NATIONAL ENERGY AUTHORITY

A SUMMARY OF DISCUSSIONS ON A SIMULATION MODEL FOR THE THJORSARVER AREA AND PROBLEMS CONNECTED WITH IT

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INTRODUCTION

On Oct. 31st and Nov. 1st 1974, Dr. G.M. Van Dyne led a discussion, aimed at clarifying some problems connected with the development of simulation model for the Þjórsárver area. Participants were engineers, a geologist and biologists. The discussion concerned the following subjects:

1. Status of reports/publication/data.

2. Spatial problems.

3. Recording of time cycles.

4. Behavioral impact.

5. Listing or cross listing of conservation / energy needs / benefit.

6. Description of the animal processes for modelling.

1. Status of reports / publication / data.

A	The pink footed goose. Breeding behaviour 1972	in report.
	Recruitment 1971-1974	evaluated data.
	Social behaviour 1973	not available.
	Chronology of events 1971-74	parts in report
	Protein polymorphism 1972,	data available
	Food 1971-72,	in reports
	Predation 1972	in reports.
B	Other terrestial fauna.	
	Vertebrates, general observations 1971-74	report in winter.
	Terrestial invertebrates 1972-73	report in winter
C	Limnological work 1974.	
	Physical and chemical characteristics of freshwater bodies.	
	Flora and fauna.	
	Life history observations	report 1975?
D	Botanical work 1970-72	
	Flora	in reports
	Distribution of plants	in reports
	Phytosociology	in reports
E	Ecosystem studies	
	Vascular plant production 1972-74	in reports and available data
	Grazing, direct 1972 and ´74	" " "
	Grazing, indirect 1971-1974	" " "
	Decomposition rates 1972,	preliminary
	Vegetation mapping 1974	just started
F	Other work	
	Weather data 1971-74	available
	Polynology 1971	in report
	Distribution of palsas	in report

Data on waterlevels and duration of different waterlevels in Isle lake storage (Gunnar Sigurðsson 1972) and Aðgerðarrannsóknir á nýtingu vatnsorku í Efri-Þjórsá, Hvítá og Skaftá (Helgi Sigvaldason 1971).

2. Spatial problems.

Determine area, location, size:

1. Mapping of vegetation, plant categories - feeding areas.
   " " nesting areas: qualities.
   " " waterlevels.
   " " palsa areas.

The vegetation is divided into five mean categories. What effect will different water levels have on respective vegetation groups?

1. A part is spoiled.
2. An area close to the reservoir is changed by means of fluctuating (or permanent) water level and changed groundwater.

The feeding behaviour of the geese is different in different seasons. Raising of water level can possibly eliminate the vegetation selectively, in such a way that vegetation groups primarily eaten in the spring or summer respectively are eliminated.

Table 1 shows the approximate standing crop for five main vegetation groups in different communities and the season when they are grazed

	palatability categories g/m^2					
Vegetation map units	pal	med herbs	med shrubs	unpal herbs*	unpal shrubs	season of use
A	+	+	3	50	5	spring
B-L	+	10	20	40	10	-
T+U		30	2	40	0	summer
V	+	50	0	30	0	-

* mainly moss

see vegetation map "Isle lake storage".

Problems due to fluctuating waterlevel: The time of highest waterlevel depends on climatic factors.

1. In cool and dry spring, the reservoir gets up to highest level later.
2. In warm and wet spring this happens earlier (fig. 1).

Waterlevel-wind-erosion: The time of snow cover and high waterlevel limit the wind erosion.

The span of time between snow cover and highest waterlevel is about 2 months.

The erosion will depend on

1. Probability of occurrence of intense wind ≥ 12 m S^{-1}.
2. Silt particle size of the bare areas and quantity of transportable material.
3. Draining (rain and natural groundwater).

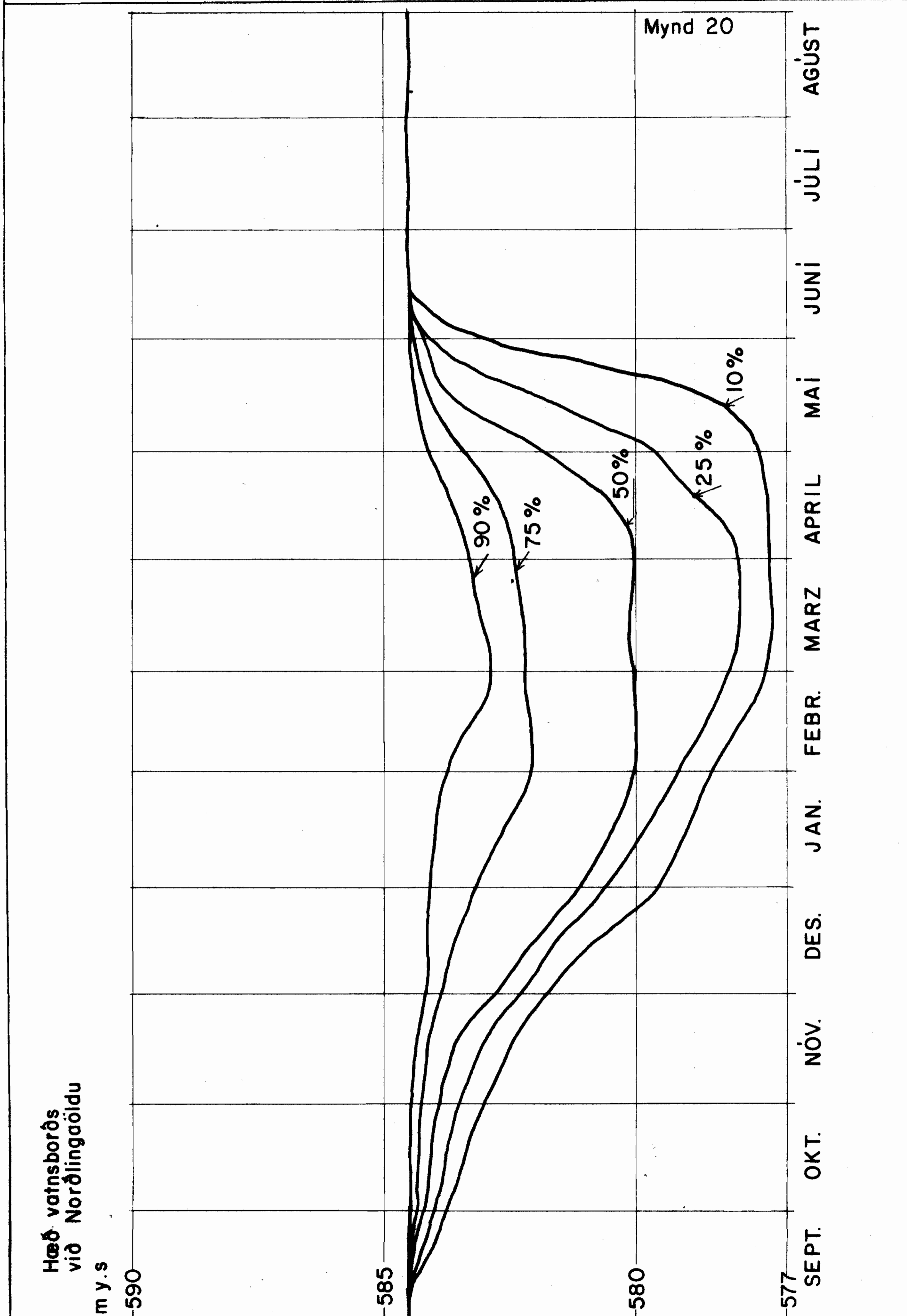
At the two highest proposed waterlevels, the draw down area is going to be very extensive, as shown in "Isle lake storage", exhibit 5,1, and the most likely times of different waterlevels are shown in "Aðgerðarrannsóknir" (figure (mynd) 20 and 21).

ORKUSTOFNUN

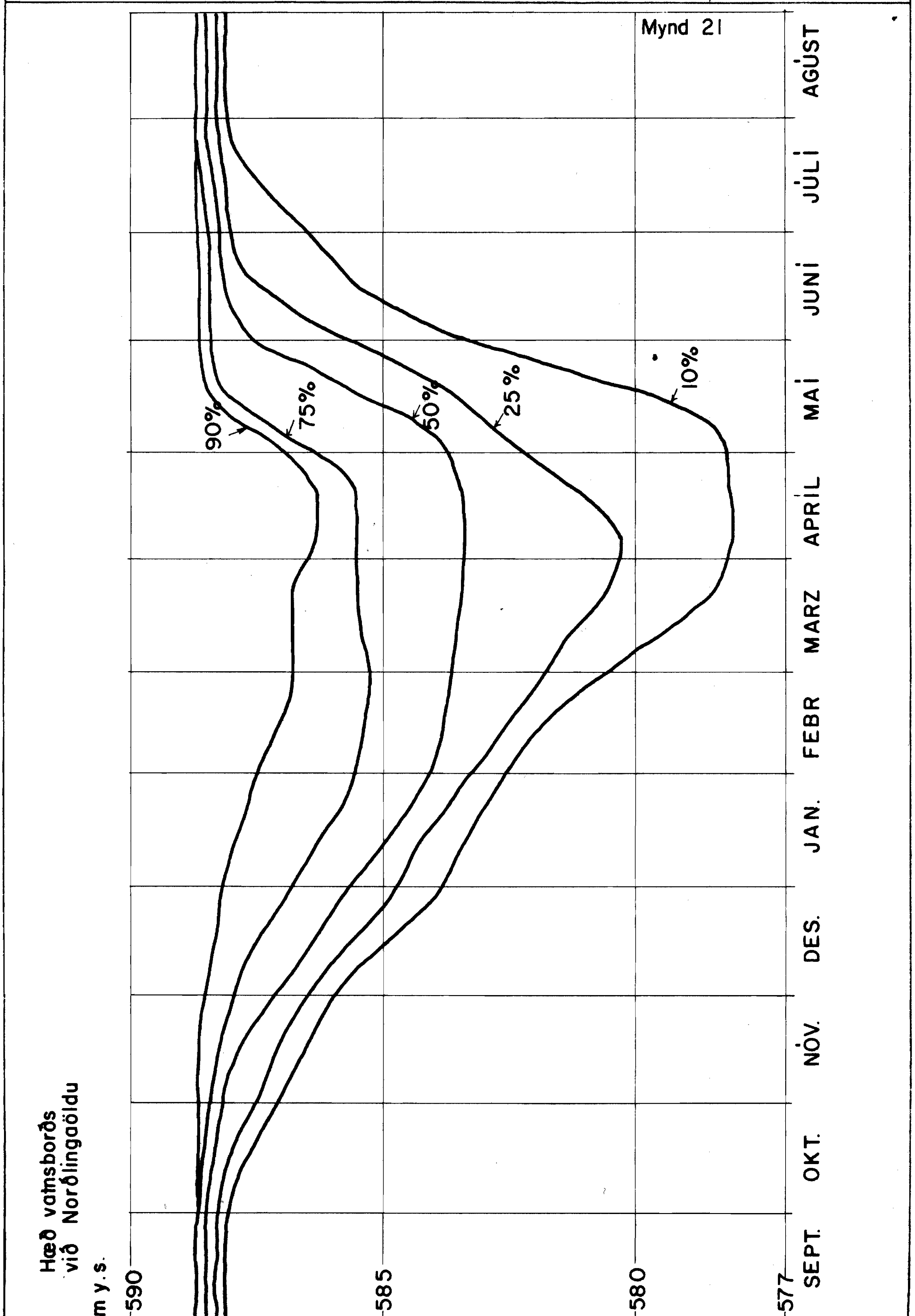
Helgi Sigvaldason
Gunnar Ámundason

Dreifing vatnshæðar í 500 GL lóni við Norðlingaöldu með lægsta vatnsborði 577 m y.s.

27.5'71 G.Á/O
Tnr. 230
B-ým
Fnr. 9870

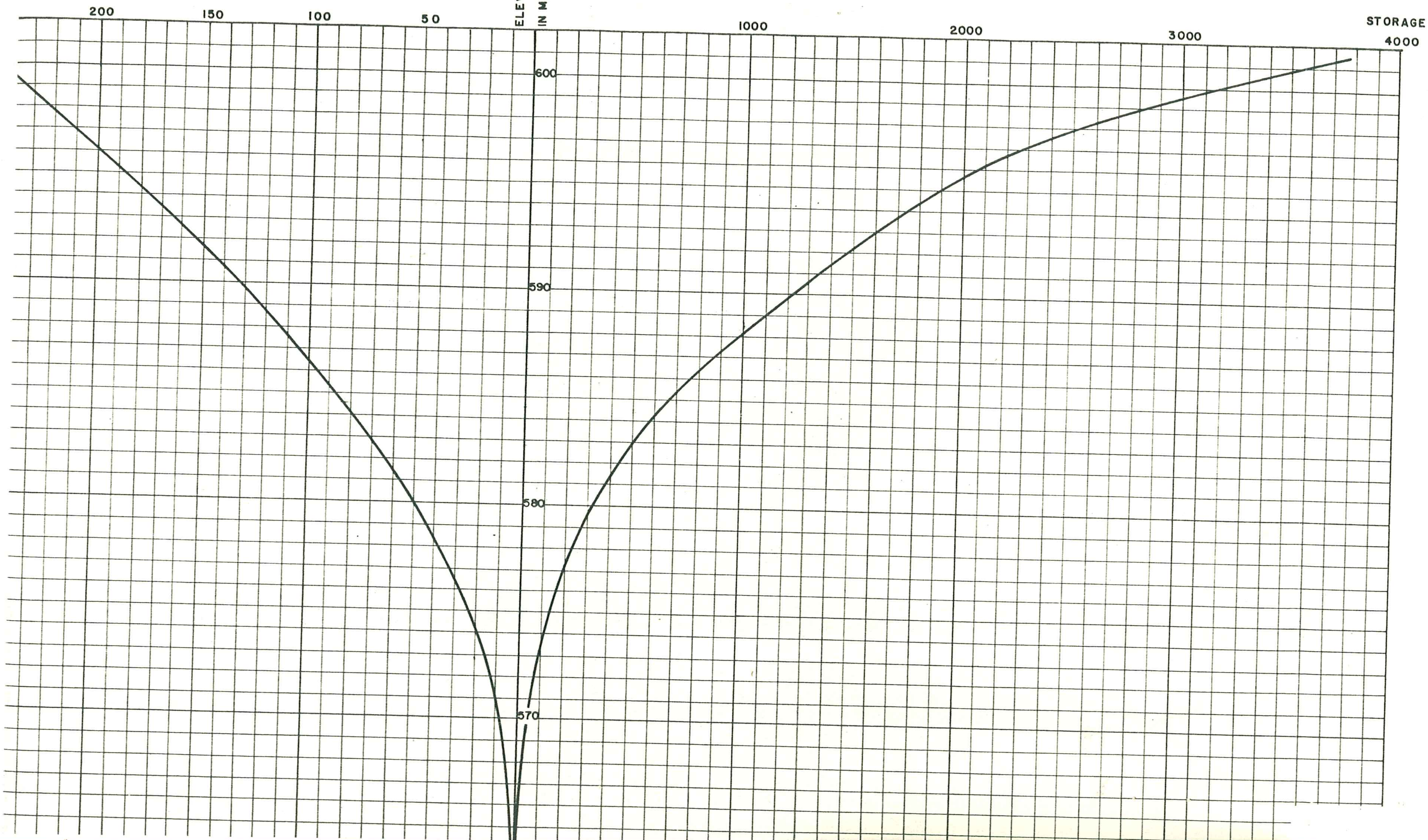


ORKUSTOFNUN Helgi Sigvaldason Gunnar Ámundason	Dreifing vatnshæðar í 1000 GL lóni við Norðlingaöldu með lægsta vatnsborði 577 m y.s.	27.5.'71 G.Á/Ó Tnr. 229 B-ým Fnr. 9869



...VOIR CHARACTERISTICS

Area in Km²

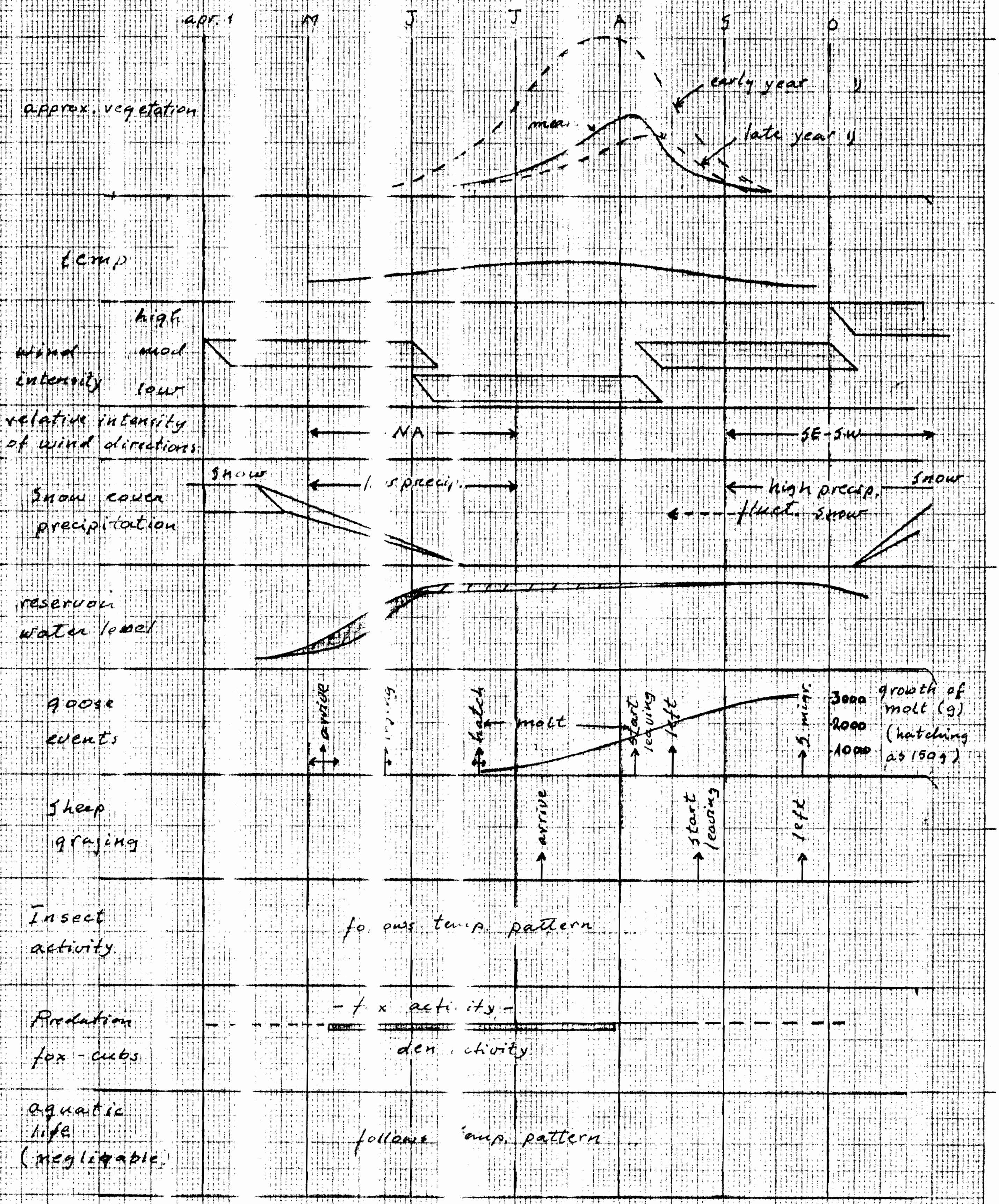


EX

ORKUSTOFNUN

3. Record time cycles (approximated)

Fig. 1.



1) Early year is due to high temp in spring and early summer

late " low " " " "

4. Behavioral impact

The effect of raised waterlevel on the p.f. geese.

1a Lake impact on the goose-return (nesting area): Increased pressure (competition) from nonbreeding, which use to concentrate around lakes (decreased food supply to breeders).

1b Lake impact on the palsas is connected to the groundwaterflow. It is a possibility that palsa and nesting would increase on the lake site in the long term, resulting in increased density of breeding population?

2. Minimum viable nesting population:

Possible minimum acceptable population size?
Rare population about 10.000 ind. The population outside Þjórsárver is about 24.000 (in Iceland and Greenland), or about the same as the Spitzbergen population. About 2/3 of the Iceland-Greenland population breeds and is produced in Þjórsárver, where 20.000 ind. are breeding (about two times the min. pop.).
Many species need a flock.
In graph 1 the hatching success is related to density of nests (this figure is somewhat modified compared with those drawn under the discussion).
When the density of the population in Þjórsárver is high, the production may become higher in areas outside Þjórsárver.

Genetic subpopulations: The oldest and best nesting sites are usually occupied (by the same pairs) year after year. There are some possibilities of genetic selection so that the breeding population in those areas is different from that of the other areas, - more effective? Research on protein polymorphism can possibly give an answer to the question of sub-populations in this case. What is going to happen to this "subpopulation" after raising of water level?

3. Can the geese adapt to improved nesting conditions?
Nesting mound/platform.
Possibilities to build such an artificial habitat are best in areas with some population of p.f. goose.
It will probably be most simply done by bulldosers. Results available after $\geq$ 4 years, this can probably be connected with fertilizing experiments.
This experiment cannot be performed in Thjórsárver.

Question: Will they nest there? Will they produce?
If they nest, they will most probably produce there.

Increased food supply:

a. Reducing competition.
b. Fertilizing - difficult to get mix of nutrients fitting to the species preferred by the goose.
It can be difficult to fertilize that kind of wet-land-ecosystem, because the nutrients may be drained in the groundwater.

4. Potential human impact on nesting causes decreased nesting success (controlled factor).

The area can be divided into subareas to study the dispersal of p.f. goose. The area should be subdivided by means of quality for feeding and/or nesting. The nesting is most highly concentrated in palsas, where the snow disappears first.

5. Listing or cross listing of conservation/energy need/benefit. In the following list, some possibilities of conservation strains and connected management are discussed.

Relative to world

Relative to other Icelandic areas

Conservation strains	Engine strains and management
In case of	
unique landscape (>560 m)	No kind of management can be allowed
" unique system ($\geq$ 581 m)	erosion prevention, human control, sheep control
	Cost: actual + marginal power out put, firm + secondary power out put
" maintain a viable p.f. goose population in Þjórsárver	nesting mounds/platform
	$\geq$ 10.000 birds in pop. - International aspects (IUCN) and agreement
in others	Possibilities that lower areas involved in the migration of the p.f. geese, become reservoir
" geology-palsa	
relict tall herb community.	
highland spring areas	
" marsh "	

need surveys

of listing areas of

conservation interest.

An area including many sorts of communities and conservation interests is more valuable than several areas with one type of conservation interest.

Discussion of some of the involved interest.

International aspects: "The area is regarded of international importance as a major production area of the Iceland-Greenland population of the p.f. goose, accounting for some 2/3 of the production of this population ..." (Garðarsson, A brief outline of the present position ... p. 2). We may need bilateral agreement and international goodwill in the case we want to protect some species/population of special interest for us. International collaboration is based on both giving and accepting.

Approximate effect of reservoir elevation on no. of nest sites and vegetation. Base nos. of nests varied from 8.000-11.000 in four years (1970-74). Two estimates are available on the distribution of nests in the area, and are shown in table 2, which shows the approx. no. of nests and percent vegetation inundated

		Total no. of nests within area above	No. of nests below respective water levels, or no. of nests lost		
Water levels		560 m	581.1 m	589.2 m	593.2 m
No. of nests	est.1 Gunnar	10700	900	6300	7900
	est.2 Arnþór	8000-11000	2400	6400-8400	7400-9400
Percent of vegetation (total) inundated			15	60	75

Energy interests: Firm + secondary output

Firm output: depends on the actual management and cold and dry years.

Secondary output: potential left + warm and wet years.

For regulating purposes there is need for a large reservoir in the river system. The most economic one is in Þjórsárver-area. Another possibility is to increase the capacity of Þórisvatn. The capacity of the alternative reservoir waterlevels in Þjórsárver

	capacity
581,1 m	4210 GWh
589,2 "	6140 "
594,3 "	8150 "

In "Isle Lake Storage" table 1,5 (page 1.19) "cost benefit computations" for these reservoir elevations are to be found and in chapter 1 (p. 1-20) a summary of engineering and benefit aspects is available.

The possibility to elevate the reservoir in steps was discussed. That would clarify many problems, like erosion, behavioral problems caused by nest-site elimination etc. Cost of further dambuilding will be higher, perhaps about 10%, but the problems of such a procedure are primarily due to uneconomic power plants downstream.

Simulation model.

A short review and discussion of the simulation model evaluated in 1973, and shown in "Discussion of a simulation model for the Þjórsárver area (Hannesdóttir, 1973).

Discussion on some further factors affecting:
Inflow Goslings IGI (s. 5 in Model disc.op.cit.)
no. of eggs laid estimated to 4.58/pair, hatching success estimated to 2.50/pair, hatching success affected by subpopulations

as non-breeders which possibly can increase in importance with higher waterlevels, as a result of increased no. of IG2 around the reservoir.
Hatching can be affected by predators (skua and fox). Predators take about 0.36 eggs per nest. The predation is not necessarily directly proportional to the amount of predators. The loss may as well be related to the success of predators, so the loss to predators may increase in bad weather conditions because of increased disturbance.

The availability of eggs depends on the time females are away from nests which is affected by cold weather resulting in decreased food supply.

The loss caused by cold weather may be as shown in graph 2. The egg loss caused by predators (or availability?) is shown in graph 3. From successful nests 0.36 eggs are lost/nest. This means that 3600 eggs are lost in 35 days of incubation, or 100 eggs lost/d., which is approximately what the skua population requires. Of these 100 eggs lost, 60% are predatory, 40% disturbance. The skua is mobile, able to migrate from the area, contrary to the fox, which population is primarily limited by surviving the winter.

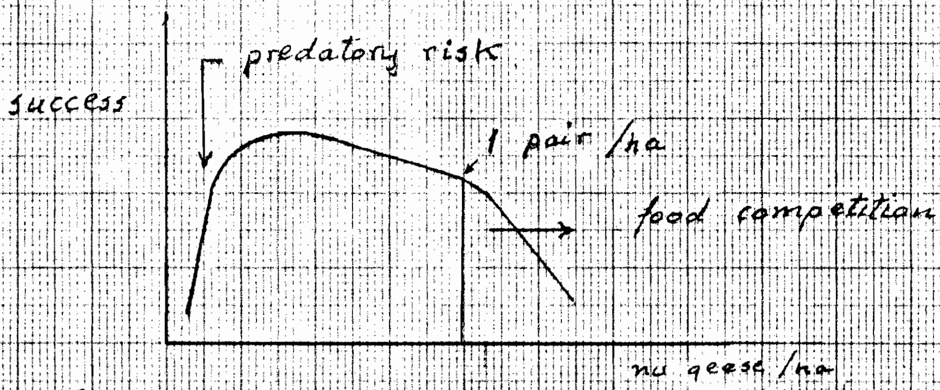
In extreme cold weather conditions the egg loss may increase about 20%, as shown in graph 4..

This further loss of eggs by cold, increases the availability of eggs to predators. It may be that the predatory factor on eggs and goslings can be ignored in the modelling.

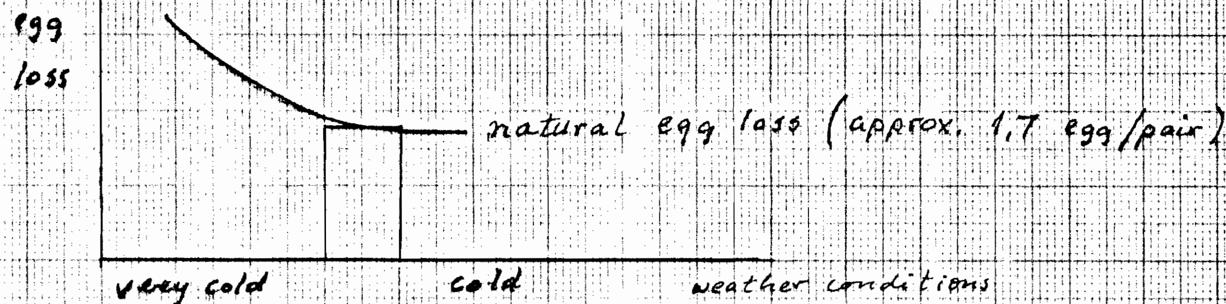
To the discussion of outflow of goslings:
The migration is a f. of time, shown in graph 10 (Hannesd. op.cit.). A part of the population is migrating from the area, N - migration, during the summer, against those staying and migrating in autumn to GB, S-migration.

Next step in the modelling work is to modify it by means of these further discussions and get needed data to run the model experimentally.

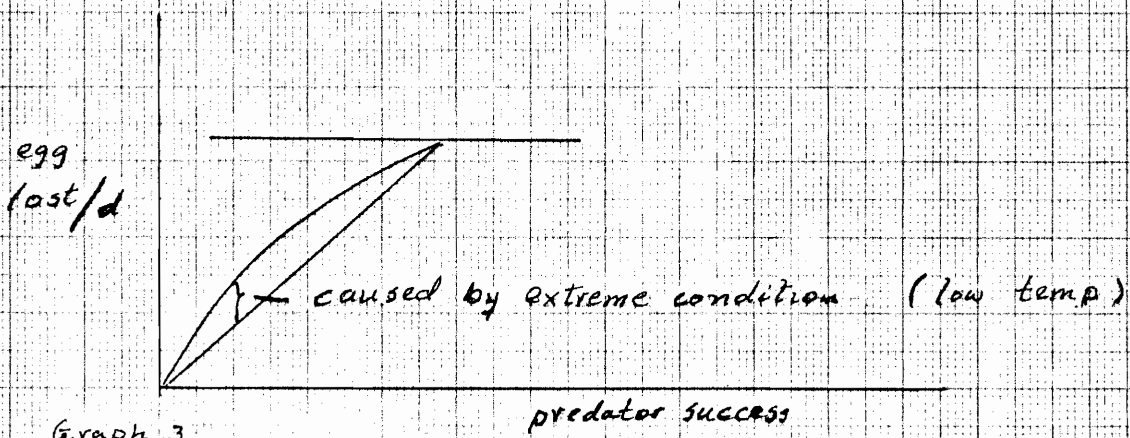
Graphs on some animal processes



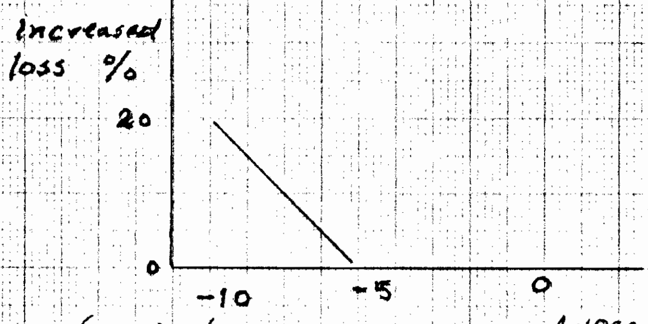
Graph 1.



Graph 2.



Graph 3.



Graph 4. Average temp past 5 days.