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Global Sensitivity Analysis of SKEBUB Parameterized for Balsfjord, A Fjord in Northern Norway

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By

Nicholas J. Bax*

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Resource Ecology and Fisheries Management
Resource Ecology and Ecosystem Simulation Task
Building 4, BIN C15700
7600 Sand Point Way N.E.
Seattle, WA 98115

*Compass Systems Inc., 4640 Jewell St., #204, San Diego, CA 92109

ABSTRACT

A sensitivity analysis of the SKEBUB simulation model parameterized to Balsfjord in northern Norway was performed using Monte Carlo error analysis. The large number of measured output variables (33) were reduced to seven principal components, and these seven principal components regressed against input parameters. Starvation of fish species which were neither piscivorous in habit nor consumers of phytoplankton predominated on the first component which explained 24% of the data variance. Input parameters determining temperature and the temperature/growth relationship of euphausiids were its primary determinants. This contrasts with a previous analysis of SKEBUB roughly parameterized to the Georges Bank, where predation predominated (Bax 1983b). Euphausiids and prawns had large loadings on most of the seven factors indicating their pervasive influence throughout the system. The cod biomass was correlated chiefly with input parameters from the euphausiid group. Cod also had a negative correlation between growth and percent consumption, (unlike the positive correlation between these two parameters for the other fish groups) perhaps resulting from their cannibalistic nature. Coefficients of variation of output variables were up to 24 times those of input parameters indicating an error magnification in line with published results. Herring biomass was negatively correlated with the biomasses of other fish groups in the factor loadings and a more detailed analysis of this feature is recommended.

SCOPE OF THIS REPORT

This report presents the results of global sensitivity analyses on an ecosimulation model of Balsfjord in northern Norway. The simulation model SKEBUB (Laevastu and Bax 1982, Bax 1983a) was parameterized for Balsfjord by J-E Eliassen of the University of Tromsø in conjunction with T. Laevastu of the Northwest and Alaska Fisheries Center and the author. Details of the simulation are presented elsewhere (Eliassen et al., in prep.).

INTRODUCTION

The Simulation

SKEBUB is a multispecies, biomass-based ecosimulation model, simulating in this instance the dynamics of 14 groups of organisms and their interactions. It is a simplification of the holistic ecosimulation models described in Laevastu and Larkins (1981) but does not have spatial resolution. The 14 groups comprise all major taxa in the ecosystem under study (microorganisms and parasites are not included), each group representing species assemblages, individual species, or age groups within a species. While the biomass of several of these groups is prescribed, the majority have biomasses determined within the simulation such that at equilibrium their annual proportionate increase in biomass (growth minus non-predation mortalities) approximates their (comparatively) fixed losses due to intergroup predation. SKEBUB runs in two modes - in the first, or equilibrium searching mode the indeterminate biomasses are individually adjusted following each of a series of 30 simulations of one year to reach the point where their annual growth equals their annual losses. In the second, or prognostic mode the indeterminate biomasses fluctuate freely from the equilibrium values, responding to system perturbations such as a change in fishing pressure or temperature anomalies.

The assumption of a constant equilibrium in an ecosystem is of course fallacious (e.g., Wiens 1984), and perhaps particularly so for a fishery ecosystem as any survey of stock and recruit relationships demonstrates. Equilibrium in the context of this simulation is envisaged as the long-term mean biomass values for the different groups. In its initial stages equilibrium searching highlights inconsistencies in input data; for example, where predation of species A on species B calculated from stomach contents analysis is larger than that available from species B as indicated by survey data. In its final stages the concept of equilibrium provides a stable, and replicable, position from which to study perturbations to the system.

Sensitivity Analyses

Sensitivity analyses of large simulation models can take two forms. If the statistical properties of all input parameters are known (an increasingly rare occurrence as model size increases) then a Monte Carlo error analysis can provide estimates of the statistical precision of the simulation results. In most instances error distributions of at least some input parameters are not known or may not exist for parameters which do not have analogues in the real world. In these instances Monte Carlo error analysis with proportionate error distributions for each parameter (e.g., ± 10% of the baseline value) determines the most sensitive parameters, variables, and interactions in the model. Properties of the simulated system are often inferred from such analyses of the model.

Although univariate sensitivity analyses are sometimes used, these procedures tacitly assume that the parameters operate independently of one another, which is usually not the case. Multivariate analyses perturb parameters simultaneously and with a sufficient number of independent runs of the model provide a measure of the sensitivity of the chosen output variables to each parameter over the prescribed range of all other parameters. The number of runs required can be reduced by the simultaneous but sequential perturbation of parameters at defined levels either in the form of a fractional factorial analysis of variance, or as a Latin hypercube sampling strategy (Rose 1983).

Several techniques have been used to analyze Monte Carlo error analysis output. One is to compare the simple correlation coefficients of all parameter/variable combinations (Gardner et al., 1981); however, this method fails to completely account for parameter interactions. Partial correlation analysis accounts for effects of other variables besides the independent variable, but *a priori* selection of variables is required to reduce chance correlations. Multiple regression analysis solves many of the problems with correlation analysis (Reed et. al., 1984), and can be used to eliminate independent variables with only minor (or perhaps chance) relationship to the dependent variable. These techniques all analyze one output variable at a time. When the analysis of many output variables is required the number can first be reduced with principal components analysis (Green 1979) or a GH'Biplot can be used to simultaneously estimate variances and correlations of all input parameters and output variables (Gabriel 1971, Huson 1982). Different researchers with different goals and different models will require different methods of sensitivity analysis, but usually more than one method should be used to gain an overall idea of model response (Huson 1982, Rose 1983).

METHODS

Simulation

The simulation model SKEBUB (Laevastu and Bax 1982, Bax 1982), parameterized to simulate the Balsfjord ecosystem (Eliassen et al., in prep.), was run to produce a stable equilibrium. Values of the parameters at equilibrium were stored to be used as the baseline values around which random perturbations were generated and input in the Monte Carlo error analysis. Results from sensitivity analyses can depend on the stage in the running of the model at which they are extracted (O'Niell et al., 1980). The equilibrium position is the logical stage at which to conduct the analysis in SKEBUB, however it is noted that the model likely would show different sensitivities to parameters if it were analyzed at a point away from this equilibrium.

Selection of Variables

An initial Monte Carlo error analysis with 1000 individual simulations, each consisting of 30 year-long iterations, was run with all input parameters perturbed independently over a triangular error distribution with limits of ± 5% of baseline values. Four output variables were measured at equilibrium for each species or group: the biomass of each group consumed in the equilibrium year; the required biomass not consumed by each biomass in the equilibrium year; the mean annual biomass of each group at equilibrium; and the commercial catch from each group in the equilibrium year.

Coefficients of variation for each measured output variable were substantially higher for 0 cod than for any other group (Table 1), indicating the sensitivity of larval and juvenile cod to parameter perturbation. Although these high coefficients of variation were a valid response from the simulation, the continued subdivision of cod into age classes would lead to a biased interpretation of species interactions since other species were not subdivided on age. Consequently, for the purposes of subsequent analyses the same random perturbation was applied to each of the cod age groups for any input parameter and each output variable was summed over all age groups. Within the simulation each age group fluctuated without constraints from the other age groups.

A second Monte Carlo error analysis indicated that coefficients of variation of the pooled cod age groups were comparable to those of other biomasses (Table 1). Before the final analyses both the biomass of each group consumed by others in the equilibrium year and the amount of required food not obtained by each group were expressed as percentages of that groups biomass. This removed the dependence of these variables on the equilibrium biomass. This transformation was not required for those groups with predetermined biomasses because all variables were standardized (expressed as a ratio of their mean) before statistical analysis.

Monte Carlo Error Analysis

Two error analyses of 2500 individual simulations with 30 iterations to equilibrium were run. All parameters (listed in Table 2) were perturbed independently for each biomass group to within ± 5% of the baseline value. A triangular error distribution was used. The one difference between the two analyses was the seed for the random number generator. Statistical results were compared from each analysis and only those results common to both analyses are presented in the body of this paper.

Statistical Analyses of Error Analysis Output

Up to four output variables were measured for each of eleven biomass groups producing 33 measured output variables. To simultaneously analyze all output variables and associated input parameters from a SKEBUB simulation a GH'Biplot (Gabriel 1971, Huson 1982) was used by Bax (1983b); however, the goodness of fit between the two dominant eigenvalues and the original data was poor. In this analysis parameters and/or biomass groups indicated to have low variance in the GH'Biplots were systematically removed from the statistical analyses. This approach was taken to increase the goodness of fit to the data matrix; however, unstable output resulted with dominant eigenvalues changing following the deletion of seemingly innocuous parameters. The need for an alternative multivariate analysis was indicated.

Principal components analysis (PCA) is recommended for reducing multivariate data sets to their primary descriptors (Green 1979), and has the added advantage of producing orthogonal factors. PCA was used to reduce the number of output variables; input parameters were already orthogonal. A standardized PCA was used since output variables were not all in the same units (Pielou 1984), and this PCA was centered to produce a more complete subdivision of the data. BMDP (Dixon et al., 1983) was used to carry out the analysis. Factor scores for each factor (or principal component) and each simulation run were stored and used as the dependent variables in subsequent forward, stepwise multiple regression analyses, where all input parameters were available to be entered as independent variables. Signed square roots of the factor scores were used in the regression analyses to normalize the residuals. It needs be remembered that in these analyses the independent variables are acting through the equilibriation process. Thus a biomass which is growing rapidly will be reduced in absolute amount through equilibriation and will appear as a reduced biomass in the final output. This procedure, though complicating the interpretation of results, will not affect the conclusions as to which output variables are most sensitive, nor which input parameters are most influential in determing those sensitivities, but the directions of the relationship between variables and parameters must be interpreted with care.

Complete tables of factor loadings from the PCA, and multiple regression summary tables are presented in Appendices; abbreviated tables are presented in the body of the paper.

Results

Simple statistics on each parameter and variable from the 2500 run Monte Carlo error analysis are given in Table 3. Coefficients of variation are very similar (0.020 - 0.021) for all input parameters (1-69) as is demanded by the construction of the error analysis. Coefficients of variation of output variables (70-102) ranged from 0.019 to 0.479, i.e., up to a 24-fold increase over input variation. Highest variations occurred for the equilibrium biomass, with lower variations for amount consumed and amount of food not obtained. Output variables 97 to 102, the amount of each group caught, were highly correlated with equilibrium biomass ($r > 0.99$) and these output variables were dropped from further analyses. The correlation occurs because the coefficients of fishing mortality are fixed during equilibriation.

Principal components analysis of the remaining 27 output variables indicated seven factors which together explained 0.78 of the variance in the data space (Table 4a). The first factor which represents general starvation accounted for 0.24 of the data space variance, the last factor representing the group "other fish" explained 0.06. Factor scores for each of the seven factors for each of the 2500 runs were regressed on all independent variables following a square root transformation to normalize the data (Table 4b). Each factor is discussed below both in terms of those output variables having the largest loadings on it and in terms of those input parameters explaining the larger parts of its variability. Complete output tables for the PCA and for the regression analyses are given in Appendix tables 1 and 2 a-h, respectively.

Factor 1: Starvation

The starvation (amount of required food not obtained expressed as a percentage of the groups biomass) of five groups were the major positive loadings on this factor (Table 4). These five groups were those which had little fish in their diet and little phytoplankton. Other more piscivorous groups (the cod) would have increased flexibility in diet, and the zooplankton groups (copepods and euphausiids) have a large proportion of the diet as phytoplankton, a group which did not appear to be limiting.

It can be difficult to visualize the mechanisms leading to the grouping of various variables on one factor and in this case I used individual regression analyses on each of the output variables with absolute loadings greater than 0.5 to supplement the information from the PCA and the regression analysis (Table 4). An increase in TAEUPH would cause a decrease in the growth rate of euphausiids because surface water temperatures (TTU) are already below the prescribed acclimation temperature for most months of the year (Fig. 1). This decreased growth rate would require that in the equilibriation process the biomass of euphausiids (BBEUPH) be raised to withstand the predation pressure still acting on it. Increases in the biomass of euphausiids, already large in comparison with fish species, means that more food is required from the system, while at the same time the decreased growth rate of euphausiids means that there would be proportionately less of the euphausiid biomass available for consumption by other species.

Other parameters associated with increased starvation in the five groups and in decreased biomasses were parameters which increased their growth directly (GCAP, GPRWN), indirectly (TACAP, TAOTH), or increased their food requirements (FRMFLAT). The equilibriation process would cause the biomasses to be lowered as growth rates increased, while increased starvation would result from the increased food requirements associated with increased growth rates.

Three general conclusions are evident from Factor 1: 1) lack of food for the herring, capelin, flatfish, other fish, and prawns contribute to the greatest variability in the system; 2) biomass of euphausiids is a key variable in determining general food availability; and 3) both 1) and 2) are sensitive to the water temperature, and to the acclimation temperatures of the different species.

Factor 2: Copepods

Input parameters which decrease growth indirectly (decreasing temperatures, TTU, or increasing acclimation temperature TACOP), or decrease growth directly (GCOP) lead to an increase in equilibrium biomass (BBCOP) necessary to sustain the incident predation. This increased biomass requires a larger consumption of phytoplankton, and percentage consumption (PCPHYT) consequently increases as phytoplankton biomass is predetermined. A direct consequence of the model formulation is that decreased growth results in a decreased availability to predation and hence percentage consumption of copepods (PCCOP) decreases.

Decreased starvation of copepods (SCCOP) as growth rate decreases may be as a result of its direct influence on food requirements, however two output variables having negative loadings on Factor 2, percent consumption of benthos (PCBEN) and of euphausiids (PCEUPH), indicate indirect interaction effects with copepods since neither of those two groups are in the diet of copepods (Appendix Table 3). A possible intermediary is the prawn biomass, the starvation of which has positive loading on this factor, and the diet of which is about 18% copepods. Temperature effects on the growth rate of euphausiids (TAEUPH) also influence Factor 2, perhaps operating through prawns as the intermediary link.

Factor 3: Euphausiids/Predation

Increased growth rate (GEUPH) and increased temperatures (TTU)/decreased acclimation temperature (TAEUPH) cause a reduction of the required biomass at equilibrium and hence the negative loading of BBEUPH.

Decreased biomass of the euphausiids and hence decreased amount of euphausiids available for predation (even though percentage consumption increases) cause switching by the cod from euphausiids to prawns and capelin causing the increased percentage consumption of these species (PCPRWN and PCCAP). These percentage consumptions can also be increased directly through increases of designated amount available (APPRWN) or increases in growth (GCAP). Similar effects also arise through an increase in cod biomass (BBCOD) produced by its decreasing growth rate (GCOD). Predation is also increased on benthos and zooplankton (PCBEN and PCZOO) while it is decreased on herring (PCHERR), though not necessarily by the same mechanism.

Factor 4: Cod

Major loadings on this factor are the percent consumption and the starvation of cod (PCCOD and SCCOD). Biomass of cod is conspicuous by its absence, but referring back to Table 5 it can be seen that parameters associated with euphausiids have a greater impact on cod biomass than those associated with the cod itself. Availability to predation (APCOD) has the expected positive relation with percent consumption. Growth parameters (GCOD and negative effect of TACOD) are negatively related to starvation and percent consumption.

In the herring, flatfish, other fish groups, where both availability to predation and growth are important parameters, their actions are positively correlated, and in other groups (euphausiids, copepods, capelin) growth is positively correlated with percent consumption, indicating an effect of the model formulation where availability to predation is made a direct function of growth. For the cod, growth and percent consumption are negatively correlated. Although this difference in response may be an artifact produced by the independent operation of the three age groups of cod within the model, it may also result from the cannibalistic nature of the cod whose largest predator is itself (Appendix Table 3).

Factor 5: Herring

Required equilibrium biomass of herring (BBHERR) increases as growth rate (GHERR) decreases directly, or indirectly through temperature effects (TAHERR and TTU), or indirectly through increased availability to predation (APHERR). Two other groups have significant loadings on this factor; there is a positive correlation with the biomass of euphausiids (BBEUPH), perhaps mediated through the cod biomass (BBCOD) which has a negative correlation with the herring biomass. Additionally, input parameters which would increase biomass of prawns (APPRWN and GPRWN) tend to increase herring biomass, possibly through an effect on the euphausiids, a shared food resource.

Factors 6 and 7: Flatfish and Other fish

For both factors, decreased growth, either directly or indirectly through temperature and predation effects, increase both the required equilibrium biomass and the percent consumption of each group. Additionally, the growth rate of prawns exerts a signficant effect on the other fish biomass/percent consumption. In both these groups and in herring, starvation does not appear as a significant loading, having already been separated out under general starvation by Factor 1.

DISCUSSION

Principal components analysis was used to reduce the large number of output variables to a more tractable number, and to an extent it was successful. Subdivisions produced by the PCA are similar to those produced by ranking simple correlation coefficients (Appendix Table 4), but in addition produced seven new orthogonal variables for comparison with input data. That seven factors were necessary to describe the system is an indication of its complexity; the complexity of the real system must be considerably greater yet than the simplified representation of this model. In this analysis of 2500 replicates it was difficult to identify linkages between different variables and parameters and it is difficult to conceive of being able to successfully identify any except the most obvious linkages from field sampling of the natural population where limited sampling, sampling errors, biases, and unknown environmental variability would cloud the data.

Coefficients of variation of output variables were increased up to 24 times over those of input parameters. This increase is in accord with those observed in previous analyses of SKEBUB (Bax 1983b), and with analyses of simpler models which also have this magnification of variability (O'Neill et al., 1980). This error magnification would be reduced substantially by placing constraints on what constituted an acceptable simulation run. For example, if all runs in the Monte Carlo error analysis were required to have each biomass as stable as that in the baseline run, few would be accepted. Objective criteria instead of, or in addition to, a stable equilibrium could also be used to take advantage of the better known features of the system - catch rates, production/biomass ratios, etc.

Analysis of the Monte Carlo-generated data with PCA reduces the number of output variables by pooling those with common variability. When pooled in this fashion starvation of five species was dominant on the factor explaining most of the variability. Very different results arise when the variables are analyzed individually; the ten variables (excluding catch) with the highest coefficients of variation in Table 3 are:

Biomass of prawns

Percent consumption of cod

Percent consumption of herring

Biomass of other fish

Biomass of capelin

Biomass of copepods

Biomass of cod

Biomass of herring

Biomass of euphausiids

Biomass of flatfish

Obviously group biomass is, in general, the output variable with highest variability, and percent consumption of cod and herring are also highly ranked. Starvation is not ranked in the top 10 for any species. Thus whereas PCA finds the greatest variability in the system by pooling the variability in starvation of several species, a univariate analysis treats each variable individually and fails to identify variability common to many groups. This common variability would be detected through analyses of the significant input parameters (e.g., Table 5).

Several general conclusions from the PCA analysis include the importance of starvation in the system, its relation to temperature, and the importance of euphausiids and prawns throughout the system. This contrasts with a previous analysis of SKEBUB, roughly parameterized to represent the Georges Bank ecosystem, where interspecific predation was found to be a more sensitive output variable than starvation, and temperature did not affect simulation results greatly (Bax 1983b). It is in the contrast between systems, where the constraints of the model itself can to a degree be cancelled out, that most information can be derived from ecosystem models. Future comparisons between the Balsfjord simulation and a simulation of a geographically similar but biologically different system are recommended.

An idea of the relative influence of the different groups on other groups in the ecosystem is gained by comparing the number of factors on which each group has a "significant" loading (an absolute value of 0.25 is used as the level of significance in this discussion). The prawns have significant loadings on six factors, euphausiids on five, cod, copepods, and phytoplankton on four, and the remaining groups have significant loadings on three factors each. Temperature appears on all seven factors. Although prawns have significant loadings on six factors, they are not the dominant influence on any one, and instead contribute to the variance of all factors. Similarly, the cod, although dominating Factor 4, have their biomass determined principally by parameters affecting the euphausiids (Table 5). All groups, with the exception of the copepods, have significant loadings on Factor 1, the dominant factor, perhaps indicating a degree of independence of copepods from the rest of the system.

Lastly, it is possible to subdivide the groups into two based on whether their biomasses have negative or positive loadings on the same factors. Only the flatfish group, which biomass appears only in the factor in which it is the dominant group, cannot be categorized in this manner, suggesting a degree of separation from the rest of the system. The grouping is as follows:

Euphausiids	Cod
Copepods	Capelin
Herring	Other fish
	Prawns

A surprising aspect here is that the herring are in an opposite group than the other fish species, including the capelin with which they share many characteristics. In view of expected increases in herring off the Norwegian coast in the next few years, a more detailed analysis of their effect on this system is warranted, although beyond the scope of this report.

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LIST OF TABLES

Table 1.--Coefficients of variation of output variables from the SKEBUB-Balsfjord simulation during Monte Carlo error analysis. Values in parentheses are coefficients of variations with output variables for cod pooled over age groups.

Species	Biomass consumed by others kg/km^2	Required food biomass not obtained kg/km^2	Biomass kg/km^2	Catch kg/km^2
0 Cod	0.84	0.69	0.83	0.84
1 Cod	0.29	0.21	0.28	0.28
2+ Cod	0.31 (0.48)	0.18 (0.28)	0.23 (0.24)	0.23 (0.25)
Herring	0.25 (0.26)	0.21 (0.21)	0.24 (0.25)	0.24 (0.26)
Capelin	0.29 (0.31)	0.22 (0.24)	0.29 (0.31)	0.29 (0.31)
Flatfish	0.19 (0.20)	0.18 (0.18)	0.18 (0.18)	0.18 (0.19)
Other finfish	0.32 (0.32)	0.29 (0.29)	0.31 (0.31)	0.31 (0.31)
Prawns	0.51 (0.48)	0.42 (0.41)	0.50 (0.47)	0.50 (0.47)
Benthos	0.04 (0.04)			
Copepods	0.22 (0.22)	0.25 (0.25)	0.27 (0.26)	
Euphausiids	0.21 (0.22)	0.23 (0.24)	0.25 (0.26)	
Other zooplankton	0.13 (0.13)			
Phytoplankton	0.15 (0.14)			

Table 2.--List of input parameters, biomass groups, output variables used in the Monte Carlo error analysis, and their abbreviations.[1/]

	INPUT PARAMETERS		BIOMASS GROUPS
AP	Availability to predation	COD	Cod
CFT	Occurrence in predators diets	HERR	Herring
V	Starting biomass	CAP	Capelin
G	Growth coefficient	FLAT	Flatfish
FRG	Food requirement for growth	OTHR	Other finfish
FRM	Food requirement for maintenance	PRWN	Prawns
TA	Acclimation temperature	BEN	Benthos
B	Rate of prey switching	COP	Copepods
DMAX	Maximum prey switching	EUPH	Euphausiids
TTU	Temperature in upper layers	ZOO	Other zooplankton
TT	Temperature in bottom layers	PHYT	Phytoplankton
	OUTPUT VARIABLES		
PC	Percent of equilibrium biomass consumed by others		
SC	Required food not obtained expressed as percent of equilibrium biomass		
BB	Equilibrium biomass		
FP	Total catch		

1/ Parameters and variables (except B, DMAX, TTU, and TT) are species specific and are identified by both parameter/variable name and a biomass name, e.g. APCOD.

Table 3.--Simple statistics on individual parameters and variables used in error analysis of the SKEBUB-BALSFJORD model.

VARIABLE NO.	NAME	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION	SKEWNESS	KURTOSIS	SMALLEST VALUE	LARGEST VALUE	SMALLEST STD SCORE	LARGEST STD SCORE
1	APCOD	2.8270	0.0584	0.020648	0.0431	-0.6346	2.6900	2.9626	-2.3458	2.3240
2	APHERR	3.9309	0.0806	0.020505	-0.0093	-0.6077	3.7382	4.1255	-2.3900	2.4144
3	APCAP	4.6705	0.0961	0.020566	0.0083	-0.6152	4.4402	4.8962	-2.3980	2.3456
4	APFLAT	4.5554	0.0926	0.020334	0.0023	-0.5904	4.3327	4.7840	-2.4046	2.4674
5	APOTHR	4.9079	0.1009	0.020566	-0.0101	-0.6430	4.6655	5.1533	-2.4024	2.4307
6	APPRWN	10.5406	0.2127	0.020182	0.0022	-0.6559	10.0284	11.0446	-2.4077	2.3692
7	APBEN	5.9605	0.1226	0.020572	-0.0152	-0.5712	5.6697	6.2574	-2.3714	2.4214
8	APCOP	9.8196	0.1976	0.020120	-0.0312	-0.5773	9.3418	10.2834	-2.4183	2.3473
9	APEUPH	9.1745	0.1864	0.020317	0.0694	-0.5795	8.7312	9.6335	-2.3782	2.4626
10	APZOO	17.7957	0.3718	0.020891	0.0316	-0.6768	16.9267	18.6844	-2.3374	2.3904
11	APPHYT	188.9862	3.8380	0.020308	0.0364	-0.6235	179.8087	198.3465	-2.3917	2.4389
12	CFCOD	0.3250	0.0066	0.020409	-0.0158	-0.6092	0.3093	0.3410	-2.3686	2.4233
13	CFHERR	1.3851	0.0290	0.020968	0.0341	-0.6428	1.3179	1.4530	-2.3133	2.3358
14	CFCAP	2.8272	0.0583	0.020625	0.0080	-0.6605	2.6907	2.9668	-2.3409	2.3940
15	CFFLAT	1.3573	0.0281	0.020693	-0.0068	-0.7133	1.2913	1.4219	-2.3530	2.2997
16	CFOTHR	1.3862	0.0284	0.020497	0.0410	-0.5620	1.3184	1.4536	-2.3835	2.3747
17	CFPRWN	5.0990	0.1022	0.020043	0.0087	-0.5719	4.8492	5.3495	-2.4344	2.4619
18	CFBEN	14.9274	0.3079	0.020625	-0.0543	-0.5878	14.1759	15.6514	-2.4409	2.3513
19	CFCOP	15.3859	0.3143	0.020430	-0.0601	-0.6478	14.6237	16.1525	-2.4250	2.4388
20	CFEUPH	19.1809	0.3835	0.019993	0.0134	-0.5129	18.2651	20.1027	-2.3880	2.4036
21	CFZOO	5.8187	0.1206	0.020721	0.0152	-0.6695	5.5403	6.1075	-2.3085	2.3960
22	CFPHYT	16.4573	0.3306	0.020089	-0.0694	-0.6173	15.6488	17.2183	-2.4454	2.3020
23	VCOD	3027.9582	61.6060	0.020346	-0.0111	-0.5752	2883.4700	3175.2500	-2.3454	2.3909
24	VHERR	1763.9802	35.6793	0.020227	0.0075	-0.5753	1676.9900	1852.0200	-2.4381	2.4675
25	VCAP	8340.2407	170.7066	0.020467	0.0606	-0.6502	7941.6700	8756.9200	-2.3349	2.4410
26	VFLAT	268.9094	5.4356	0.020213	0.0150	-0.5779	255.7800	282.2200	-2.4154	2.4488
27	VOTHR	957.7537	19.9427	0.020829	-0.0044	-0.6375	910.6300	1005.7000	-2.3641	2.4014
28	VPRWN	2800.6315	56.2613	0.020089	0.0329	-0.5376	2665.3500	2938.0500	-2.4045	2.4425
29	VBEN	72484.9113	1492.8704	0.020596	-0.0265	-0.5830	68975.7000	76044.7100	-2.3506	2.3845
30	VCOP	91134.0208	1822.4454	0.019997	-0.0325	-0.5718	86596.3400	95549.3400	-2.4899	2.4227
31	VEUPH	58784.9876	1187.8458	0.020207	0.0004	-0.5621	55857.2100	61674.4200	-2.4648	2.4325
32	VZOO	33528.1832	677.0475	0.020193	0.0381	-0.5678	31863.3400	35151.8300	-2.4590	2.3981
33	VPHYT	212747.5598	4319.1971	0.020302	-0.0384	-0.5757	202391.2800	223081.1700	-2.3977	2.3925
34	GCOD	0.0337	0.0007	0.020216	0.0050	-0.5736	0.0312	0.0343	-2.3897	2.3845
35	GHERR	0.0498	0.0010	0.020306	0.0110	-0.5748	0.0473	0.0523	-2.4328	2.4553
36	GCAP	0.0590	0.0012	0.020337	-0.0370	-0.6557	0.0561	0.0618	-2.4255	2.3441
37	GFLAT	0.0524	0.0011	0.020124	-0.0784	-0.5717	0.0499	0.0550	-2.4117	2.4709
38	GOTHR	0.0524	0.0011	0.020176	0.0707	-0.6458	0.0499	0.0550	-2.3723	2.4343
39	GPRWN	0.1283	0.0026	0.020393	-0.0029	-0.5803	0.1222	0.1347	-2.3578	2.4256
40	GCOP	0.2095	0.0042	0.020200	-0.0408	-0.5886	0.1993	0.2199	-2.4146	2.4606
41	GEUPH	0.1965	0.0040	0.020107	0.0156	-0.5747	0.1871	0.2061	-2.3829	2.4357
42	FRMCOD	0.8000	0.0153	0.020388	0.0279	-0.6231	0.7615	0.8397	-2.3762	2.4340
43	FRMHERR	0.8999	0.0186	0.020682	0.0093	-0.6333	0.8553	0.9441	-2.3988	2.3745
44	FRMCAP	0.9005	0.0184	0.020439	-0.0341	-0.6643	0.8554	0.9424	-2.4539	2.2762
45	FRMFLAT	0.7003	0.0144	0.020567	-0.0211	-0.6423	0.6653	0.7338	-2.4305	2.3204
46	FRMOTHR	0.9001	0.0189	0.020970	-0.0107	-0.6967	0.8560	0.9441	-2.3375	2.3322
47	FRMPRWN	1.1599	0.0245	0.020384	-0.0243	-0.6171	1.1403	1.2575	-2.4374	2.3517
48	FRMCOP	1.3004	0.0264	0.020301	-0.0001	-0.5648	1.2363	1.3638	-2.4285	2.4031
49	FRMEUPH	1.3006	0.0266	0.020453	-0.0215	-0.6268	1.2364	1.3629	-2.4152	2.3408
50	FRGCOD	1.3002	0.0264	0.020296	-0.0044	-0.5884	1.2369	1.3641	-2.4017	2.4215
51	FRGHERR	1.5001	0.0314	0.020859	0.0162	-0.6180	1.4260	1.5731	-2.3640	2.3306
52	FRGCAP	1.5007	0.0309	0.020581	-0.0663	-0.6499	1.4291	1.5710	-2.3194	2.2742
53	FRGFLAT	1.1997	0.0246	0.020513	0.0650	-0.6636	1.1426	1.2598	-2.3241	2.4396
54	FRGOTHR	1.4991	0.0304	0.020262	-0.0022	-0.5935	1.4273	1.5738	-2.3659	2.4593
55	FRGPRWN	1.5008	0.0311	0.020705	-0.0278	-0.6172	1.4282	1.5733	-2.3375	2.3331

Table 3 continued

56	FRGCOP	1.3000	0.0263	0.020226	0.0043	-0.5827	1.2373	1.3636	-2.3826	2.4216
57	FRGEUPH	1.2999	0.0267	0.020559	0.0044	-0.6295	1.2369	1.3643	-2.3591	2.4113
58	TACOD	3.0005	0.0624	0.020809	0.0318	-0.6378	2.8533	3.1462	-2.3563	2.3334
59	TAHERR	4.4995	0.0940	0.020901	0.0104	-0.6774	4.2775	4.7189	-2.3610	2.3327
60	TACAP	4.4971	0.0913	0.020303	-0.0014	-0.6200	4.2755	4.7170	-2.4265	2.4087
61	TAFLAT	2.9983	0.0617	0.020582	0.0209	-0.6223	2.8559	3.1443	-2.3079	2.3650
62	TAOTHR	4.0010	0.0810	0.020249	0.0173	-0.6036	3.8060	4.1985	-2.4070	2.4385
63	TAPRWA	4.0015	0.0822	0.020551	-0.0232	-0.5959	3.8073	4.1939	-2.3611	2.3399
64	TACOP	5.9964	0.1233	0.020569	0.0206	-0.6073	5.7046	6.2934	-2.3661	2.4076
65	TAEUPH	6.0024	0.1194	0.019899	0.0034	-0.5983	5.7042	6.2876	-2.4963	2.3878
66	B	2.0006	0.0412	0.020599	-0.0258	-0.5734	1.9029	2.0972	-2.3709	2.3444
67	DAMX	2.0003	0.0408	0.020401	-0.0773	-0.5705	1.9035	2.0954	-2.3700	2.4251
68	TTU	0.9996	0.0207	0.020695	-0.0073	-0.6642	0.9518	1.0481	-2.3100	2.3416
69	TT	0.9999	0.0204	0.020358	-0.0130	-0.6220	0.9504	1.0485	-2.4304	2.3882
70	PCCOD	0.0524	0.0174	0.331646	1.2314	1.9143	0.0242	0.1463	-1.6251	5.4034
71	PCHERR	0.0218	0.0066	0.303478	0.6393	0.4860	0.0070	0.0571	-2.2411	5.3391
72	PCCAP	0.0459	0.0012	0.025814	-0.4406	1.0059	0.0399	0.0490	-5.0580	2.6326
73	PCFLAT	0.0456	0.0009	0.020398	0.0023	-0.5895	0.0433	0.0479	-2.4262	2.4704
74	PCOTHR	0.0491	0.0010	0.020554	-0.0142	-0.6443	0.0466	0.0515	-2.4065	2.4476
75	PCPRWA	0.1041	0.0020	0.019108	0.1260	-0.1286	0.0962	0.1106	-3.9855	3.2656
76	PCBEN	4003.2752	149.0612	0.037235	0.4567	0.1589	3607.2200	4546.1600	-2.6570	3.6420
77	PCCOP	0.0895	0.0059	0.066452	-0.2688	-0.5535	0.0710	0.1019	-3.0964	2.0965
78	PCEUPH	0.0829	0.0058	0.069520	-0.1978	-0.6548	0.0658	0.0961	-2.9680	2.2823
79	PCZOO	2207.6431	261.2563	0.118342	1.7678	3.8588	1742.3200	3471.8700	-1.7811	4.8390
80	PCPHYT	68120.5892	9741.4276	0.143003	-0.1705	1.0102	23837.3400	117742.3500	-4.5459	5.0939
81	SCCOD	0.4401	0.0737	0.167412	1.1267	1.7912	0.2810	0.8559	-2.1587	5.6440
82	SCHERR	0.3197	0.0204	0.063910	-3.6557	18.8584	0.1199	0.3462	-9.7959	1.2985
83	SCCAP	0.3320	0.0214	0.064417	-3.8491	21.1099	0.1118	0.3598	-10.3076	1.2987
84	SCFLAT	0.2732	0.0078	0.028377	-2.7238	18.0061	0.1897	0.2917	-10.7728	2.3845
85	SCOTH	0.3404	0.0174	0.051042	-2.6640	10.8590	0.1969	0.3702	-8.2609	1.7150
86	SCPRWA	0.5066	0.0224	0.044197	-3.2753	17.2796	0.2892	0.5450	-9.7101	1.5947
87	SCCOP	0.5174	0.0152	0.029434	-0.0731	-0.0810	0.4690	0.5701	-3.1742	3.4645
88	SCEUPH	0.5055	0.0143	0.028328	0.1103	-0.2001	0.4643	0.5513	-2.8812	3.1979
89	BBCOD	3517.2183	828.2095	0.235473	1.3739	3.0979	1893.7300	8760.3100	-1.9723	6.3306
90	BBHERR	1870.3579	441.4996	0.236051	0.6357	0.8355	801.5200	4050.9400	-2.4209	4.9390
91	BBCAP	7965.0684	2309.2062	0.285917	1.7926	10.6109	3180.7400	31395.2800	-2.0718	10.1464
92	BBFLAT	270.5951	48.2433	0.178023	0.4775	0.1567	150.4800	473.3000	-2.4981	4.1934
93	BBOTH	957.0072	287.4555	0.300401	0.6171	0.4009	300.3100	2247.1200	-2.2843	4.4876
94	BBPRWA	3138.3432	1484.2282	0.472934	2.3165	9.7834	835.1600	15208.4900	-1.5518	8.1373
95	BBCOP	76805.0425	21017.2478	0.273644	0.1340	1.2343	11807.8900	192237.6700	-3.0926	5.4923
96	BBEUPH	50067.4878	12454.0051	0.249543	-0.2799	0.3288	8325.7200	87261.1400	-3.3409	2.9769
97	FPCOD	181.1088	44.9639	0.248270	1.4326	3.4088	90.2213	444.0448	-2.0213	5.8477
98	FPHERR	13.9409	3.3251	0.238517	0.6529	0.8317	6.1106	29.9171	-2.3549	4.8047
99	FPCAP	0.9560	0.2796	0.292507	1.8339	10.8408	0.3865	3.8369	-2.0366	10.3018
100	FPFLAT	13.0039	2.3538	0.181007	0.4859	0.1868	7.3247	23.1037	-2.4128	4.2908
101	FPOTH	1.7232	0.5218	0.302832	0.6321	0.4391	0.5414	4.1059	-2.2647	4.5658
102	FPPRWA	64.1524	30.7217	0.478886	2.3851	10.4736	16.4158	327.4415	-1.5538	8.5701

NOTE - KURTOSIS VALUES GREATER THAN ZERO INDICATE A DISTRIBUTION WITH HEAVIER TAILS THAN NORMAL DISTRIBUTION.

Table 4.--Principal components of a 2500 run error analysis of SKEBUB-Balsfjord. a) Output variables with largest loadings on each component, and b) input parameters with largest partial correlation from stepwise regression analysis.

Factor Description	1 Starvation	2 Copepods	3 Euphausiids/predation	4 Cod	5 Herring	6 Flatfish	7 Other fish
a) FACTOR LOADINGS OF OUTPUT VARIABLES							
Positive loadings 1/	SCCAP SCHERR SCOTH SCPRWN SCFLAT bbeuph pcphyt	BBCOP PCPHYT scprwn	PCPRWN PCEUPH SCEUPH PCCAP BBCOD pcben pczoo bbprwn	SCCOD PCCOD bbeuph pcphyt	PCHERR BBHERR bbeuph	BBFLAT PCFLAT	PCOTH BBOTH
Negative loadings	PCZOO BBCAP BBCOD BBPRWN bbherr pcben pceuph sceuph bboth pccod	PCCOP SCCOP pcben pceuph	BBEUPH pcherr pcphyt scoth		bbcod pccap sceuph pceuph		
Proportion of variance explained by factor	0.24	0.14	0.13	0.08	0.07	0.06	0.06
b) ASSOCIATED INPUT PARAMETERS							
Positive independent variables 2/	TAEUPH gcap apprwn apeuph gprwn frmflat tt	TACOP	TTU APPRWN geuph gcap tacop taherr vben	TACOD APCOD apprwn	TAHERR APPRWN APHERR gcod	APFLAT TAFLAT	APOTH TAOTH gprwn
Negative independent variables	tacap geuph taoth	TTU gcop taeuph frmcop	TAEUPH tacap gcod	GCOD ttu tacop	gherr ttu tacop gprwn	gflat tt	goth ttu
Coefficient of determination	0.49	0.88	0.75	0.84	0.79	0.93	0.88

1/ Loadings: uppercase > 0.50; lower case > 0.25

2/ Partial correlation coefficient: underlined > 0.50; uppercase > 0.10; lower case > 0.01,

Table 5.--Stepwise multiple regression analyses on the output variables with largest loadings on the principal component of data output from error analyses of SKEBUB-Balsfjord.

Variable	SCCAP	SCHERR	SCOTH	SCPRWN	SCFLAT	bbeuph	PCZOO	BBCAP	BBCOD	BBPRWN
Loading on factor 1	0.907	0.889	0.858	0.850	0.714	0.419	-0.815	-0.698	-0.544	-0.538
Positive I.V.'s	TAEUPH frmcap tacop	TAEUPH frmherr tacop	TAEUPH frmoth	taeuph frmprwn gprwn tacop	FRMFLAT taeuph tt	TAEUPH apeuph	TTU geuph tacap	TACAP APCAP	TTU geuph	APPRWN TTU
Negative I.V.'s	TTU tacap	TTU geuph	ttu taoth geuph	TTU	taflat ttu	TTU geuph tacop	TAEUPH apeuph	GCAP taeuph tacop	TAEUPH GCOD apeuph	GPRWN taeuph tt
Total r^2	0.38	0.38	0.49	0.47	0.55	0.82	0.56	0.73	0.61	0.71

LIST OF FIGURES

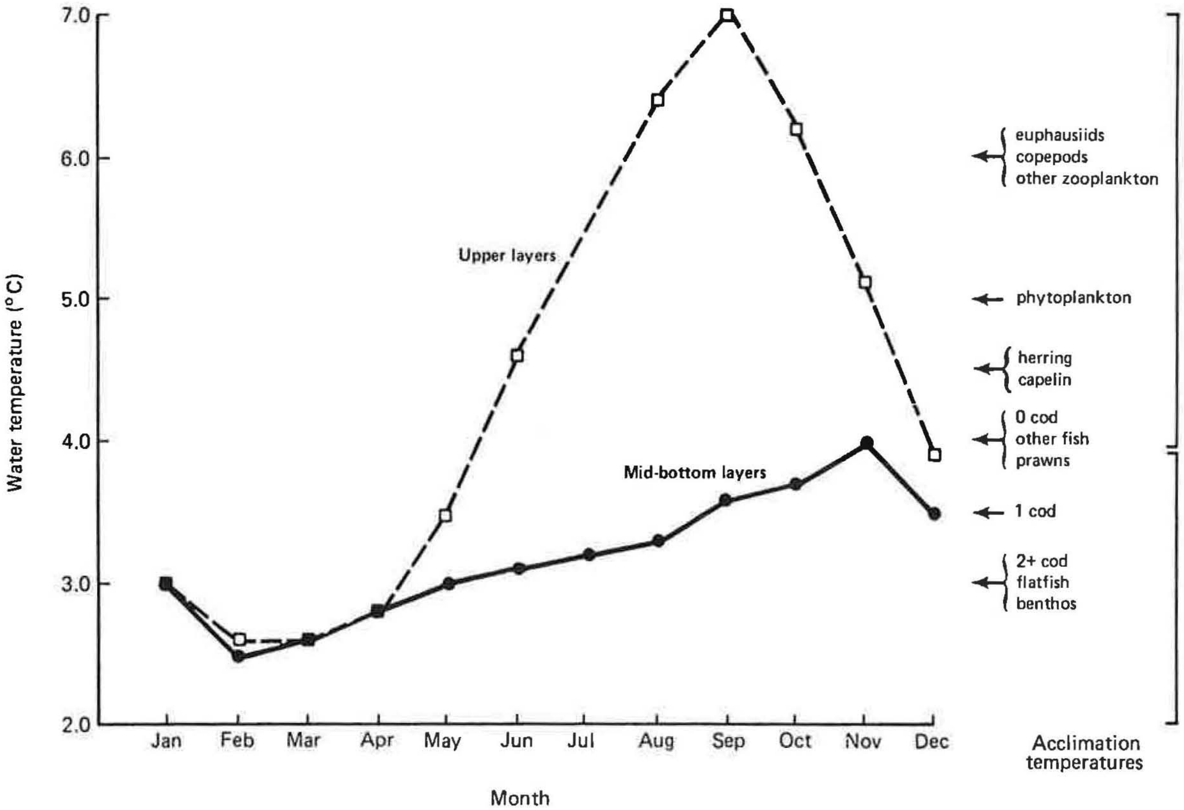

Figure 1.--Input water temperature values for Balsfjord in the upper and mid to bottom layers. Acclimation temperatures of the species groups are given on the right.

LIST OF APPENDIX TABLES

Appendix Table 1.--Factor loadings of each output variable on the seven principal components of data output from a 2500-run error analysis of SKEBUB-Balsfjord.

ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7
PCCOD	70	-0.292	0.114	0.080	0.911	-0.053	0.006	0.054
PCHERR	71	0.046	0.117	-0.315	0.006	0.895	-0.009	-0.056
PCCAP	72	-0.078	-0.230	0.525	0.003	-0.284	0.044	0.046
PCFLAT	73	0.024	-0.004	0.012	0.019	0.004	0.897	0.042
PCOTHR	74	0.061	-0.040	0.060	-0.028	0.001	0.045	0.831
PCPRWN	75	-0.002	-0.050	0.739	0.086	0.111	-0.032	0.131
PCBEN	76	-0.385	-0.352	0.486	0.102	0.115	0.026	-0.006
PCCOP	77	-0.198	-0.886	0.243	-0.042	-0.099	0.014	-0.036
PCEUPH	78	-0.357	-0.261	0.705	-0.132	-0.271	0.029	-0.103
PCZOO	79	-0.815	-0.114	0.445	0.120	0.009	0.017	0.041
PCPHYT	80	0.289	0.791	-0.269	0.271	0.194	-0.017	0.083
SCCOD	81	0.057	0.137	-0.105	0.966	0.079	-0.007	-0.025
SCHERR	82	0.889	0.181	-0.223	0.008	-0.092	-0.003	-0.054
SCCAP	83	0.907	0.240	-0.103	-0.027	-0.018	-0.008	-0.043
SCFLAT	84	0.714	0.070	-0.079	0.023	-0.002	-0.112	0.007
SCOTH	85	0.858	0.059	-0.257	0.007	0.122	-0.003	-0.182
SCPRWN	86	0.850	0.282	-0.191	0.062	0.027	-0.021	0.035
SCCOP	87	-0.131	-0.866	0.157	-0.056	-0.062	-0.000	-0.037
SCEUPH	88	-0.356	-0.193	0.624	-0.209	-0.275	0.032	-0.159
BBCOD	89	-0.544	0.023	0.504	0.031	-0.420	0.017	0.201
BBHERR	90	-0.415	0.167	0.079	0.061	0.732	0.016	0.134
BBCAP	91	-0.698	0.051	-0.154	0.207	0.108	0.005	0.048
BBFLAT	92	-0.131	-0.012	0.022	-0.025	-0.011	0.900	-0.001
BBOTH	93	-0.300	0.200	-0.048	0.079	0.027	-0.008	0.788
BBPRWN	94	-0.538	-0.249	0.434	-0.023	0.221	0.015	-0.118
BBCOP	95	0.071	0.965	0.039	0.038	0.022	0.003	0.024
BBEUPH	96	0.419	-0.115	-0.635	0.409	0.327	-0.038	0.126
	VP	6.419	3.762	3.469	2.165	2.023	1.639	1.516

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE ELEMENTS OF THE COLUMN OF THE FACTOR PATTERN MATRIX CORRESPONDING TO THAT FACTOR. WHEN THE ROTATION IS ORTHOGONAL, THE VP IS THE VARIANCE EXPLAINED BY THE FACTOR.

Appendix Table 2.--Stepwise multiple regressions on the seven principal components identified from error analyses of SKEBUB-Balsfjord. a) Factor 1

MULTIPLE R	0.7242
MULTIPLE R-SQUARE	0.5245
ADJUSTED R-SQUARE	0.5216
STD. ERROR OF EST.	0.5205

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	742.29964	15	49.48664	182.64
RESIDUAL	673.02800	2484	0.2709453	

VARIABLES IN EQUATION FOR FACTOR1

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		-30.32188)				
APCAP	3	-0.71553	0.1086	-0.091	0.99657	43.47
APOTHR	5	0.67982	0.1036	0.091	0.99214	43.09
APPRWN	6	0.59775	0.0491	0.169	0.99382	148.24
APCOP	8	0.29876	0.0530	0.078	0.98594	31.81
APEUPH	9	0.75261	0.0560	0.188	0.99465	180.54
GCAP	36	125.83622	8.6917	0.201	0.99784	209.60
GPRWN	39	42.06709	3.9900	0.146	0.99415	111.15
GEUPH	41	-37.25137	2.6422	-0.196	0.99465	155.19
FRMHERR	43	2.77588	0.5606	0.065	0.99609	24.52
FRMFLAT	45	7.27657	0.7247	0.139	0.99512	100.82
TACAP	60	-2.53478	0.1143	-0.308	0.99493	491.50
TAOTHR	62	-1.03982	0.1290	-0.112	0.99236	64.95
TAEUPH	65	2.76592	0.0875	0.439	0.99306	999.57
TTL	68	-3.56434	0.5048	-0.098	0.99412	49.85
TT	69	3.76156	0.5130	0.102	0.99430	53.77

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F TO ENTER
1	65 TAEUPH		0.4296	0.1845	0.1845	565.2052
2	60 TACAP		0.5292	0.2800	0.0955	331.2458
3	36 GCAP		0.5670	0.3215	0.0414	152.4457
4	41 GEUPH		0.6002	0.3603	0.0388	151.3158
5	6 APPRWN		0.6274	0.3937	0.0334	137.4901
6	9 APEUPH		0.6515	0.4249	0.0313	135.5139
7	39 GPRWN		0.6678	0.4459	0.0210	94.3186
8	45 FRMFLAT		0.6822	0.4654	0.0195	90.9330
9	62 TAOTHR		0.6908	0.4769	0.0115	54.6726
10	69 TT		0.6982	0.4875	0.0106	51.3216
11	5 APOTHR		0.7053	0.4974	0.0099	49.0066
12	68 TTU		0.7113	0.5059	0.0086	43.0652
13	3 APCAP		0.7168	0.5138	0.0079	40.3502
14	8 APCOP		0.7210	0.5198	0.0059	30.7219
15	43 FRMHERR		0.7242	0.5245	0.0047	24.5226

Appendix Table 2b: Factor 2

MULTIPLE R	0.9582
MULTIPLE R-SQUARE	0.9181
ADJUSTED R-SQUARE	0.9176
STD. ERROR OF EST.	0.2552

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	1811.8077	15	120.7872	1855.28
RESIDUAL	161.71958	2484	.6510450E-01	

VARIABLES IN EQUATION FOR FACTOR2

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		24.04833)				
AFOTHR	5	-0.53264	0.0507	-0.060	0.99478	110.37
AFBEN	7	-0.26664	0.0417	-0.037	0.99727	40.92
AFCCP	8	0.43683	0.0259	0.097	0.99148	283.48
AFELPH	9	-0.33825	0.0275	-0.071	0.99498	151.62
VBEN	29	-.23047E-04	.3425E-05	-0.035	0.99649	45.28
GCAF	36	-23.74998	4.2636	-0.032	0.99646	31.03
GCOF	40	-63.64547	1.2097	-0.303	0.99419	2767.91
GELPH	41	19.74273	1.2950	0.088	0.99490	232.40
FRMCOP	48	-3.92856	0.1938	-0.117	0.99545	410.98
FRGCCP	56	-1.53232	0.1951	-0.045	0.98998	61.68
TACAP	60	0.44558	0.0561	0.046	0.99354	63.14
TAOTHR	62	0.40113	0.0632	0.037	0.99415	40.30
TACCP	64	4.55627	0.0416	0.632	0.99029	12004.75
TAELPH	65	-1.39353	0.0430	-0.187	0.98926	1052.01
TTU	68	-23.98860	0.2475	-0.558	0.99392	9395.91

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	RSQ	INCREASE IN RSQ	F TO ENTER
1	64 TACOP		0.6573	0.4320	0.4320	1900.0800
2	68 TTU		0.8582	0.7365	0.3044	2864.3774
3	40 GCOF		0.9132	0.8339	0.0975	1454.7445
4	65 TAELPH		0.9327	0.8700	0.0361	692.4869
5	48 FRMCOF		0.9403	0.8841	0.0141	303.8300
6	8 AFCCP		0.9448	0.8927	0.0085	198.4124
7	41 GELPH		0.9490	0.9006	0.0080	200.1840
8	9 AFELPH		0.9514	0.9052	0.0046	119.9189
9	5 AFOTHR		0.9533	0.9088	0.0036	57.0524
10	60 TACAP		0.9543	0.9108	0.0020	55.6447
11	56 FRGCCF		0.9554	0.9128	0.0021	59.6285
12	29 VBEN		0.9562	0.9144	0.0015	44.4254
13	62 TAOTHR		0.9569	0.9157	0.0014	40.0228
14	7 AFBEN		0.9576	0.9170	0.0013	38.9481
15	36 GCAF		0.9582	0.9181	0.0010	31.0300

Appendix Table 2c: Factor 3

MULTIPLE R	0.8899
MULTIPLE R-SQUARE	0.7919
ADJUSTED R-SQUARE	0.7907
STD. ERROR OF EST.	0.4105

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	1593.3396	15	106.2226	630.36
RESIDUAL	418.58237	2484	0.1685114	

VARIABLES IN EQUATION FOR FACTOR3

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		-34.57652)				
AFCOD	1	1.42161	0.1410	0.092	0.99586	101.70
AFFFWN	6	1.65509	0.0387	0.392	0.99303	1825.66
APBEN	7	0.67145	0.0672	0.092	0.99438	99.87
AFELPH	9	-0.41938	0.0442	-0.087	0.99500	90.17
VBEN	29	.99060E-04	.9259E-05	0.098	0.99678	114.51
GCOD	34	-180.91728	12.4221	-0.133	0.99746	212.12
GHEFR	35	-79.52172	8.1462	-0.090	0.99490	95.29
GCAF	36	117.82044	6.8583	0.157	0.99675	295.12
GEUPH	41	52.50457	2.0832	0.231	0.99517	635.23
TACOD	58	1.14930	0.1319	0.080	0.99494	75.98
TAHERR	59	1.06073	0.0874	0.111	0.99714	147.16
TACAP	60	-2.14378	0.0901	-0.218	0.99626	566.03
TACOP	64	1.02296	0.0668	0.141	0.99292	234.41
TAELPH	65	-3.67004	0.0689	-0.469	0.99550	2836.88
ITU	68	19.00488	0.3983	0.436	0.99315	2276.62

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED		VARIABLE REMOVED	MULTIPLE R	RSQ	INCREASE IN RSQ	F TO ENTER
1	65	TAELPH		0.4894	0.2395	0.2395	786.6593
2	68	ITU		0.6483	0.4203	0.1808	778.5870
3	6	APPFWN		0.7565	0.5723	0.1521	887.3578
4	41	GEUPH		0.7896	0.6235	0.0512	339.1174
5	60	TACAP		0.8174	0.6682	0.0447	336.1683
6	36	GCAF		0.8316	0.6916	0.0234	188.8651
7	34	GCOD		0.8435	0.7115	0.0199	172.0049
8	64	TACOP		0.8545	0.7302	0.0187	172.8555
9	59	TAHERR		0.8618	0.7426	0.0124	120.0263
10	29	VBEN		0.8675	0.7526	0.0100	100.3225
11	1	AFCOD		0.8726	0.7614	0.0089	92.3641
12	7	APBEN		0.8772	0.7696	0.0081	87.4621
13	35	GHEFR		0.8819	0.7778	0.0082	81.9235
14	9	AFELPH		0.8863	0.7856	0.0078	90.5820
15	58	TACOD		0.8899	0.7919	0.0064	75.9755

Appendix Table 2d: Factor 4

MULTIPLE R	0.9380
MULTIPLE R-SQUARE	0.8798
ADJUSTED R-SQUARE	0.8791
STD. ERROR OF EST.	0.3050

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	1691.2128	15	112.7475	1212.32
RESIDUAL	231.0158	2484	.9300145E-01	

VARIABLES IN EQUATION FOR FACTOR4

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		-18.10347)				
AFCOD	1	7.54805	0.1048	0.502	0.99388	5184.43
AFCAP	3	0.81908	0.0636	0.090	0.99576	165.82
AFOTHR	5	-0.55431	0.0606	-0.064	0.99346	83.56
AFFRWK	6	0.47645	0.0287	0.118	0.99517	274.72
AFCOP	8	-0.25287	0.0310	-0.057	0.99359	66.64
VEEN	29	.29927E-04	.4092E-05	0.051	0.99746	53.50
GCOD	34	-490.36622	9.2279	-0.370	0.99755	2823.79
GCAP	36	-36.04153	5.0950	-0.049	0.99627	50.04
GCOP	40	19.23373	1.4446	0.093	0.99595	177.36
TACOD	58	7.84790	0.0979	0.555	0.99535	6422.06
TAHERR	59	-0.49377	0.0649	-0.053	0.99744	57.90
TACAP	60	0.73176	0.0670	0.076	0.99555	119.41
TACOP	64	-1.33864	0.0496	-0.188	0.99610	728.65
B	66	0.88293	0.1483	0.041	0.99590	35.43
ITU	68	-13.33567	0.2959	-0.315	0.99331	2031.45

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F TO ENTER
1	58 TACOD		0.5357	0.2870	0.2870	1005.6248
2	1 AFCOD		0.7454	0.5556	0.2686	1508.9845
3	34 GCOD		0.8348	0.6969	0.1413	1163.4514
4	68 ITU		0.8913	0.7944	0.0975	1182.6159
5	64 TACOP		0.9093	0.8269	0.0325	468.0705
6	6 AFFRWK		0.9166	0.8401	0.0133	206.6044
7	3 AFCAP		0.9215	0.8492	0.0091	150.4883
8	40 GCOP		0.9257	0.8570	0.0078	135.8591
9	60 TACAP		0.9285	0.8629	0.0059	106.9082
10	5 AFOTHR		0.9313	0.8673	0.0044	83.0585
11	8 AFCOP		0.9330	0.8705	0.0031	60.2322
12	59 TAHERR		0.9344	0.8731	0.0026	50.9573
13	29 VEEN		0.9358	0.8757	0.0026	52.1818
14	36 GCAP		0.9371	0.8781	0.0024	49.5908
15	66 B		0.9380	0.8798	0.0017	35.4289

Appendix Table 2e: Factor 5

MULTIPLE R	0.9166
MULTIPLE R-SQUARE	0.8402
ADJUSTED R-SQUARE	0.8393
STD. ERROR OF EST.	0.3580

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	1674.8046	15	111.6536	871.00
RESIDUAL	318.42514	2484	0.1281905	

VARIABLES IN EQUATION FOR FACTOR5

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		-25.76046)				
APHERR	2	3.96093	0.0892	0.359	0.99306	1993.13
APPRMN	6	1.62830	0.0338	0.388	0.99371	2324.42
CFCOD	12	-9.16422	1.0826	-0.068	0.99511	71.97
VHERR	24	.15084E-02	.2017E-03	0.076	0.99047	85.52
VBEN	29	.44834E-04	.4805E-05	0.075	0.99704	87.07
GCOD	34	232.72162	10.8314	0.172	0.99802	461.64
GHERR	35	-300.85848	7.1023	-0.340	0.99566	1794.59
GPRMN	39	-45.65316	2.7478	-0.134	0.99178	276.04
FRMCOD	42	-3.98432	0.4404	-0.073	0.99421	81.86
TACOD	58	-1.26076	0.1149	-0.068	0.99594	120.31
TAHERR	59	4.55313	0.0763	0.484	0.99550	3621.19
TACCP	64	-1.21185	0.0583	-0.167	0.99326	432.60
TAELPH	65	0.63934	0.0602	0.088	0.99365	112.56
B	66	2.06511	0.1740	0.095	0.99712	140.79
TTU	68	-11.88957	0.3472	-0.275	0.99454	1172.95

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F TO ENTER
1	59 TAHERR		0.4916	0.2417	0.2417	796.2500
2	6 APPRMN		0.6408	0.4107	0.1689	715.8161
3	2 APHERR		0.7301	0.5331	0.1224	654.4066
4	35 GHERR		0.8008	0.6414	0.1083	753.2774
5	68 TTU		0.8455	0.7148	0.0734	642.2352
6	34 GCOD		0.8632	0.7451	0.0304	296.8923
7	64 TACCP		0.8794	0.7734	0.0283	310.7190
8	39 GPRMN		0.8908	0.7935	0.0201	242.5374
9	66 B		0.8959	0.8026	0.0091	115.1765
10	58 TACOD		0.9003	0.8106	0.0079	104.2116
11	65 TAELPH		0.9046	0.8182	0.0076	104.6775
12	24 VHERR		0.9080	0.8244	0.0062	88.2585
13	29 VBEN		0.9112	0.8303	0.0059	86.4205
14	42 FRMCOD		0.9141	0.8356	0.0053	79.6888
15	12 CFCOD		0.9166	0.8402	0.0046	71.9703

Appendix Table 2f: Factor 6

MULTIPLE R	0.9665
MULTIPLE R-SQUARE	0.9341
ADJUSTED R-SQUARE	0.9337
STD. ERROR OF EST.	0.2322

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	1899.0812	14	135.6487	2515.52
RESIDUAL	134.00265	2485	.5392461E-01	

VARIABLES IN EQUATION FOR FACTOR6

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		-24.63130)				
AFCOD	1	0.24135	0.0799	0.016	0.99142	9.12
AFCAP	3	0.05874	0.0286	0.011	0.99222	4.14
APFLAT	4	8.58744	0.0503	0.882	0.99532	29188.27
VFLAT	26	.11582E-01	.8570E-03	0.070	0.99431	182.63
VFRWN	28	-.20629E-03	.8286E-04	-0.013	0.99294	6.20
GFLAT	37	-308.56588	4.4151	-0.361	0.99500	4884.38
GOTHR	38	11.53721	4.4200	0.014	0.98870	6.81
GFRWN	39	-4.21612	1.7808	-0.012	0.99328	5.61
GCOF	40	-2.27547	1.0999	-0.011	0.99616	4.28
FRMHERR	43	0.56130	0.2504	0.012	0.99369	5.03
FRMFLAT	45	-1.92188	0.3238	-0.031	0.99179	35.22
TAFLAT	61	1.94355	0.0756	0.133	0.99133	660.89
TAOTHR	62	-0.34600	0.0575	-0.031	0.99537	36.25
TT	69	-5.19608	0.2291	-0.117	0.99262	514.57

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F TO ENTER
1	4 APFLAT		0.8753	0.7662	0.7662	8186.8695
2	37 GFLAT		0.9450	0.8931	0.1269	2964.1656
3	61 TAFLAT		0.9549	0.9118	0.0187	530.3977
4	69 TT		0.9623	0.9260	0.0141	475.9322
5	26 VFLAT		0.9645	0.9311	0.0051	184.7546
6	62 TAOTHR		0.9654	0.9320	0.0009	34.2930
7	45 FRMFLAT		0.9659	0.9330	0.0009	35.2325
8	38 GOTHR		0.9660	0.9332	0.0002	8.8536
9	1 AFCOD		0.9661	0.9334	0.0002	8.3761
10	28 VFRWN		0.9662	0.9336	0.0002	6.3225
11	43 FRMHERR		0.9663	0.9337	0.0001	5.3010
12	39 GFRWN		0.9664	0.9339	0.0001	5.4075
13	40 GCOF		0.9664	0.9340	0.0001	4.2189
14	3 AFCAP		0.9665	0.9341	0.0001	4.1365

Appendix Table 2g: Factor 7

MULTIPLE R	0.9556
MULTIPLE R-SQUARE	0.9131
ADJUSTED R-SQUARE	0.9126
STD. ERROR OF EST.	0.2671

ANALYSIS OF VARIANCE

	SUM OF SQUARES	DF	MEAN SQUARE	F RATIO
REGRESSION	1861.4958	15	124.0997	1739.81
RESIDUAL	177.18265	2484	.7132957E-01	

VARIABLES IN EQUATION FOR FACTOR7

VARIABLE		COEFFICIENT	STD. ERROR OF COEFF	STD REG COEFF	TOLERANCE	F TO REMOVE
(Y-INTERCEPT		-33.28785)				
APOTHR	5	7.21317	0.0532	0.806	0.99083	18355.39
APEUPH	9	-0.32172	0.0287	-0.066	0.99543	125.41
CFCCD	12	5.85973	0.8076	0.043	0.99511	52.65
VOTHR	27	.17644E-02	.2685E-03	0.039	0.99460	43.17
GCOD	34	-62.46656	8.0835	-0.046	0.99707	59.72
GCTHR	38	-185.04503	5.0625	-0.217	0.99695	1336.08
GPRWN	39	41.28242	2.0462	0.120	0.99513	407.02
GCOF	40	9.32959	1.2656	0.044	0.99525	54.34
FRMEUPH	49	-1.66604	0.2012	-0.049	0.99606	68.55
TACAP	60	-0.54649	0.0586	-0.055	0.99561	86.84
TAOTHR	62	4.16286	0.0661	0.373	0.99417	3961.65
TACCP	64	-0.70681	0.0434	-0.097	0.99415	264.71
8	66	-0.88176	0.1300	-0.040	0.99481	46.01
TTU	68	-6.07566	0.2589	-0.139	0.99526	550.85
TT	69	1.76385	0.2637	0.040	0.99063	44.74

SUMMARY TABLE

STEP NO.	VARIABLE ENTERED	VARIABLE REMOVED	MULTIPLE R	MULTIPLE RSQ	INCREASE IN RSQ	F TO ENTER
1	5 APOTHR		0.8137	0.6621	0.6621	4854.0277
2	62 TAOTHR		0.8953	0.8015	0.1394	1753.6563
3	38 GCTHR		0.9215	0.8492	0.0477	788.9717
4	68 TTU		0.9319	0.8685	0.0193	366.8742
5	39 GPRWN		0.9402	0.8841	0.0156	334.5720
6	64 TACCP		0.9451	0.8932	0.0091	213.5394
7	9 APEUPH		0.9472	0.8973	0.0041	98.6842
8	60 TACAP		0.9490	0.9005	0.0032	81.2338
9	34 GCOD		0.9500	0.9026	0.0021	52.7539
10	49 FRMEUPH		0.9511	0.9046	0.0021	53.6193
11	40 GCOF		0.9522	0.9066	0.0020	52.7571
12	12 CFCCD		0.9531	0.9084	0.0018	48.7184
13	27 VOTHR		0.9540	0.9100	0.0016	44.8888
14	66 E		0.9547	0.9115	0.0015	41.8612
15	69 TT		0.9556	0.9131	0.0016	44.7367

Appendix Table 3.--Mean annual food composition of the species groups in SKEBUB-Balsfjord in the equilibrium year of the baseline run.

SPECIES AS PREY (columns); SPECIES AS PREDATOR (rows)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.5	2.9	0.1	0.4	5.3	2.7	8.7	51.6	5.0	1.4
3	0.0	0.9	0.0	0.0	0.8	3.2	0.1	0.4	11.0	3.6	3.8	42.5	12.0	0.0
4	0.0	0.3	1.4	3.5	0.7	7.9	0.1	0.4	8.8	3.3	0.0	15.4	6.8	0.0
5	0.0	0.3	0.0	0.0	0.0	0.9	0.1	0.2	0.8	0.0	13.6	40.5	8.7	0.1
6	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.4	0.0	8.5	15.1	4.0	0.1
7	0.0	0.1	0.2	0.6	0.0	0.2	0.0	0.1	4.0	65.2	1.8	6.5	16.1	0.0
8	0.0	0.4	0.9	2.2	0.5	3.4	0.1	0.3	5.5	12.8	8.3	34.2	9.0	0.0
9	0.0	0.3	0.0	0.0	0.2	0.9	0.0	0.1	0.3	8.6	5.5	13.1	5.9	2.9
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	1.1	0.0	0.2	8.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	2.2
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	3.0
13	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.2	11.6	2.6	0.6	3.8
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix Table 4.--Simple correlation coefficients between output variables and their grouping corresponding to the identified principal components.

CORRELATION MATRIX

		PCCOD 70	PCHERR 71	PCCAP 72	PCFLAT 73	PCOTHR 74	PCPRWN 75	PCBEN 76	PCCOP 77	PCEUPH 78	PCZOO 79	PCPHYT 80	SCCOD 81	SCHERR 82
PCCOD	70	1.000												
PCHERR	71	-0.032	1.000											
PCCAP	72	0.042	-0.365	1.000										
PCFLAT	73	0.016	-0.009	0.023	1.000									
PCOTHR	74	0.022	-0.058	0.018	0.050	1.000								
PCPRWN	75	0.090	-0.231	0.254	-0.020	0.061	1.000							
PCBEN	76	0.144	-0.169	0.235	0.030	0.021	0.274	1.000						
PCCOP	77	-0.062	-0.258	0.370	0.012	-0.010	0.173	0.465	1.000					
PCEUPH	78	0.023	-0.458	0.505	0.023	-0.009	0.365	0.493	0.539	1.000				
PCZOO	79	0.329	-0.201	0.307	0.020	0.037	0.321	0.604	0.391	0.648	1.000			
PCPHYT	80	0.177	0.337	-0.396	-0.012	0.046	-0.211	-0.410	-0.833	-0.590	-0.354	1.000		
SCCOD	81	0.888	0.150	-0.128	0.001	-0.015	-0.032	-0.043	-0.211	-0.254	-0.011	0.408	1.000	
SCHERR	82	-0.274	0.050	-0.223	-0.008	-0.008	-0.225	-0.482	-0.356	-0.443	-0.808	0.482	0.098	1.000
SCCAP	83	-0.267	0.099	-0.153	-0.018	-0.013	-0.184	-0.479	-0.380	-0.427	-0.806	0.488	0.073	0.896
SCFLAT	84	-0.194	0.089	-0.133	0.037	-0.010	-0.156	-0.303	-0.205	-0.278	-0.553	0.295	0.060	0.626
SCOTH	85	-0.291	0.231	-0.266	-0.018	-0.013	-0.244	-0.445	-0.289	-0.476	-0.787	0.411	0.108	0.846
SCPRWN	86	-0.188	0.169	-0.237	-0.009	-0.002	-0.135	-0.508	-0.435	-0.491	-0.785	0.553	0.151	0.842
SCCOP	87	-0.094	-0.202	0.291	-0.003	-0.023	0.135	0.377	0.834	0.423	0.276	-0.723	-0.209	-0.293
SCEUPH	88	-0.029	-0.414	0.416	0.018	-0.040	0.289	0.422	0.463	0.803	0.559	-0.515	-0.301	-0.431
BBCOD	89	0.284	-0.571	0.403	0.019	0.097	0.310	0.368	0.268	0.607	0.665	-0.345	-0.108	-0.590
BBHERR	90	0.223	0.685	-0.052	0.012	0.030	0.034	0.112	-0.090	-0.017	0.336	0.116	0.113	-0.459
BBCAP	91	0.287	0.117	0.028	0.020	0.028	-0.018	0.213	0.088	0.178	0.623	0.055	0.150	-0.523
BBFLAT	92	0.019	-0.042	0.066	0.629	0.033	0.021	0.076	0.058	0.090	0.122	-0.074	-0.040	-0.113
BBOTH	93	0.208	0.011	-0.018	0.029	0.408	0.068	0.064	-0.146	-0.059	0.234	0.181	0.065	-0.227
BBPRWN	94	0.084	-0.092	0.151	-0.007	-0.014	0.344	0.587	0.375	0.465	0.709	-0.386	-0.102	-0.581
BBCOP	95	0.117	0.122	-0.216	0.004	0.027	-0.056	-0.293	-0.841	-0.256	-0.121	0.845	0.168	0.244
BBEUPH	96	0.114	0.449	-0.411	-0.025	0.040	-0.326	-0.329	-0.195	-0.740	-0.515	0.437	0.464	0.487

		SCCAP 83	SCFLAT 84	SCOTH 85	SCPRWN 86	SCCOP 87	SCEUPH 88	BBCOD 89	BBHERR 90	BBCAP 91	BBFLAT 92	BBOTH 93	BBPRWN 94	BBCOP 95
SCCAP	83	1.000												
SCFLAT	84	0.612	1.000											
SCOTH	85	0.823	0.584	1.000										
SCPRWN	86	0.844	0.622	0.770	1.000									
SCCOP	87	-0.323	-0.168	-0.212	-0.364	1.000								
SCEUPH	88	-0.398	-0.289	-0.452	-0.479	0.356	1.000							
BBCOD	89	-0.514	-0.404	-0.695	-0.529	0.192	0.547	1.000						
BBHERR	90	-0.331	-0.259	-0.327	-0.256	-0.097	-0.034	0.157	1.000					
BBCAP	91	-0.646	-0.366	-0.469	-0.458	0.019	0.123	0.159	0.310	1.000				
BBFLAT	92	-0.115	-0.268	-0.114	-0.129	0.038	0.091	0.103	0.054	0.066	1.000			
BBOTH	93	-0.219	-0.160	-0.425	-0.130	-0.160	-0.088	0.261	0.267	0.248	0.032	1.000		
BBPRWN	94	-0.566	-0.499	-0.490	-0.701	0.307	0.411	0.290	0.167	0.244	0.101	0.023	1.000	
BBCOP	95	0.299	0.127	0.128	0.323	-0.782	-0.205	-0.027	0.125	0.046	-0.024	0.178	-0.231	1.000
BBEUPH	96	0.406	0.339	0.553	0.496	-0.125	-0.699	-0.629	0.010	-0.012	-0.099	0.046	-0.376	-0.100

		BBEUPH 96
BBEUPH	96	1.000

Appendix Table 4 continued

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ABSOLUTE VALUES OF CORRELATIONS IN SORTED AND SHADED FORM
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 63 SCCAP    ■
 62 SCHERR   ■■
 65 SCOTH    ■■■
 66 SCPRWN   ■■■■
 79 PCZOC    ■■■■■
 84 SCFLAT   XXXMX■
 91 BBCAP    MXXXM+■
 89 BBCOD    XX▣XX+.■
 94 BBPRWN   MMX▣▣X--■
 95 BBCOP    --.-..  -■
 77 PCCOP    ++-++. -+■■
 87 SCCOP    --.+-. .-▣■■
 80 PCPHYI   XX+X+- ++■■■■
 75 PCPRWN   .--.-. -+ ...■
 78 PCEUPH   ++XXM-.MX-X+M+■
 96 BBEUPH   +XXXX+ M+ ..+-■■
 88 SCEUPH   ++XXX-.X+.X+X-■▣■
 72 PCCAP    ..---. +..+-+-X++■
 81 SCCOD       .  .  ...+ -X-.■
 70 PCCOD    ---.-.-- .  .  .  ■■
 71 PCHERR     -.. .M .-.+-XX++. ■
 90 BBHERR   -X-----...  .     ..■■
 92 BBFLAT   .....-                ■
 73 PCFLAT                         M■
 74 PCOTHR                           ■
 93 BBOTH    .-+.-.-- ....      . -  +■
 76 PCBEN    XX+XM-.+M-X++-X-+- ...    ■


THE ABSOLUTE VALUES OF
THE MATRIX ENTRIES HAVE BEEN PRINTED ABOVE IN SHADED FORM
ACCORDING TO THE FOLLOWING SCHEME
                    LESS THAN OR EQUAL TO          0.112
    .          0.112  TO AND INCLUDING             0.224
    -          0.224  TO AND INCLUDING             0.336
    +          0.336  TO AND INCLUDING             0.448
    X          0.448  TO AND INCLUDING             0.560
    M          0.560  TO AND INCLUDING             0.672
    ▣          0.672  TO AND INCLUDING             0.784
    ■                        GREATER THAN          0.784
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