RUNGROW: A Forest Growth Modeling Software
Package to Implement the GROW Routine

by

Laura A. Weber, Alan R. Ek, and Marian Eriksson

Staff Paper Series No. 47

November 20, 1984

Table of Contents

INTRODUCTION

RUNGROW is a software package designed to implement the GROW subprogram developed by the USDA Forest Service, North Central Forest Experiment Station (Brand, 1982). GROW is the condensed core of the STEMS (Stand and Tree Evaluation and Modeling System) program (Belcher, et. al., 1982). Specifically, RUNGROW is a set of input, output and related routines to implement the GROW program on modest computer facilities. In its present form it runs on the MERITSS instructional system on the University of Minnesota Cyber computer system. The program is written in a structured FORTRAN style that should facilitate modification, elaboration and adaptation to other computer systems. The principle reason for its construction was to facilitate usage by students and researchers with minimal computer background and limited interest in the elaborate input, output, and the other options available in the larger STEMS package.

RUNGROW is listed in APPENDIX A and sample run input and output are shown in APPENDIX B. Subprograms which accomplish site index code conversion were adapted from those used in the STEMS program. Annotations are made in the program listing as a further form of user information. Magnetic tape or other format copies of the program are available upon request.

STRUCTURE OF RUNGROW

Implementation of the subprogram GROW (Brand, 1981) requires a driving progam which:

i)   Inputs user options/specifications and plot and tree list data,

ii) Calls GROW (for each plot and each projection period) to update the tree list,

iii) Computes desired yields, and

iv) Outputs plot summaries for each projection period.

RUNGROW is such a driving program. Its structure in algorithmic form is:

1. Read from a file named CONVERT the mapping by which the input species codes are to be associated with the thirty-one species codes used by GROW.

2. Read run options/specifications from a file named LIST1.

3. Set crown ratio and tree status codes.

4. Read plot data and the associated tree list from the file LIST1.

5. Compute species specific site indicies for each tree in the tree list.

6. Compute plot yields.

7. Write plot summaries to a file named OUTPUT.

8. If another projection for the current plot is desired call GROW to update the tree list and then go to Step 6.

9. If there are more plots to be projected then go to Step 3.

10. Terminate run.

INPUTS TO RUNGROW

The user must provide two input files, CONVERT and LIST1. CONVERT defines the mapping by which the input species codes are associated with the thirty-one species codes used by GROW (Brand, 1981 and APPENDIX C). Use of this file provides flexibility in species code useage. LIST1 contains run options/specifications and plot data and the associated tree list for each plot. File structures are defined in APPENDIX B.

ACCESSING RUNGROW ON THE MERITSS SYSTEM

To run RUNGROW on the MERITSS system one must acquire the two input files and the RUNGROW (source) code. Assuming the simplest case where the input files reside in the Cyber account under which RUNGROW is to be executed and are called CONVERT and LIST1, the following two statements will acquire the files

```
            A,CONVERT,LIST1
            OLD,RUNGROW/UN=2219303/ND.
And

            M77,I=RUNGROW,L=0
```

will cause RUNGROW to be compiled, linked and executed by the resident FORTRAN M77 compiler.

LITERATURE CITED

Belcher, D. W., M. R. Holdaway and G. J. Brand. 1982. A description of STEMS, the stand and tree evaluation and modeling system. USDA For. Ser. GTR NC-79.

Brand, Gary J. 1981. GROW - a computer subroutine that projects the growth of trees in Lake States' forests. USDA For. Serv. Res. Pap. NC-207. 11p.

Carmean, W. H. and A. Vasilesky. 1971. Site-index comparisons for tree species in northern Minnesota. USDA For. Ser. Res. Pap. NC-65. 8p.

Carmean, W. H. 1979. Site indes comparisons among northern hardwoods in northern Wisconsin and upper Michigan. USDA For. Ser. Res. Pap. NC-169. 17p.

Ek, A. R., E. T. Birdsall and R. J. Spears. 1984. A simple model for estimating total and merchantable tree heights. USDA For. Ser. Res. Note NC-309. 5p.

Gevarkiantz, S. R. and L. P. Olsen. 1955. Composite volume tables for timber and their application in the Lake States. USDA For. Ser. Tech. Bul. 1104. 51p.

Green, D. C. and D. F. Grigal. 1978. Generalized biomass estimation equation for Jack pine (Pinus banksiana Lamb.). Univ. Minn. College of Forestry Research Note No. 268. 4p.

Schlaegal, B. E. 1975. Estimating aspen volume and weight for individual trees, diameter classes or entire stands. USDA For. Ser. GTR NC-20. 16p.

APPENDIX A: Listing of RUNGROW Source code.

```
      PROGRAM RUNGROW(INPUT,OUTPUT,LIST1,CONVERT,SICOEFF,TAPE4=SICOEFF,
    1     TAPE5=LIST1,TAPE6=OUTPUT,TAPE8=CONVERT)
C*********          PROGRAM IDENTIFICATION
C
C*                      RUNGROW
C
C*    RUNGROW IS A FORTRAN PROGRAM WHICH PROJECTS STAND
C*    CHARACTERISTICS THROUGH THE USE OF THE USFS NCFES
C*    SUBROUTINE 'GROW'.    PROJECTIONS ARE MADE FOR USER
C*    SPECIFIED PROJECTION PERIODS AND CAN BE   OUTPUTTED
C*    AT SPECIFIED INTERVALS IN EACH PERIOD.
C
C*    WRITTEN   11/20/84 BY L. A. WEBER AND A. R. EK
C*                      COLLEGE OF   FORESTRY
C*                      UNIVERSITY OF MINNESOTA
C
C********
C****              INPUT/OUTPUT FILES
C*
C*        TAPE4 = SITE INDEX COEFFICIENTS
C*        TAPE5 = CARD READER INPUT FILE
C*        TAPE6 = LINE PRINTER OUTPUT FILE
C*        TAPE8 = SPECIES CODE - SPECIES GROUP CONVERSION TABLE FILE
C*
C****              SUBROUTINES
C*
C*        GROW   = SUBROUTINE TO PROJECT TREE ATTRIBUTES
C*        GRPSI  = SUBROUTINE TO COMPUTE SITE INDICES FOR EACH SPECIES
C*                 GROUP
C*        OUTPUT = SUBROUTINE TO PRODUCE AND PRINT TREE PROJECTIONS
C*        TREAT  = SUBROUTINE TO APPLY SILVICULTURAL TREATMENTS TO PLOTS
C*
C****              SIMPLE VARIABLES
C*
C*        AGE    = INITIAL AGE OF STAND
C*        BATOT  = TOTAL PER ACRE TREE BASAL AREA OF PLOT
C*        BIOMASS= INDIVIDUAL TREE BIOMASS
C*        BIOTOT = TOTAL PER ACRE TREE BIOMASS
C*        FORM   = STEM FORM FACTOR
C*        IDIA   = DIAMETER CLASS OF TREE (.95-2.95, 2.95-4.95,
C*                 4.95-6.95,...,46.95-48.954, 48.95-50.955)
C*        IDNO   = PLOT IDENTIFICATION NUMBER
C*        IERR   = ERROR FLAG RETURNED BY GROW SUBROUTINE
C*        IP     = PROJECTION PERIOD COUNTER
C*        ISPC   = CONVERSION TABLE SPECIES CODE
C*        MORT   = TYPE OF MORTALITY (STOCHASTIC OR DETERMINISTIC)
C*        NC     = NUMBER OF SPECIES CODE ASSIGNMENTS
C*        NT     = NUMBER OF TREES IN PLOT
C*        NUPL   = NEW PLOT INDICATOR
C*        NYRS   = NUMBER OF YEARS IN PROJECTION
C*        OPT1   = IMPOSE SILVICULTURAL TREATMENT (0 - NO, 1 - YES)
C*        PROJPER= NUMBER OF PROJECTION PERIODS
C*        QDTOT  = TOTAL QUADRATIC MEAN DBH
C*        SI     = SITE INDEX OF PLOT (HEIGHT AT 50 YEARS)
```

```
C*           TIME   = NUMBER OF YEARS FROM BASE YEAR TO END OF PROJECTION
C*                    PERIOD
C*           TRTOT  = TOTAL NUMBER OF TREES PER ACRE IN PLOT
C*           VOLTOT = TOTAL PER ACRE STEM VOLUME OF TREES
C*           YRB    = BASE YEAR (START) OF PROJECTION
C*           YRPROJ = YEAR OF PROJECTION
C*
C****                        ARRAY VARIABLES
C*
C*           ASI    = SCRATCH VECTOR
C*           BA     = BASAL AREA PER ACRE OF TREES BY SPECIES GROUP
C*           BIOMAS = TREE BIOMASS PER ACRE BY SPECIES GROUP
C*           BSI    = SCRATCH VECTOR
C*           B1-B6  = COEFFICIENTS IN BIOMASS FUNCTION
C*           CFAC   = BIOMASS CORRECTION FACTOR FOR EACH SPECIES GROUP
C*           CRC    = CROWN RATIO CODES OF TREES
C*           CRD    = DIFFERENCES BETWEEN OBSERVED AND PREDICTED CROWN
C*                    RATIOS OF TREES
C*           DBH    = DBH'S OF TREES
C*           DBH2   = SQUARED DBH BY SPECIES GROUP
C*           DCLASS = NUMBER OF LIVE TREES IN EACH 2" DIAMETER CLASS
C*           G0-G1  = COEFFICIENTS FOR COMPUTING SPECIES CODE SITE INDEX
C*                    FROM PLOT (MAJOR SPECIES) SITE INDEX
C*           HT     = TOTAL HEIGHTS OF TREES
C*           ISP1   = SCRATCH VECTOR
C*           ISP2   = SCRATCH VECTOR
C*           ISPG   = SPECIES GROUP CODES OF TREES
C*           ISTAT  = STATUS CODES OF TREES
C*           PERLGTH= NUMBER OF YEARS FROM BASE YEAR TO END OF PROJECTION
C*                    PERIOD
C*           QMEAND = QUADRATIC MEAN DBH BY SPECIES GROUP
C*           SPGRP  = SPECIES CODE TO SPECIES GROUP CONVERSION
C*           SPP    = TREE SPECIES CODE
C*           SPSI   = SITE INDEX OF EACH DIFFERENT SPECIES GROUP IN PLOT
C*           TRACRE = TREES PER ACRE FACTOR EXPANSION BY SPECIES GROUP
C*           TRFAC  = TREES PER ACRE EXPANSION
C*           VOLUME = PER ACRE STEM VOLUME BY SPECIES GROUP
C*
C****                        EXTERNALS
C*
C*           AMAX1  = REAL MAXIMUM NUMBER FUNCTION
C*
C*********                   INITIALIZATION BLOCK
C*
             INTEGER  AGE
             REAL     BA(31)
             REAL     BATOT
             REAL     BIOMAS(31)
             REAL     BIOMASS
             REAL     BIOTOT
             REAL     B1,B2,B3,B4,B6
             REAL     CFAC
             REAL     CRC(200)
             REAL     CRD(200)
             REAL     DBH(200)
```

```
        REAL      DBH2(31)
        REAL      DCLASS(25)
        REAL      FORM
        REAL      G0,G1
        REAL      HT(200)
        INTEGER   IDIA
        INTEGER   IDNO
        INTEGER   IERR
        INTEGER   IP
        INTEGER   ISPC
        INTEGER   ISPG(200)
        INTEGER   ISTAT(200)
        INTEGER   MORT
        INTEGER   NC
        INTEGER   NT
        INTEGER   NUPL
        INTEGER   NYRS
        INTEGER   OPT1
        INTEGER   PERLGTH(100)
        INTEGER   PROJPER
        REAL      QDTOT
        REAL      QMEAND(31)
        INTEGER   SPGRP(999)
        REAL      SI
        INTEGER   SPP(100)
        REAL      SPSI(31)
        INTEGER   TIME
        REAL      TRACRE(31)
        REAL      TRFAC(200)
        REAL      TRTOT
        REAL      VOLTOT
        REAL      VOLUME(31)
        INTEGER   YRB
        INTEGER   YRPROJ
        COMMON /BLK1/ CFAC(31),B1(31),B2(31),B3(31),B4(31),B6(31),
       1              G0(31,31),G1(31,31)
        COMMON /DUMMY/ B5(31),ASI(113),BSI(113),ISP1(113),ISP2(113)
        DATA      G0/961*0.0/
        DATA      NSIC,MAXNC/113,100/
        DATA      G1/961*0.0/
        DATA      MORT/0/
C*
C*********              EXECUTION BLOCK
C*
C*    READ SPECIES CODE - SPECIES GROUP CONVERSION TABLE
C*
      C = 0
      DO 1 I=1,MAXNC
         READ(8,*,END=2) ISPC,SPGRP(ISPC)
         NC = NC + 1
    1 CONTINUE
    2    CONTINUE
C*
C*    READ SITE INDEX COEFFICIENTS
C*
```

```
         DO 3 I=1,NSIC
            IF(ISP1(I) .EQ. 0) GO TO 3
            GO(ISP2(I),ISP1(I)) = ASI(I)
            G1(ISP2(I),ISP1(I)) = BSI(I)
3        CONTINUE
C*
C*     READ RUN OPTIONS
C*
       READ(5,*,END=99) OPT1,PROJPER,(PERLGTH(I),I=1,PROJPER)
C*
C*     SET ALL CROWN RATIOS TO ZERO AND ALL STATUS CODES TO ONE
C*     FOR BASE YEAR
C*
     5 DO 6 I=1,200
          CRC(I)=0.0
          ISTAT(I)=1
     6 CONTINUE
C*
C*     READ PLOT DATA
C*
       READ(5,8,END=99) IDNO,YRB,AGE,SI,NT
     8 FORMAT(I5,19X,I5,6X,I4,F4.0,6X,I4)
C*
C*     READ INDIVIDUAL TREE DATA AND ASSIGN SPECIES GROUP TO SPECIES CODE
C*
          DO 10 I=1,NT
             READ(5,*) SPP(I),DBH(I),TRFAC(I)
          ISPG(I)=SPGRP(SPP(I))
   10     CONTINUE
          IP=0
          GO TO 18
   13     NUPL=0
C*
C*        CALL TREAT SUBROUTINE
C*
          IF(OPT1.EQ.1) WRITE(6,14)
   14      FORMAT('THE TREATMENT SUBROUTINE IS ',
      1        'NOT AVAILABLE IN THIS VERSION')
C*
C*        CALL GROW SUBROUTINE - LOOP OVER A PROJECTION PERIOD
C*
   15     IP=IP+1
             IF(IP.EQ.1) THEN
               NYRS=PERLGTH(IP)
             ELSE
               NYRS=PERLGTH(IP) - PERLGTH(IP-1)
             ENDIF

C***********************************************************************
C
C          SEE GROW LISTING IN BRAND (1982).
C
C***********************************************************************

          CALL GROW(NYRS,NT,DBH,ISPG,ISTAT,TRFAC,CRC,CRD,SI,MORT,NUPL,
```

```
    1                IERR)
C*
C*        EXIT LOOP IF THERE IS AN ERROR AND PRINT MESSAGE
C*
          IF(IERR.EQ.3) GO TO 50
          IF(IERR.EQ.2) GO TO 60
          IF(IERR.EQ.1) GO TO 70
C*
C*        PER ACRE CALCULATIONS OF BASAL AREA, QUADRATIC MEAN DBH AND
C*        NUMBER OF TREES BY SPECIES FOR LIVE TREES
C*
   18         DO 20 J=1,31
                 BA(J)=0.
                 DBH2(J)=0.
                 TRACRE(J)=0.
   20         CONTINUE
              BATOT=0.
              QDTOT=0.
              TRTOT=0.
              DO 30 K=1,NT
                 IF(ISTAT(K).NE.1) GO TO 30
                   L=ISPG(K)
                   BA(L)=BA(L) + .005454*DBH(K)*DBH(K)*TRFAC(K)
                   DBH2(L)=DBH2(L)+DBH(K)*DBH(K)*TRFAC(K)
                   TRACRE(L)=TRACRE(L) + TRFAC(K)
                   QDTOT=QDTOT+DBH(K)*DBH(K)*TRFAC(K)
   30         CONTINUE
C*
C*        CALCULATE SITE INDEX FOR EACH SPECIES GROUP (BASE YEAR ONLY)
C*
          IF(IP.EQ.0) CALL GRPSI(SI,BA,SPSI)
C*
              DO 35 L=1,31
                 IF(TRACRE(L).EQ.0.) GO TO 35
                 BATOT=BATOT + BA(L)
                 TRTOT=TRTOT + TRACRE(L)
                 QMEAND(L)=SQRT(DBH2(L)/TRACRE(L))
   35         CONTINUE
              QDTOT=SQRT(QDTOT/TRTOT)
C*
C*        HEIGHT,BIOMASS,AND STEM VOLUME CALCULATIONS
C*
              DO 40 I=1,31
                 BIOMAS(I)=0.
                 VOLUME(I)=0.
   40         CONTINUE
              BIOTOT=0.
              VOLTOT=0.
              DO 42 I=1,NT
                 IF(ISTAT(I).NE.1) GO TO 42
                 J=ISPG(I)

C*********************************************************************
C*
C*            CALCULATE TOTAL TREE HEIGHT
```

```
C*            HEIGHT EQUATION FROM EK, ET. AL. 1982
C*            (SEE LITERATURE SITED)
C*
C********************************************************************

            HT(I)=4.5 + B1(J)*(1 - EXP(-B2(J)*DBH(I)))**B3(J)*SPSI(J)
     1      **B4(J)*BATOT**B6(J)


C********************************************************************
C*
C*            CALCULATE SOFTWOOD BIOMASS
C*                ADAPTED FROM AN EQUATION FOR JACK PINE GIVEN BY
C*                GREEN D. C. AND D. F. GRIGAL (1978)
C*
C********************************************************************

            IF(ISPG(I).LE.10.OR.ISPG(I).EQ.27) THEN
            BIOMASS=0.26745956*(DBH(I)**2.0394286)
     1      *(HT(I)**0.66084593)*TRFAC(I)
            ELSE


C********************************************************************
C*
C*            CALCULATE HARDWOOD BIOMASS
C*                ADAPTED FORM AND EQUATION FOR ASPEN GIVEN BY
C*                SCHLAEGAL, B. E. (1975)
C*
C********************************************************************

            BIOMASS=0.089199*(DBH(I)**1.97992)
     1      *(HT(I)**0.98996)*TRFAC(I)
            ENDIF


C********************************************************************
C*
C*            CORRECTION FACTOR
C*                NOTE:  BIOMASS VALUES ARE FOR DRY WEIGHT IN LBS ABOVE
C*                       A 0.5 FOOT STUMP; INCLUDES STEM AND BRANCH WOOD
C*                       AND BARK.  VALUES FOR THESE TWO SPECIES ARE
C*                       REPRESENTATIVE OF VALUES FOR OTHER SPECIES IN
C*                       THE HARDWOOD AND SOFTWOOD CATEGORIES.
C*
C********************************************************************

            BIOMAS(J)=BIOMAS(J) + AMAX1(BIOMASS*CFAC(J),0.0)

C********************************************************************
C*
C*            CALCULATE TOTAL STEM AND WOOD VOLUME
C*                VOLUME EQUATION ADAPTED FROM GEVORKIANTZ, S. R. AND
C*                L. P. OLSEN (1955) AND MODIFIED FOR TREES LESS THAN
C*                30 FEET BY ALAN R. EK.
C*
C********************************************************************
```

```
                FORM=0.42
                IF(HT(I).LT.30.) FORM=0.42 + (30. - HT(I))*0.006
                VOLUME(J)=VOLUME(J) + FORM*HT(I)*(.005454*DBH(I)*DBH(I)
       1        *TRFAC(I))
   42       CONTINUE
C*
C*        CALCULATE TOTAL BIOMASS AND VOLUME FOR PLOT
C*
            DO 45 J=1,31
                IF(TRACRE(J).EQ.0.) GO TO 45
                BIOTOT=BIOTOT + BIOMAS(J)
                VOLTOT=VOLTOT + VOLUME(J)
   45       CONTINUE
C*
C*        CALCULATE NUMBER OF LIVE TREES IN EACH DIAMETER CLASS
C*
            DO 46 K=1,25
                DCLASS(K)=0.
   46       CONTINUE
            DO 47 L=1,NT
                IF(ISTAT(L).NE.1) GO TO 47
                IF(DBH(L).LE.0.95) GO TO 47
                IDIA=IFIX((DBH(L)-0.95)/(50.)*(24.9999999)+1.)
                DCLASS(IDIA)=DCLASS(IDIA) + TRFAC(L)
   47       CONTINUE
C*
C*        PRINT OUTPUT
C*
            TIME=0
            IF(IP.GT.0) TIME=PERLGTH(IP)
            YRPROJ=YRB+TIME
            CALL OUTPUT(QMEAND,QDTOT,TRACRE,BA,TRTOT,BATOT,YRPROJ,
       1                BIOMAS,BIOTOT,VOLUME,VOLTOT,IDNO,AGE,YRB,
       2                DCLASS)
C*
            IF(IP.EQ.0) GO TO 13
            IF(IP.LT.PROJPER) GO TO 15
            GO TO 5
C*
C*   PRINT ERROR MESSAGES RESULTING FROM GROW PROCESSING
C*
   50       WRITE(6,55)
   55       FORMAT('1',"THERE IS AN ILLEGAL SPECIES GROUP CODE.")
            GO TO 5
   60       WRITE(6,65)
   65       FORMAT('1',"NT IS LESS THAN 1 OR THERE ARE NO LIVE TREES.")
            GO TO 5
   70       WRITE(6,75)
   75       FORMAT('1',"NYRS IS LESS THAN 1.")
            GO TO 5
C*
   99 STOP
      END
C*
```

```
      SUBROUTINE GRPSI(SI,BA,SPSI)
C*********          PROGRAM IDENTIFICATION
C*
C*        SUBROUTINE GRPSI COMPUTES SITE INDICES FOR EACH SPECIES GROUP
C*         IN THE PLOT.  SITE INDEX EQUATIONS ARE FROM CARMEAN, W. H.
C*         AND A. VASILESKY (1971) AND CARMEAN, W. H. (1979).
C*
C*
C****               SIMPLE VARIABLES
C*
C*        BAMAX  = MAXIMUM SPECIES GROUP BASAL AREA
C*        ISPGMX = SPECIES GROUP HAVING THE MAXIMUM BASAL AREA
C*        SI     = PLOT SITE INDEX
C*
C****               ARRAY VARIABLES
C*
C*        BA     = BASAL AREA PER ACRE OF TREES BY SPECIES GROUP
C*        G0-G1  = COEFFICIENTS FOR COMPUTING SPECIES CODE SITE INDEX
C*                 FROM PLOT (MAJOR SPECIES) SITE INDEX
C*        SPSI   = SPECIES GROUP SITE INDEX
C*
C*********          INITIALIZATION BLOCK
C*
        REAL      BA(31)
        REAL      BAMAX
        REAL      G0,G1
        INTEGER   ISPGMX
        REAL      SI
        REAL      SPSI(31)
        COMMON /BLK1/ CFAC(31),B1(31),B2(31),B3(31),B4(31),B6(31),
     1                G0(31,31),G1(31,31)
C*
C*********          EXECUTION BLOCK
C*
C*    SET ALL GROUP SITE INDICES TO ZERO
C*
      DO 10 I=1,31
          SPSI(I)=0.0
   10 CONTINUE
C*
C*    FIND SPECIES GROUP WITH MAXIMUM BASAL AREA
C*
      ISPGMX=1
      BAMAX=BA(1)
      DO 20 J=2,31
         IF(BA(J).GT.BAMAX) THEN
           ISPGMX=J
           BAMAX=BA(J)
         ENDIF
   20 CONTINUE
C*
C*    ASSIGN PLOT SITE INDEX TO SPECIES GROUP WITH MAXIMUM BASAL AREA
C*    AND CALCULATE SPECIES GROUP SITE INDICES ON BASIS OF PLOT SITE
C*    INDEX.  SET GROUP SITE INDEX EQUAL TO PLOT SITE INDEX FOR SPECIES
```

```
C*      GROUPS WITHOUT SITE INDEX COEFFICIENTS
C*
        SPSI(ISPGMX)=SI
        DO 30 K=1,31
            IF(SPSI(K).LE.0.0)
      1     SPSI(K)=G0(K,ISPGMX) + G1(K,ISPGMX)*SI
            IF(SPSI(K).LT.0.0001) SPSI(K)=SI
   30 CONTINUE
        RETURN
        END
C*
```

```
      SUBROUTINE OUTPUT(QMEAND,QDTOT,TRACRE,BA,TRTOT,BATOT,YRPROJ,
     1                  BIOMAS,BIOTOT,VOLUME,VOLTOT,IDNO,AGE,YRB,
     2                  DCLASS)
C*********          PROGRAM IDENTIFICATION
C*
C*        SUBROUTINE OUTPUT PRINTS PLOT SUMMARIES
C*
C****              SIMPLE VARIABLES
C*
C*        AGE    = INITIAL AGE OF STAND
C*        BATOT  = TOTAL PER ACRE TREE BASAL AREA OF PLOT
C*        BIOTOT = TOTAL PER ACRE TREE BIOMASS
C*        IDNO   = PLOT IDENTIFICATION NUMBER
C*        NT     = NUMBER OF TREES ON PLOT
C*        QDTOT  = TOTAL QUADRATIC MEAN DBH
C*        TRTOT  = TOTAL NUMBER OF TREES PER ACRE IN PLOT
C*        YRB    = BASE YEAR (START) OF PROJECTION
C*        YRPROJ = YEAR OF PROJECTION
C*        VOLTOT = TOTAL PER ACRE STEM VOLUME OF TREES
C*
C****              ARRAY VARIABLES
C*
C*        BA     = BASAL AREA PER ACRE OF TREES BYECIES GROUP
C*        BIOMAS = TREE BIOMASS PER ACRE BY SPECIES GROUP
C*        DCLASS = NUMBER OF LIVE TREES IN EACH 2" DIAMETER CLASS
C*        QMEAND = QUADRATIC MEAN DBH BY SPECIES GROUP
C*        TRACRE = TREES PER ACRE EXPANSION FACTOR BY SPECIES GROUP
C*        VOLUME = PER ACRE STEM VOLUME BY SPECIES GROUP
C*
C****              INPUT/OUTPUT FILES
C*
C*        TAPE6 = LINE PRINTER OUTPUT FILE
C*
C*********          INITIALIZATION BLOCK
C*
          INTEGER   AGE
          REAL      BA(31)
          REAL      BATOT
          REAL      BIOMAS(31)
          REAL      BIOTOT
          REAL      DCLASS(25)
          INTEGER   IDNO
          REAL      QDTOT
          REAL      QMEAND(31)
          REAL      TRACRE(31)
          REAL      TRTOT
          REAL      VOLTOT
          REAL      VOLUME(31)
          INTEGER   YRB
          INTEGER   YRPROJ
C*
C*
C*        PRINT THE RUN TITLE AND TABLE HEADER
C*
```

```
      WRITE(6,5) IDNO,AGE,YRB
  5 FORMAT('1',"PLOT ID NO.= ",I5,3X,"INITIAL AGE OF STAND= ",I4,3X,"B
   1ASE YEAR= ",I5)
      WRITE(6,7) YRPROJ
  7 FORMAT(//" YEAR = ",I4)
      WRITE(6,9)
  9 FORMAT(/" SPECIES",8X,"QUADRATIC",8X,"TREES",8X,"BASAL AREA",8X,
   1        "BIOMASS",7X,"VOLUME")
      WRITE(6,10)
 10 FORMAT(2X,"CODE",10X,"MEAN  DBH",6X,"PER ACRE",8X,"PER ACRE",8X,
   1        "PER ACRE",6X,"PER ACRE")
C*
      DO 20 I=1,31
         IF (BA(I).LT..00001)GO TO 20
         WRITE(6,15) I,QMEAND(I),TRACRE(I),BA(I),BIOMAS(I),VOLUME(I)
 15      FORMAT(' ',3X,I2,10X,F6.1,11X,F6.1,10X,F6.1,7X,F9.1,6X,F8.1)
 20 CONTINUE
C*
      WRITE(6,30) QDTOT,TRTOT,BATOT,BIOTOT,VOLTOT
 30 FORMAT(" ALL SPECIES",4X,F6.1,11X,F6.1,10X,F6.1,7X,F9.1,6X,F8.1)
C*
      RETURN
      END
C*
```

COEFFICIENTS ADDED TO THE BLOCK DATA SUBPROGRAM OF GROW

```
C*****************************************    BLOCK DATA ABOVE THIS POINT ARE
C*                                            DATA FOR THE GROW ROUTINE, BELOW
C*                                            ARE DATA FOR THE RUNGROW PROGRAM
C*
C*      BIOMASS COEFFICIENTS
C*
        DATA CFAC/
C  1.000, 1.070, 0.814, 0.930, 0.837, 0.930, 1.232, 0.721,
C  0.930, 0.930, 1.289, 1.053, 1.658, 1.421, 1.316, 1.632,
C  0.974, 1.421, 1.579, 1.789, 1.658, 1.658, 1.316, 1.026,
C  1.000, 1.447, 1.070, 1.000, 1.000, 1.316, 1.000/
C*
C*      HEIGHT EQUATION COEFFICIENTS
C*
        DATA (B1(I),B2(I),B3(I),B4(I),B5(I),B6(I),I=1,31)/
C  .16934E+02,.12972E+00,.10000E+01,.20854E+00,.77792E+00,.12902E+00
C,.36851E+02,.82980E-01,.10000E+01,.10000E-04,.63884E+00,.18231E+00
C,.16281E+02,.86211E-01,.10000E+01,.16220E+00,.86833E+00,.23316E+00
C,.31957E+02,.18511E+00,.17020E+01,.00000E+00,.68967E+00,.16200E+00
C,.14304E+02,.19894E+00,.14195E+01,.23349E+00,.76878E+00,.12399E+00
C,.20038E+02,.18981E+00,.12909E+01,.17836E+00,.57343E+00,.10159E+00
C,.13620E+02,.24255E+00,.12885E+01,.25831E+00,.68128E+00,.10771E+00
C,.82079E+01,.19672E+00,.13112E+01,.33978E+00,.76173E+00,.11666E+00
C,.53117E+01,.10357E+00,.10000E+01,.68454E+00,.71410E+00,.00000E+00
C,.16934E+02,.12972E+00,.10000E+01,.20854E+00,.77792E+00,.12902E+00
C,.11291E+02,.25250E+00,.15466E+01,.35711E+00,.75060E+00,.68588E-01
C,.13625E+02,.28668E+00,.16124E+01,.30651E+00,.10292E+01,.74605E-01
C,.69572E+01,.26564E+00,.10000E+01,.48660E+00,.76954E+00,.16175E-01
C,.68600E+01,.27725E+00,.14287E+01,.40115E+00,.85299E+00,.12403E+00
C,.84580E+01,.27527E+00,.19602E+01,.34894E+00,.89213E+00,.12594E+00
C,.71852E+01,.28384E+00,.14417E+01,.38884E+00,.82157E+00,.11411E+00
C,.63628E+01,.27859E+00,.18677E+01,.49589E+00,.76169E+00,.58409E-01
C,.53416E+01,.23044E+00,.11529E+01,.54194E+00,.83440E+00,.63716E-01
C,.81782E+01,.27316E+00,.17250E+01,.38694E+00,.75822E+00,.10847E+00
C,.92078E+01,.22208E+00,.10000E+01,.31723E+00,.82560E+00,.13465E+00
C,.66844E+01,.19049E+00,.10000E+01,.43972E+00,.82962E+00,.10806E+00
C,.38011E+01,.39213E+00,.29053E+01,.55634E+00,.84317E+00,.95929E-01
C,.61034E+01,.17368E+00,.10000E+01,.44725E+00,.10237E+01,.14610E+00
C,.55346E+01,.22637E+00,.10000E+01,.46918E+00,.72456E+00,.11782E+00
C,.64301E+01,.23545E+00,.13380E+01,.47370E+00,.73385E+00,.82279E-01
C,.72773E+01,.22721E+00,.10000E+01,.41179E+00,.76498E+00,.11046E+00
C,.64301E+01,.23545E+00,.13380E+01,.47370E+00,.73385E+00,.82279E-01
C,.64301E+01,.23545E+00,.13380E+01,.47370E+00,.73385E+00,.82279E-01
C,.64301E+01,.23545E+00,.13380E+01,.47370E+00,.73385E+00,.82279E-01
C,.64301E+01,.23545E+00,.13380E+01,.47370E+00,.73385E+00,.82279E-01
C,.64301E+01,.23545E+00,.13380E+01,.47370E+00,.73385E+00,.82279E-01
C/
```

```
C*
C*      SITE COEFFICIENT ARRAYS
C*

        DATA ASI/
     , 23.850, 19.380, 18.840, 26.580, 15.900, 20.060,-11.870, -1.300,
     , 24.470, 18.690, 11.560,  7.480,  4.870,  7.040,  5.616, 13.004,
     , 22.082, 13.427,  7.706,  3.969, 35.708, 20.283,  8.686, 10.943,
     ,  9.417,  3.336,   .017, 18.470, 21.133, 21.133, 21.976, 11.452,
     , 19.926, 11.861, 14.611, 10.609,  4.696, 35.862,  6.593,  6.593,
     , 14.042,  1.628,  7.837,  1.371, 11.951,  6.787,  9.273, 14.390,
     , 12.670, 12.670, 17.342, 13.243,  4.068,  6.421,  2.585,  6.299,
     ,   .885, 17.712, 17.712, 13.238, 20.285,  9.362,  8.840, 10.327,
     , 15.101, 10.572, 35.432, 25.430, 25.430, 21.018, 12.862, 21.977,
     , 10.769, 12.318, 18.977, 11.189, 27.478, 23.089, 23.089, 21.765,
     , 10.430, -9.946, -1.339,  7.671,  3.045,   .906,-22.933, 13.919,
     , 13.919, 23.734, -5.865,  1.483,  2.624,-17.000, 15.208,  5.271,
     ,  5.206, -5.865,  1.483,  2.624,-17.000, 15.208,  5.271, -3.591,
     ,  5.168,  -.765,  9.115,  6.306, -3.853, 29.010,   .014,  -.239,
     ,  -.239  /
C

        DATA BSI/
     ,   .630,   .640,   .680,   .560,   .690,   .600,  1.170,  1.030,
     ,   .920,   .810,   .540,   .950,   .470,   .650,   .870,   .804,
     ,   .585,   .797,   .801,   .981,   .444,   .688,   .899,   .802,
     ,   .892,   .930,  1.065,   .760,   .766,   .766,   .675,   .814,
     ,   .628,   .746,   .770,   .766,   .963,   .429,  1.011,  1.011,
     ,   .784,  1.049,   .876,  1.050,   .880,   .885,   .956,   .867,
     ,   .958,   .958,   .806,   .789,   .881,   .904,   .883,   .832,
     ,  1.012,   .847,   .847,   .813,   .743,   .851,   .925,   .825,
     ,   .821,   .941,   .493,   .776,   .776,   .726,   .766,   .593,
     ,   .807,   .715,   .689,   .728,   .566,   .767,   .767,   .674,
     ,   .760,  1.154,   .951,   .903,   .849,   .885,  1.362,   .883,
     ,   .883,   .628,   .934,   .855,   .780,  1.111,   .672,   .849,
     ,   .816,   .934,   .855,   .780,  1.111,   .672,   .849,   .999,
     ,   .899,   .903,   .825,   .809,  1.023,   .580,   .997,  1.077,
     ,  1.077  /
C

        DATA ISP1/
     ,      2,      1,      3,      4,      2,      4,      2,      3,
     ,      8,     11,      7,      6,      5,      5,     11,     11,
     ,     11,     11,     11,     11,     11,     14,     14,     14,
     ,     14,     14,     14,     14,     14,     14,     14,     15,
     ,     15,     15,     15,     15,     15,     15,     15,     15,
     ,     15,     16,     16,     16,     16,     16,     16,     16,
     ,     16,     16,     16,     17,     17,     17,     17,     17,
     ,     17,     17,     17,     17,     18,     18,     18,     18,
     ,     18,     18,     18,     18,     18,     18,     19,     19,
     ,     19,     19,     19,     19,     19,     19,     19,     19,
     ,     26,     22,     22,     22,     22,     22,     22,     22,
     ,     22,     22,     24,     24,     24,     24,     24,     24,
     ,     25,     25,     25,     25,     25,     25,     25,     26,
     ,     26,     26,     26,     26,     26,     21,     26,     26,
     ,     26  /
C
```

```
      DATA ISP2/
,         1,         2,         2,         2,         3,         3,         4,         4,
,         5,         5,         6,         7,         8,        11,        14,        15,
,        16,        17,        18,        19,        22,        11,        15,        16,
,        17,        18,        19,        22,        24,        25,        26,        11,
,        14,        16,        17,        18,        19,        22,        24,        25,
,        26,        11,        14,        15,        17,        18,        19,        22,
,        24,        25,        26,        11,        14,        15,        16,        18,
,        19,        24,        25,        26,        11,        14,        15,        16,
,        17,        19,        22,        24,        25,        26,        11,        14,
,        15,        16,        17,        18,        22,        24,        25,        26,
,        21,        11,        14,        15,        16,        18,        19,        24,
,        25,        26,        16,        17,        18,        19,        22,        26,
,        15,        16,        17,        18,        19,        22,        26,        14,
,        15,        16,        17,        18,        19,        26,        22,        24,
,        25  /
      END
```

APPENDIX B.1: Sample CONVERT File.

The sample input file LIST1, given below, contains the information for three species: yellow birch, basswood and hard maples. These are coded (according to the U.S.D.A. Forest Service, Forest Survey coding system) as 27, 382, and 465, respectively. APPENDIX C lists the species group codes used by GROW (Brand, 1982). Consequently, for this sample run, CONVERT must contain at least three records to map the Forest Survey code 27 to the GROW code 16, etc.

SAMPLE INPUT FILE.

Record	Definition of input fields
1) 465 18	Correspondence of species codes.
2) 382 17	[Free format:
3) 27 16	LIST1 input code, GROW code.]

APPENDIX B.2:   Sample LIST1 File.

	Record	Definition of input fields

1)   0   3   10 20 30   Run options.
```
                             ⎡ Free format.
                             ⎢ Variables:            Values:
                             ⎢   Dummy                  0
                             ⎢   No. projections        3
                             ⎢   Yrs. to 1st proj.     10
                             ⎢   Yrs. to 2nd proj.     20
                             ⎣   Yrs. to 3rd proj.     30
```

2)   24 27 1   5 069N 21W 2 1984 15 91 10 60. 1421.   5
```
                             Plot record.
                             ⎡ FORMAT(I5,19X,I5,6X,I4,F4.0,6X,I5)
                             ⎢ Variables:            Values:
                             ⎢   Plot number            24
                             ⎢   Base year            1984
                             ⎢   Stand age              10
                             ⎢   Site index             60
                             ⎣   Number of trees          5
```

```
3)  465 3.0 100     Tree records (five trees in this example)
4)   27 4.2 200     ⎡ Free format.
5)  382 6.0 800     ⎢ Variables[1]:        Values[2]:
6)  382 4.0  20     ⎢   Species              465
7)   27 2.4  10     ⎢   Diameter             3.0
                    ⎣   Tree factor          100
```

---

[1] For each tree.
[2] For the first tree.

APPENDIX B.3: Sample Run Output.

PLOT ID NO.=   24   INITIAL AGE OF STAND=   10   BASE YEAR= 1984

YEAR = 1984

SPECIES CODE	QUADRATIC MEAN DBH	TREES PER ACRE	BASAL AREA PER ACRE	BIOMASS PER ACRE	VOLUME PER ACRE
16	4.1	210.0	19.6	20098.2	338.0
17	6.0	820.0	158.8	114758.2	3261.3
18	3.0	100.0	4.9	3679.5	70.4
ALL SPECIES	5.5	1130.0	183.3	138535.9	3669.7

PLOT ID NO.=   24   INITIAL AGE OF STAND=   10   BASE YEAR= 1984

YEAR = 1994

SPECIES CODE	QUADRATIC MEAN DBH	TREES PER ACRE	BASAL AREA PER ACRE	BIOMASS PER ACRE	VOLUME PER ACRE
16	4.6	148.3	16.9	18637.8	314.2
17	6.7	730.8	179.8	140023.4	3991.9
18	3.3	68.7	4.0	3196.5	61.3
ALL SPECIES	6.2	947.8	200.7	161857.7	4367.4

PLOT ID NO.=   24   INITIAL AGE OF STAND=   10   BASE YEAR= 1984

YEAR = 2004

SPECIES CODE	QUADRATIC MEAN DBH	TREES PER ACRE	BASAL AREA PER ACRE	BIOMASS PER ACRE	VOLUME PER ACRE
16	4.9	99.9	13.3	15485.5	261.6
17	7.4	659.7	194.8	159633.3	4561.6
18	3.5	49.2	3.3	2751.8	52.9
ALL SPECIES	6.9	808.8	211.5	177870.6	4876.1

PLOT ID NO.=   24   INITIAL AGE OF STAND=   10   BASE YEAR= 1984

YEAR = 2014

SPECIES CODE	QUADRATIC MEAN DBH	TREES PER ACRE	BASAL AREA PER ACRE	BIOMASS PER ACRE	VOLUME PER ACRE
16	5.3	64.9	9.9	11896.0	201.3
17	7.9	602.0	206.1	175072.8	5012.1
18	3.7	36.5	2.7	2379.5	45.8
ALL SPECIES	7.5	703.5	218.7	189348.3	5259.2

APPENDIX C: Species Group Codes Used by GROW.

Code	Species
1	Jack Pine
2	Red Pine
3	White Pine
4	White Spruce
5	Balsam Fir
6	Black Spruce
7	Tamarack
8	Northern White-Cedar
9	Hemlock
10	Other Softwoods
11	Black Ash
12	Cottonwood
13	Silver Maple
14	Red Maple
15	Elm
16	Yellow Birch
17	Basswood
18	Hard Maples
19	White Ash
20	White Oak
21	Northern Red Oak
22	Other Red Oaks
23	Hickories
24	Bigtooth Aspen
25	Quaking Aspen
26	Paper Birch
27	Red Pine Plantation
28	Not Used
29	Not Used
30	Other Commercial Hardwoods
31	Noncommercial