49	2002198.80					
TOTAL	65265.87	10548.42	3435257.75					
TOTAL, SOIL AND DEAD ORGANIC MATERIAL	16969614.00	1051438.52	16434444.87	57921552.00	7074549.12	260925244.00	325971940.00	652497848.00
TOTAL IN ECOSYSTEM	17075296.75	1063374.59	16546073.75	58324776.50	7649782.62	263021390.00	329035944.00	660157904.00

ACCUMULATED NET GAIN OR LOSS TO ECOSYSTEM

	WATER	MINERAL SOIL	NITROGEN	P + ANIONS	CATIONS	TOTAL C
TO OR FROM ATMOSPHERE	3726625728.00	.00	20925.99	795.54	6763.44	-118868.90
BY RUN-OFF OR RUN-ON	-2925473664.00	.00	.00	.00	.00	.00
TO OR FROM SUBSOIL	-839999984.00	.00	.00	.00	.00	.00
TOTAL	-38847920.00	.00	20925.99	795.54	6763.44	-118868.90

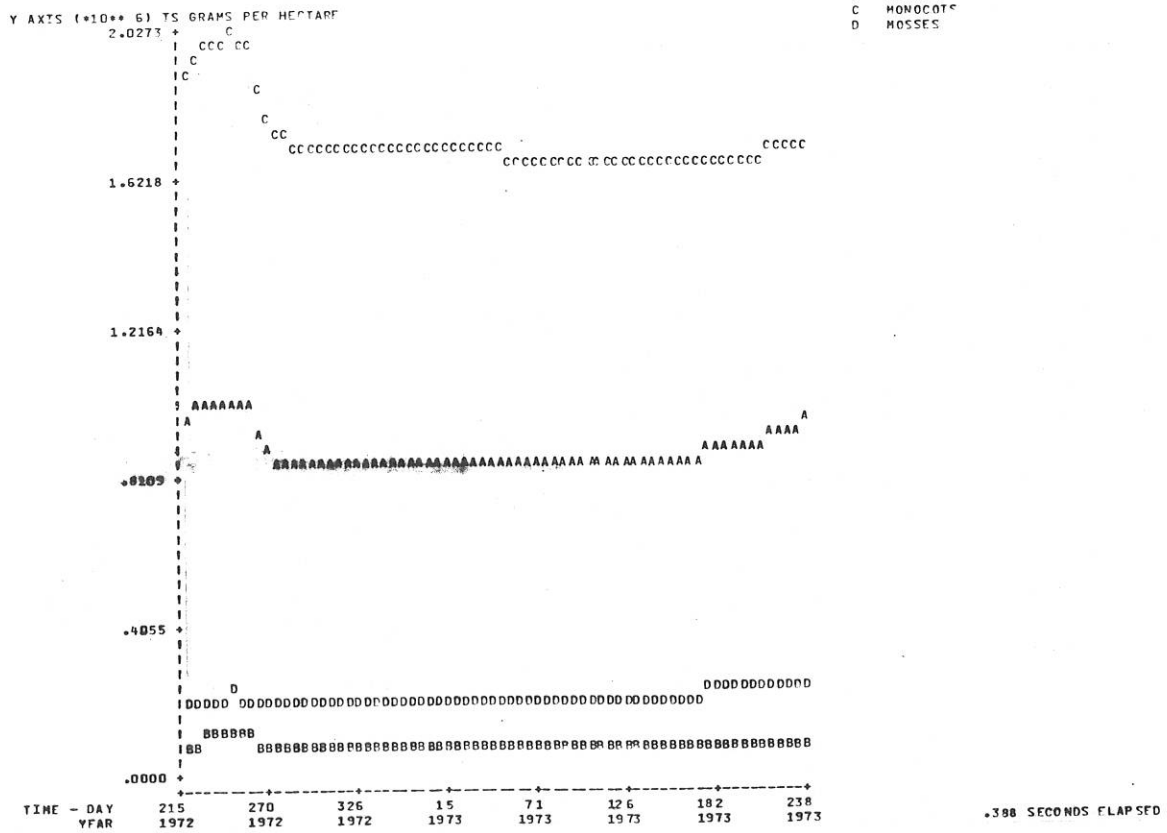
SOIL WATER POTENTIAL, ATM.

FROM 0. TO 120. MM.	-.05
FROM 120. TO 350. MM.	.00

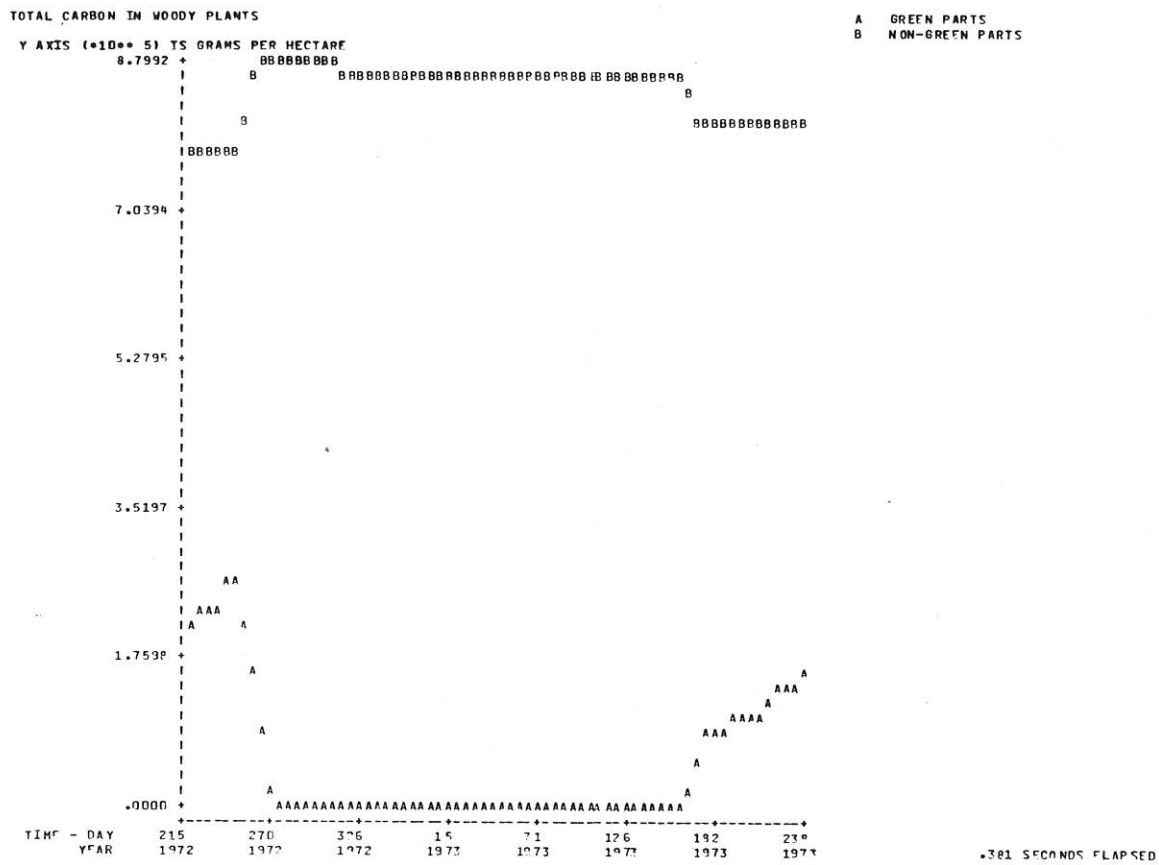
ACCUMULATED PRECIPITATION TO AUG 26 1973 INCLUSIVE IS 629.1 MM. - THAT IS 6291.0 TONS PER HECTARE .337 SECONDS ELAPSED

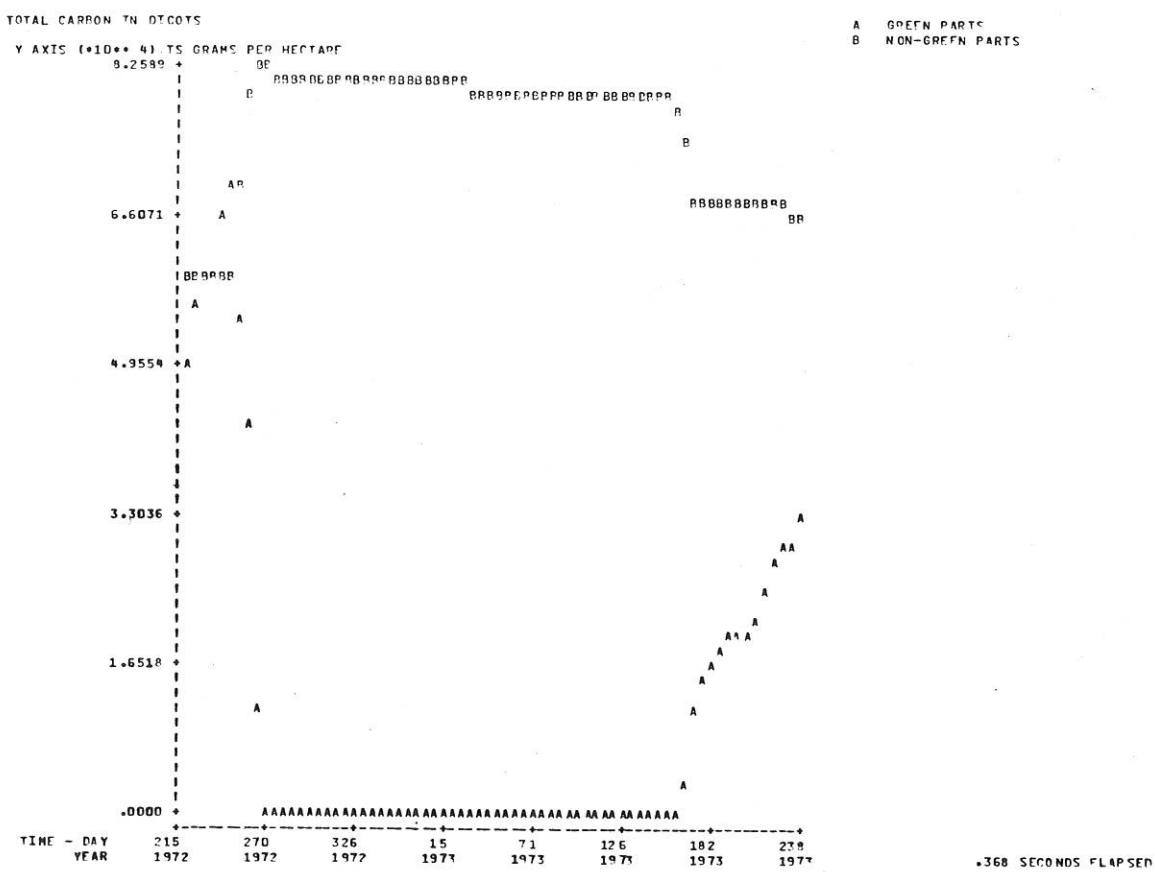
TOTAL CARBON IN PLANTS

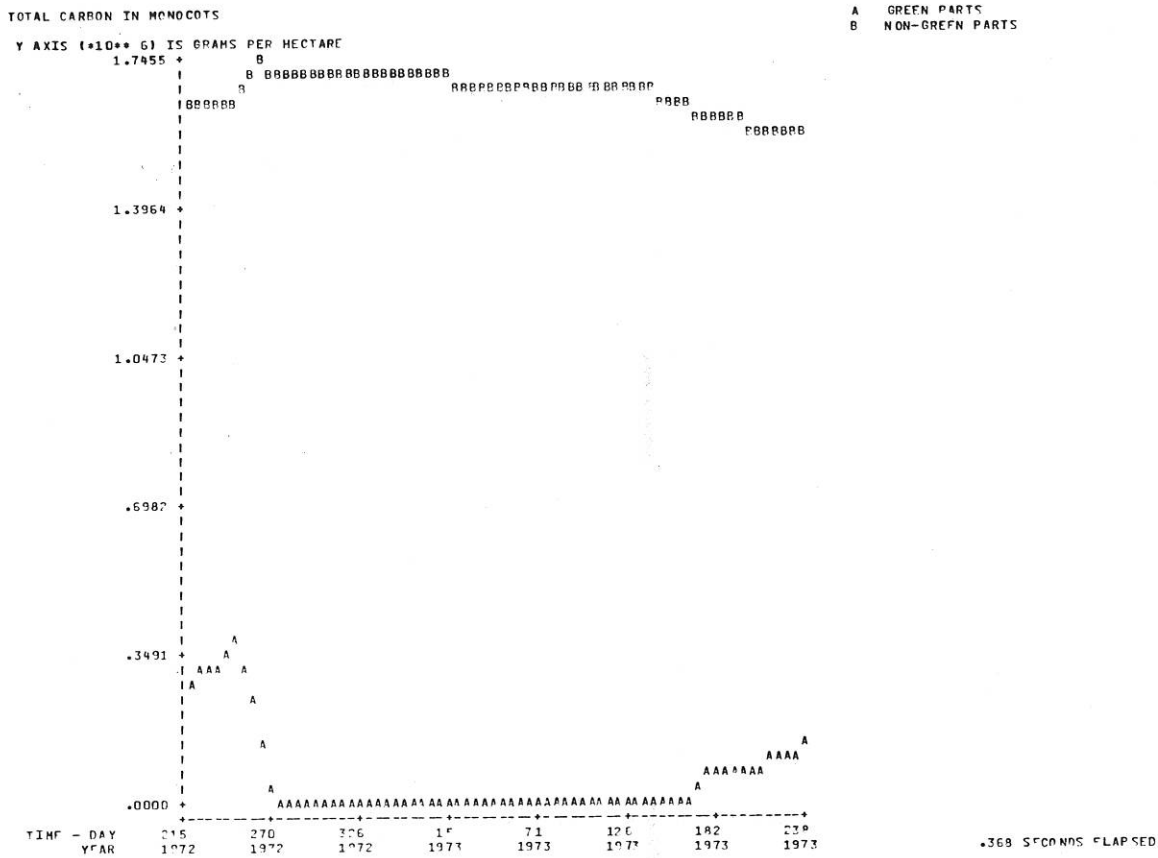
A WOODY PLANTS
B DICOTS
C MONOCOTS
D MOSSES

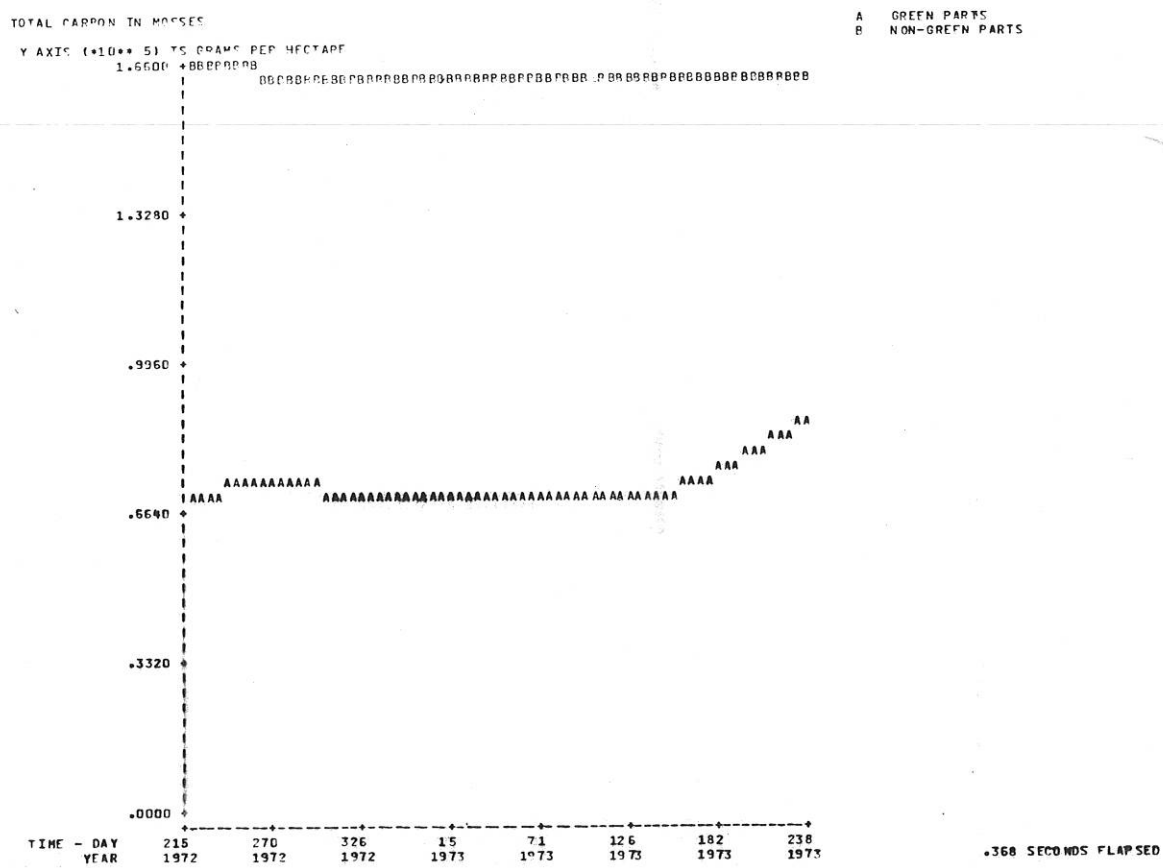


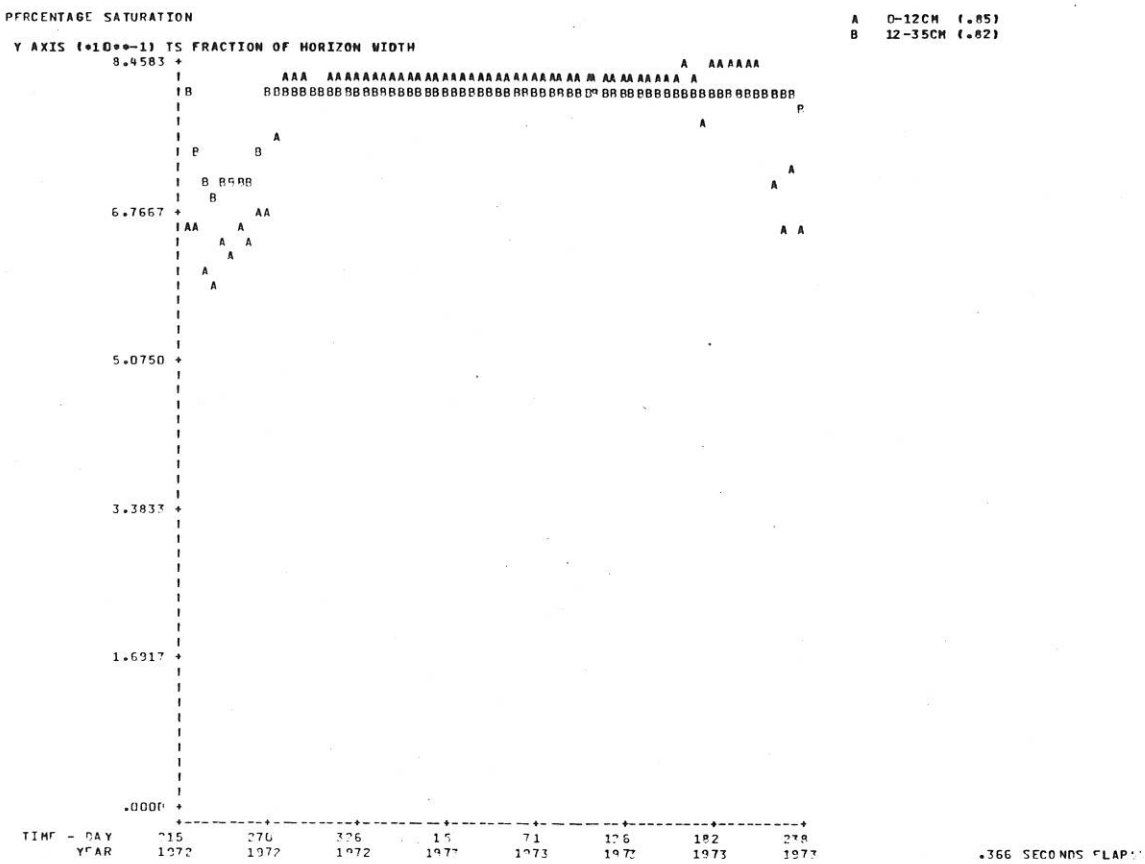
.388 SECONDS ELAPSED

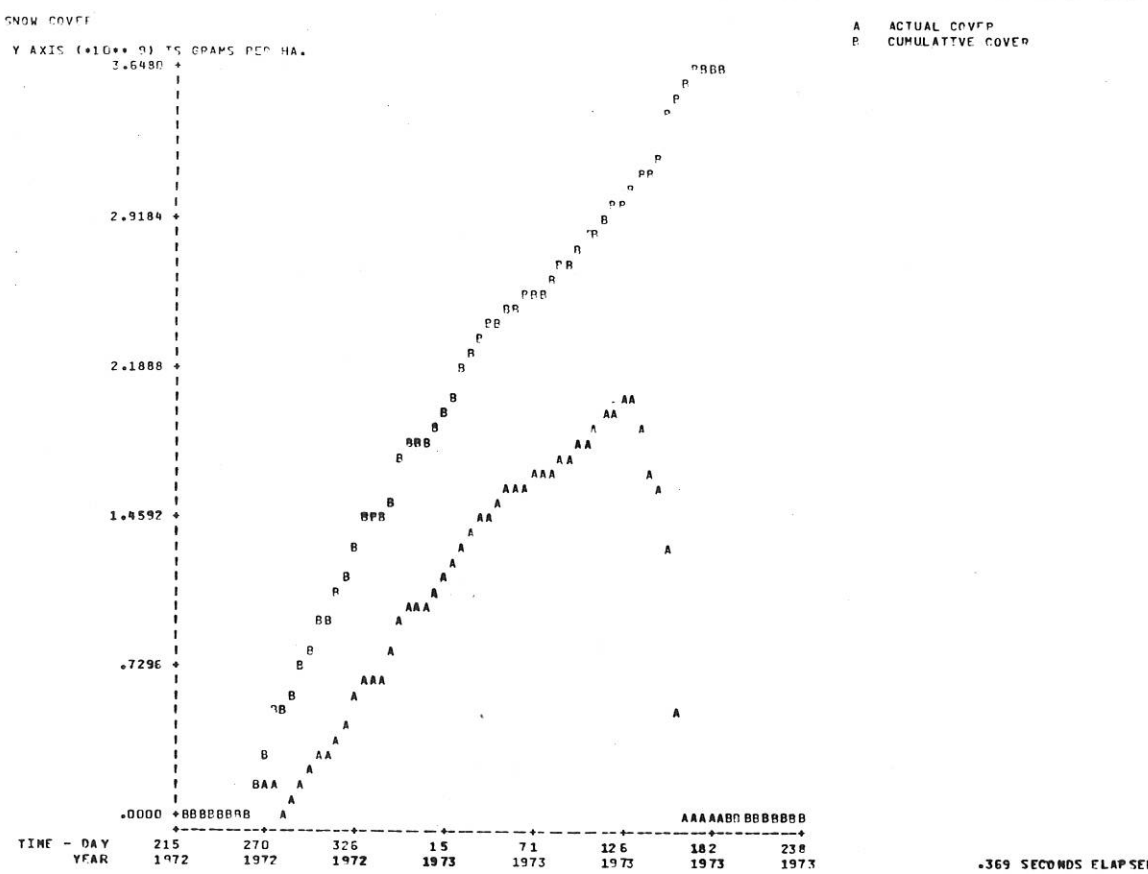

TOTAL CARBON IN WOODY PLANTS
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 5) TS GRAMS PER HECTARE
8.7992
7.0394
5.2795
3.5197
1.7598
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.381 SECONDS ELAPSED

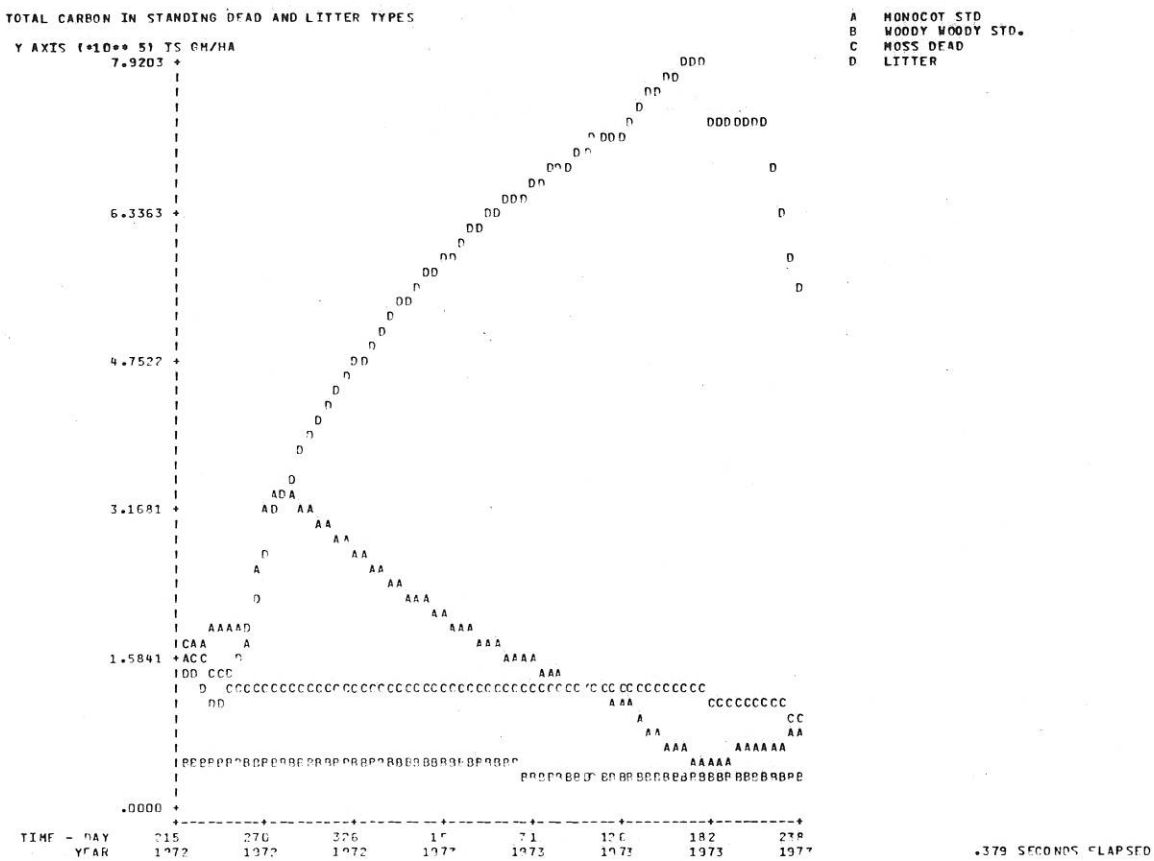

TOTAL CARBON IN DICOTS
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 4) TS GRAMS PER HECTARE
8.2589
6.6071
4.9554
3.3036
1.6518
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.368 SECONDS ELAPSED

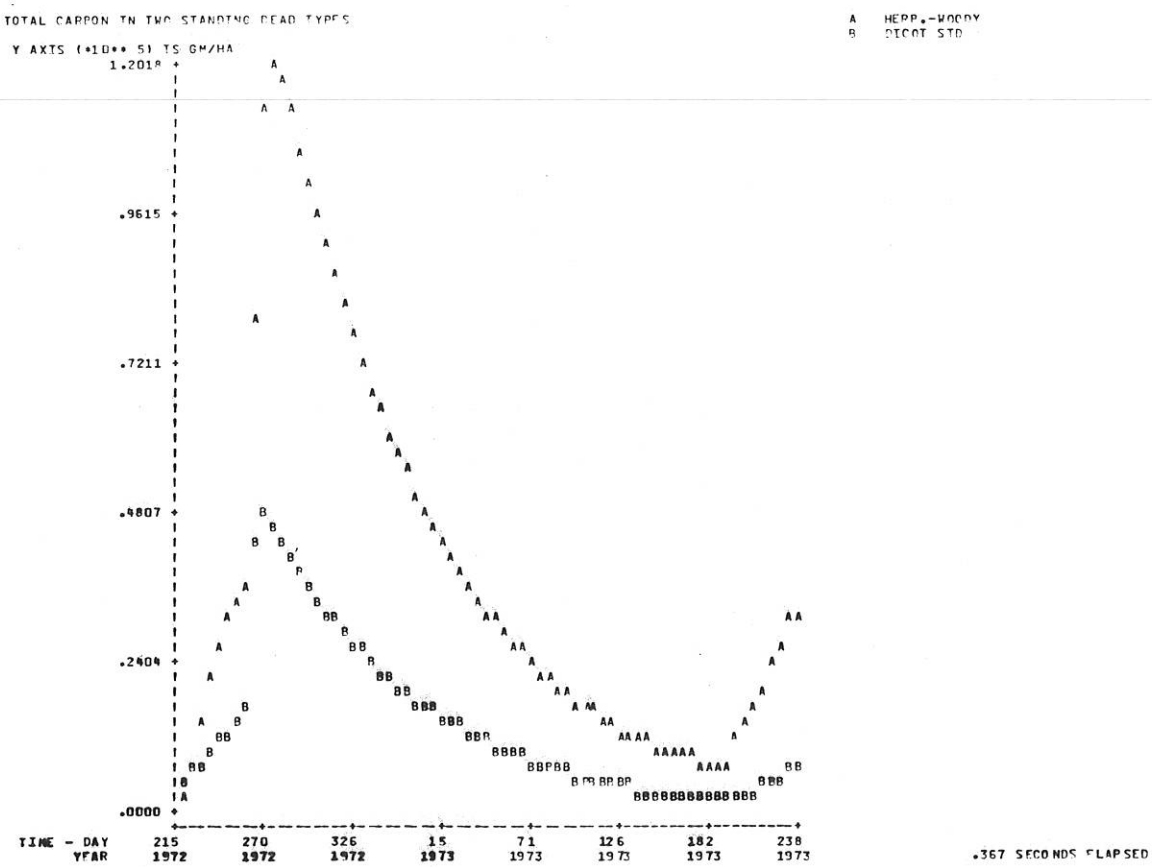

TOTAL CARBON IN MONOCOTS
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 6) IS GRAMS PER HECTARE
1.7455
1.3964
1.0473
.6982
.3491
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.368 SECONDS ELAPSED


TOTAL CARBON IN MOOSES
A GREEN PARTS
B NON-GREEN PARTS
Y AXIS (*10** 5) IS GRAMS PER HECTARE
1.6600
1.3280
.9960
.6640
.3320
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.368 SECONDS ELAPSED


PERCENTAGE SATURATION
Y AXIS (*10**-1) TS FRACTION OF HORIZON WIDTH
A 0-12CM (.85)
B 12-35CM (.82)
8.4583
6.7667
5.0750
3.3833
1.6917
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.366 SECONDS ELAPSED


SNOW COVER
Y AXIS (*10** 9) TS GRAMS PER HA.
A ACTUAL COVER
B CUMULATIVE COVER
3.6480
2.9184
2.1888
1.4592
.7296
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.369 SECONDS ELAPSED


TOTAL CARBON IN STANDING DEAD AND LITTER TYPES
A MONOCOT STD
B WOODY WOODY STD.
C MOSS DEAD
D LITTER
Y AXIS (*10** 5) TS GM/HA
7.9203
6.3363
4.7522
3.1681
1.5841
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.379 SECONDS ELAPSED


TOTAL CARBON IN TWO STANDING DEAD TYPES
A HERB.-WOODY
B DICOT STD
Y AXIS (*10** 5) TS GM/HA
1.2018
.9615
.7211
.4807
.2404
.0000
TIME - DAY 215 270 326 15 71 126 182 238
YEAR 1972 1972 1972 1973 1973 1973 1973 1973
.367 SECONDS ELAPSED