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ENERGY FLOW IN UTA STANSBURIANA:

COMPUTER PROGRAMS AND OTHER TABULATIONS

by

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December 1971

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ABSTRACT

The following report discusses some of the procedures and assumptions involved in a three-year analysis of energy flow in southern Nevada populations of Uta stansburiana.

The first part of the report is composed of five Fortran IV computer programs. The second portion of the report includes tabular data too extensive to publish in any other form, but which contributed to the definitive scientific article.

ENERGY FLOW IN UTA STANSBURIANA:
COMPUTER PROGRAMS AND OTHER TABULATIONS

INTRODUCTION

This report has been prepared in support of a three-year analysis of energy flow in populations of Uta stansburiana in southern Nevada. The analysis covers a three-year period, from March 1, 1965 to February 29, 1968. Energy flow is visualized as the sum of energy of respiration (R) and production (P). Production (P) is considered the algebraic sum of elimination (E) and change in standing crop. The last term may assume either positive or negative values. Energy lost in the excretion of nitrogenous wastes (U) is not considered in this analysis.

The report consists of tabulations too extensive or unimportant for formal publication, but which may be of use to other workers in the interpretation and evaluation of this research. The report is divided into two parts. The first part is made up of five Fortran IV programs. These programs are not represented as artistic triumphs, and some of them are obviously inefficient. However, they were validated carefully and are believed to be correct. The second part of the report is made up of various data compilations and program outputs.

A. The basic simulation of energy of respiration (R)

1. This program is specifically exemplified by the simulation for adult males in 1965-66. In general, the program calculates the total respiration energy for a group of adult male or female Uta over a

period of one year. The total cohort is subdivided into three age groups (8, 20, and 32+ months of age), each of which has its own death rate. The size of each age group changes daily according to an exponential function:

$$N_1 = N_0 e^{-\lambda}$$

with λ equal to the daily death rate factor for the age class. The maximum body temperature ($T_{\max}$) attainable changes daily in accordance with a sine function:

$$T_{\max} = 35 + 3[\sin(J+314)]$$

with J equal to zero on March 1, and all days numbered consecutively thereafter. The weight of each surviving individual of each age group also changes daily in accordance with the linear functions given in Tables 1, 2 and 3 of this report.

The daily changes in density and individual body weights are incorporated in a do loop initiated by the statement numbered one and concluded with the statement numbered 70. Within this do loop is another loop (initiated by statement 51) which takes into account hourly changes in body temperature for each day in question, and calculates for each age (and size) class the daily metabolism (in cc of oxygen) and calories (assuming 4.7 cal per cc of oxygen).

The hourly metabolism of an individual Uta is calculated according to the following function:

$$\text{cc } O_2 = XW^Y Z^T$$

with time-specific values of X , Y and Z as summarized in Table 4 of this report. W is the body weight of the individual and T is its

body temperature. During daylight, when T is $9 - 25^{\circ}\text{C}$ the oxygen consumption is increased by a factor of 2.5. When T is greater than 25° the scope factor is 2.0. If T is $<9^{\circ}\text{C}$, or it is dark, the oxygen consumption is not modified. The oxygen consumption values of yearling Uta (8 months of age in March) and older Uta are calculated separately. Oxygen consumption values at all three levels of activity are also computed separately. Hourly air temperatures and pyrhelimeter readings for each day of the year are read consecutively from a disc pack and used in the computations of Uta body temperatures and metabolism.

Following statement 70, the program is composed of no more than various summations and conversions, followed by instructions for printing out the results.

The program listing follows.

```

DIMENSION SOXA(38),ACROXA(38),ROXA(38),ATEM(24)
DIMENSION ATEMP(24),P(38),BTEMP(24),ROXJ(38),ACROXJ(38),SOXJ(38)
DIMENSION C(3),RMET(366),SMET(366),TMET(366),VMET(366),WMET(366)
DIMENSION XMET(366),WJ(366),WA(366),N(38),M(38),JTEMP(24)
REAL*8 TODAY
DATA M/38*0/
DATA N/38*0/
DATA P/38*0.0/
DATA WA/366*3.6/
DATA RMET, SMET, TMET, VMET, WMET, XMET/2196*0.0/
CALL DATE (TODAY)
1 DO 70 J=1,365
  DO 6 I=1,38
    N(I)=0
    M(I)=0
  6 CONTINUE
  TMAX = 35.0 + 3.0*(SIN((J+314)*0.01745))
  TMAXF=TMAX+0.5
  MAXT=TMAXF
  IF(J.LT.153) WJ(J) =2.3941 +J*(0.0059)
  IF(J.GT.152.AND.J.LT.306) WJ(J)=3.3
  IF(J.GT.305) WJ(J) =3.2948+((J-305)*0.00517)
  IF(J.LT.185)X=0.01047
  IF(J.GT.184.AND.J.LT.276)X=0.00643
  IF(J.GT.275)X=0.04256
  IF(J.LT.93)Y=0.742
  IF(J.GT.92.AND.J.LT.276)Y=0.679
  IF(J.GT.275)Y=0.177
  IF(J.LT.185)Z=1.1015
  IF(J.GT.184.AND.J.LT.276)Z=1.1247
  IF(J.GT.275)Z=1.084
  DO 50 I=1,38
    ROXJ(I)=X*(WJ(J)**Y)*(Z**I)
    ROXA(I)=X*(WA(J)**Y)*(Z**I)
    ACROXJ(I)=2.5*ROXJ(I)
    ACROXA(I)=2.5*ROXA(I)
    SOXJ(I)=2.0*ROXJ(I)
  50 SOXA(I)=2.0*ROXA(I)
  C(1)=149.5*(EXP(-0.0034*J))
  C(2)=47.74*(EXP(-0.0045*J))
  C(3)=3.52*(EXP(-0.0054*J))
51 DO 4 I=1,24
  4 P(I)=0.0
  READ(8,2) ATEM(24),(ATEM(I), I=1,23)
  2 FORMAT (8X,24F3.0)
  READ(8,3)(P(I),I=5,20)
  3 FORMAT (12X,16F4.2)
  DO 5 I=1,24
  5 ATEMP(I)=5.0*(ATEM(I)-32.0)/9.0
  DO 12 I=4,10
  12 L = I
  IF(P(I).LT.P(I+1)) GO TO 13
  12 CONTINUE
  13 NPF=L+1

```

```

      NPQ=NPFF+1
      NPZ=NPFF-1
      DO 15 I=14,20
      L = I
      IF (P(I).EQ.0.0) GO TO 16
15  CONTINUE
16  NPL=L-1
      NPY=NPL-2
      NPR=NPL-1
      DO 18 I=NPQ,NPY
18  BTEMP(I)=TMAXF
      DO 20 I=1,NPZ
      BTEMP(I)=ATEMP(I)
20  IF (BTEMP(I).GT.MAXT) BTEMP(I)=MAXT
      DO 21 I=NPL,24
      BTEMP(I)=ATEMP(I)
21  IF (BTEMP(I).GT.MAXT) BTEMP(I)=MAXT
      BTEMP(NPF)=ATEMP(NPZ)+0.5000*(TMAX-ATEMP(NPZ))
      BTEMP(NPR)=ATEMP(NPL)+0.5*(TMAX-ATEMP(NPL))
      DO 22 I=1,24
22  JTEMP(I)=BTEMP(I)
      M(MAXT)=NPY-NPQ+1
      DO 40 I=1,NPZ
      IF (JTEMP(I).LT.4) JTEMP(I)=4
      K=JTEMP(I)
40  N(K)=N(K)+1
      K=0
      DO 41 I=NPL,24
      IF (JTEMP(I).LT.4) JTEMP(I)=4
      K=JTEMP(I)
41  N(K)=N(K)+1
      K=0
      IF (JTEMP(NPF).LT.4) JTEMP(NPF)=4
      K=JTEMP(NPF)
      M(K)=M(K)+1
      K = 0
      IF (JTEMP(NPR).LT.4) JTEMP(NPR)=4
      K=JTEMP(NPR)
      M(K)=M(K)+1
      K = 0
      DO 60 K=4,8
60  N(K)=N(K)+M(K)
      RMET(J)=0.0
      SMET(J)=0.0
      DO 62 I=1,38
      RMET(J)=C(1)*N(I)*ROXJ(I)+RMET(J)
62  SMET(J)=(C(2)+C(3))*N(I)*ROXA(I)+SMET(J)
      TMET(J)=0.0
      VMET(J)=0.0
      DO 63 I=9,25
      TMET(J)=C(1)*M(I)*ACROXJ(I)+TMET(J)
63  VMET(J)=(C(2)+C(3))*M(I)*ACROXA(I)+VMET(J)
      WMET(J)=0.0
      XMET(J)=0.0

```

```

DO 64 I=26,MAXI
WMET(J)=C(1)*M(I)*SOXJ(I)+WMET(J)
64 XMET(J)=(C(2)+C(3))*M(I)*SOXA(I)+XMET(J)
70 CONTINUE
RMARCH=0.0
SMARCH=0.0
TMARCH=0.0
VMARCH=0.0
WMARCH=0.0
XMARCH=0.0
DO 80 I=1,31
RMARCH=RMET(I)+RMARCH
SMARCH=SMET(I)+SMARCH
TMARCH=TMET(I)+TMARCH
VMARCH=VMET(I)+VMARCH
WMARCH=WMET(I)+WMARCH
80 XMARCH=XMET(I)+XMARCH
RAPRIL=0.0
SAPRIL=0.0
TAPRIL=0.0
VAPRIL=0.0
WAPRIL=0.0
XAPRIL=0.0
DO 81 I=32,61
RAPRIL=RMET(I)+RAPRIL
SAPRIL=SMET(I)+SAPRIL
TAPRIL=TMET(I)+TAPRIL
VAPRIL=VMET(I)+VAPRIL
WAPRIL=WMET(I)+WAPRIL
81 XAPRIL=XMET(I)+XAPRIL
RMAY=0.0
SMAY=0.0
TMAY=0.0
VMAY=0.0
WMAY=0.0
XMAY=0.0
DO 82 I=62,92
RMAY=RMET(I)+RMAY
SMAY=SMET(I)+SMAY
TMAY=TMET(I)+TMAY
VMAY=VMET(I)+VMAY
WMAY=WMET(I)+WMAY
82 XMAY=XMET(I)+XMAY
RJUNE=0.0
SJUNE=0.0
TJUNE=0.0
VJUNE=0.0
WJUNE=0.0
XJUNE=0.0
DO 83 I=93,122
RJUNE=RMET(I)+RJUNE
SJUNE=SMET(I)+SJUNE
TJUNE=TMET(I)+TJUNE
VJUNE=VMET(I)+VJUNE

```

```

WJUNE=WMET(I)+WJUNE
83 XJUNE=XMET(I)+XJUNE
RJULY=0.0
SJULY=0.0
TJULY=0.0
VJULY=0.0
WJULY=0.0
XJULY=0.0
DO 84 I=123,153
RJULY=RMET(I)+RJULY
SJULY=SMET(I)+SJULY
TJULY=TMET(I)+TJULY
VJULY=VMET(I)+VJULY
WJULY=WMET(I)+WJULY
84 XJULY=XMET(I)+XJULY
RAUG=0.0
SAUG=0.0
TAUG=0.0
VAUG=0.0
WAUG=0.0
XAUG=0.0
DO 85 I=154,184
RAUG=RMET(I)+RAUG
SAUG=SMET(I)+SAUG
TAUG=TMET(I)+TAUG
VAUG=VMET(I)+VAUG
WAUG=WMET(I)+WAUG
85 XAUG=XMET(I)+XAUG
RSEPT=0.0
SSEPT=0.0
TSEPT=0.0
VSEPT=0.0
WSEPT=0.0
XSEPT=0.0
DO 86 I=185,214
RSEPT=RMET(I)+RSEPT
SSEPT=SMET(I)+SSEPT
TSEPT=TMET(I)+TSEPT
VSEPT=VMET(I)+VSEPT
WSEPT=WMET(I)+WSEPT
86 XSEPT=XMET(I)+XSEPT
ROCT=0.0
SOCT=0.0
TOCT=0.0
VOCT=0.0
WOCT=0.0
XOCT=0.0
DO 87 I=215,245
ROCT=RMET(I)+ROCT
SOCT=SMET(I)+SOCT
TOCT=TMET(I)+TOCT
VOCT=VMET(I)+VOCT
WOCT=WMET(I)+WOCT
87 XOCT=XMET(I)+XOCT

```

```

RNOV=0.0
SNOV=0.0
TNOV=0.0
VNOV=0.0
WNOV=0.0
XNOV=0.0
DO 88 I=246,275
RNOV=RMET(I)+RNOV
SNOV=SMET(I)+SNOV
TNOV=TMET(I)+TNOV
VNOV=VMET(I)+VNOV
WNOV=WMET(I)+WNOV
88 XNOV=XMET(I)+XNOV
RDEC=0.0
SDEC=0.0
TDEC=0.0
VDEC=0.0
WDEC=0.0
XDEC=0.0
DO 89 I=276,306
RDEC=RMET(I)+RDEC
SDEC=SMET(I)+SDEC
TDEC=TMET(I)+TDEC
VDEC=VMET(I)+VDEC
WDEC=WMET(I)+WDEC
89 XDEC=XMET(I)+XDEC
RJAN=0.0
SJAN=0.0
TJAN=0.0
VJAN=0.0
WJAN=0.0
XJAN=0.0
DO 90 I=307,337
RJAN=RMET(I)+RJAN
SJAN=SMET(I)+SJAN
TJAN=TMET(I)+TJAN
VJAN=VMET(I)+VJAN
WJAN=WMET(I)+WJAN
90 XJAN=XMET(I)+XJAN
RFEB=0.0
SFEB=0.0
TFEB=0.0
VFEB=0.0
WFEB=0.0
XFEB=0.0
DO 91 I=338,365
RFEB=RMET(I)+RFEB
SFEB=SMET(I)+SFEB
TFEB=TMET(I)+TFEB
VFEB=VMET(I)+VFEB
WFEB=WMET(I)+WFEB
91 XFEB=XMET(I)+XFEB
ALLMAR=RMARCH+SMARCH+TMARCH+VMARCH+WMARCH+XMARCH
ALLAPR=RAPRIL+SAPRIL+TAPRIL+VAPRIL+WAPRIL+XAPRIL

```

```

ALLMAY=RMAY+SMAY+TMAY+VMAY+WMAY+XMAY
ALLJUN=RJUNE+SJUNE+TJUNE+VJUNE+WJUNE+XJUNE
ALLJUL=RJULY+SJULY+TJULY+VJULY+WJULY+XJULY
ALLAUG=RAUG+SAUG+TAUG+VAUG+WAUG+XAUG
ALLSEP=RSEPT+SSEPT+TSEPT+VSEPT+WSEPT+XSEPT
ALLOCT=ROCT+SOCT+TOCT+VOCT+WOCK+XOCK
ALLNOV=RNOV+SNOV+TNOV+VNOV+WNOV+XNOV
ALLDEC=RDEC+SDEC+TDEC+VDEC+WDEC+XDEC
ALLJAN=RJAN+SJAN+TJAN+VJAN+WJAN+XJAN
ALLFEB=RFEB+SFEB+TFEB+VFEB+WFEB+XFEB
R=RMARCH+RAPRIL+RMAY+RJUNE+RJULY+RAUG+RSEPT+ROCT+RNOV+RDEC
1  +RJAN+RFEB
S=SMARCH+SAPRIL+SMAY+SJUNE+SJULY+SAUG+SSEPT+SOCT+SNOV+SDEC+
1  SJAN+SFEB
T=TMARCH+TAPRIL+TMAY+TJUNE+TJULY+TAUG+TSEPT+TOCT+TNOV+TDEC+
1  TJAN+TFEB
V=VMARCH+VAPRIL+VMAY+VJUNE+VJULY+VAUG+VSEPT+VOCT+VNOV+VDEC+
1  VJAN+VFEB
W=WMARCH+WAPRIL+WMAY+WJUNE+WJULY+WAUG+WSEPT+WOCK+WNOV+WDEC+
1  WJAN+WFEB
X=XMARCH+XAPRIL+XMAY+XJUNE+XJULY+XAUG+XSEPT+XOCK+XNOV+XDEC+
1  XJAN+XFEB
ACTJUV=T+W
ACTADT=V+X
TOTJUV=R+T+W
TOTADT=S+V+X
YEAR=R+S+T+V+W+X
ALLMET=TOTJUV+TOTADT
ALLCAL=4.7*ALLMET*0.001
CALJR=4.7*R*0.001
CALAR=4.7*S*0.001
CALJA=4.7*ACTJUV*0.001
CALAA=4.7*ACTADT*0.001
CALJT=4.7*TOTJUV*0.001
CALAT=4.7*TOTADT*0.001
WRITE(6,100) TODAY
100 FORMAT('1',48X,'MALES, 8+ MONTHS OF AGE (1965-1966)', 30X, A8)
WRITE(6,101)
101 FORMAT('0', 54X, 'RESPIRATION (CC OXYGEN)')
WRITE(6,102)
102 FORMAT('0',21X,'RMET',12X,'SMET',12X,'TMET',12X,'VMET',12X,'WMET',
1  12X,'XMET',11X,'MONTHLY TOTALS')
WRITE(6,103) RMARCH,SMARCH,TMARCH,VMARCH,WMARCH,XMARCH,ALLMAR
103 FORMAT('0','MARCH', 13X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,104) RAPRIL,SAPRIL,TAPRIL,VAPRIL,WAPRIL,XAPRIL,ALLAPR
104 FORMAT('0','APRIL', 13X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,105) RMAY,SMAY,TMAY,VMAY,WMAY,XMAY,ALLMAY
105 FORMAT('0','MAY', 15X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,106) RJUNE,SJUNE,TJUNE,VJUNE,WJUNE,XJUNE,ALLJUN
106 FORMAT('0','JUNE', 14X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,107) RJULY,SJULY,TJULY,VJULY,WJULY,XJULY,ALLJUL
107 FORMAT('0','JULY', 14X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,108) RAUG,SAUG,TAUG,VAUG,WAUG,XAUG,ALLAUG
108 FORMAT('0','AUGUST', 12X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)

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```

WRITE(6,109) RSEPT,SSEPT,TSEPT,VSEPT,WSEPT,XSEPT,ALLSEP
109 FORMAT('0','SEPTEMBER',9X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,110) ROCT,SOCT,TOCT,VOCT,WOCT,XOCT,ALLOCT
110 FORMAT('0','OCTOBER',11X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,111) RNOV,SNOV,TNOV,VNOV,WNOV,XNOV,ALLNOV
111 FORMAT('0','NOVEMBER',10X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,112) RDEC,SDEC,TDEC,VDEC,WDEC,XDEC,ALLDEC
112 FORMAT('0','DECEMBER',10X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,113) RJAN,SJAN,TJAN,VJAN,WJAN,XJAN,ALLJAN
113 FORMAT('0','JANUARY',11X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,114) RFEF,SFEF,TFEF,VFEF,WFEF,XFEF,ALLFEF
114 FORMAT('0','FEBRUARY',10X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,115) R,S,T,V,W,X,YEAR
115 FORMAT('0','TOTALS',12X,3(F8.2,8X),F8.2,7X,2(F9.2,7X),4X,F10.2)
WRITE(6,116)
116 FORMAT('1',47X,'MALE ADULT ANNUAL SUMMARY (1965-1966)')
WRITE(6,117)
117 FORMAT('0',46X,'CC OXYGEN',30X,'KILOCALORIES')
WRITE(6,118) R,CALJR
118 FORMAT('0','RESTING METABOLISM BY'/' 8-MONTH AGE CLASS',29X,
1 F9.2,32X,F8.2)
WRITE(6,119) ACTJUV,CALJA
119 FORMAT('0','ACTIVE METABOLISM BY'/' 8-MONTH AGE CLASS',29X,
1 F9.2,32X,F8.2)
WRITE(6,120) TOTJUV,CALJT
120 FORMAT('0','TOTAL METABOLISM BY'/' 8-MONTH AGE CLASS',29X,
1 F9.2,32X,F8.2)
WRITE(6,121) S,CALAR
121 FORMAT('0','RESTING METABOLISM BY'/' 20+-MONTH AGE CLASS',27X,
1 F9.2,32X,F8.2)
WRITE(6,122) ACTADT,CALAA
122 FORMAT('0','ACTIVE METABOLISM BY'/' 20+-MONTH AGE CLASS',27X,
1 F9.2,32X,F8.2)
WRITE(6,123) TOTADT,CALAT
123 FORMAT('0','TOTAL METABOLISM BY'/' 20+-MONTH AGE CLASS',27X,
1 F9.2,32X,F8.2)
WRITE(6,124) ALLMET,ALLCAL
124 FORMAT('0','TOTAL ANNUAL METABOLISM'/' BY MALES 8+ MONTHS OLD',
1 24X,F9.2,32X,F8.2)
STOP
END

```

Some of the variables dimensioned at the beginning of this program are as follows:

C   size of three age cohorts (8, 20 and 32+ months of age)
         on each day of the year

RMET, SMET, TMET, VMET, WMET, AND XMET represent cc of oxygen respired at three levels of activity by yearling and older Uta for each day of the year.

RMET   minimum oxygen consumption by yearlings
TMET   oxygen consumption at 2.5 times minimum rate by yearlings
WMET   oxygen consumption at 2.0 times minimum rate by yearlings
SMET   minimum oxygen consumption by older Uta
VMET   oxygen consumption at 2.5 times minimum rate by older Uta
XMET   oxygen consumption at 2.0 times minimum rate by older Uta

ROXJ, ROXA, ACROXJ, ACROXA, SOXJ AND SOXA represent rates of oxygen utilization by yearling and older Uta at body temperatures ranging from 1 to 38°C.

ROXJ   night minimum rate for yearlings
ROXA   night minimum rate for older Uta
ACROXJ   rate at 2.5 times minimum rate for yearlings
ACROXA   rate at 2.5 times minimum rate of older Uta
SOXJ   rate at 2.0 times minimum rate for yearlings
SOXA   rate at 2.0 times minimum rate for older Uta
WJ   body weight (g) of yearling Uta for each day of the year¹

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¹In this particular program (male Uta, 1965-66) the body weight of older Uta (WA) was a constant 3.2 g. However, in general, this variable was also dimensioned so that WA underwent daily changes in the same manner as WJ.

ATEM   hourly air temperature (in $^{\circ}\text{F}$) for one day
 ATEMP   hourly air temperatures for one day converted to $^{\circ}\text{C}$
 BTEMP   hourly body temperatures of Uta for one day, calculated
             from air temperature and pyrhelimeter data and daily value
             of T_{max}
 P   hourly pyrhelimeter reading

2. The program listing which follows is for juvenile male Uta
 hatched on July 15, 1965. Similar programs were used for males and
 females of all other clutches hatched later in 1965 and during 1966
 and 1967. The mechanics of this program are like that of the one
 described for adult Uta. Values of density, body weight, and maximum
 body temperature attainable change daily. Body temperatures and
 oxygen consumption are calculated hourly for each day.

Because the starting dates varied according to the time of
 hatching, specifications regarding T_{max} , time-specific values of
X, Y and Z, and instructions for reading temperature and pyrhelimeter
 data from the disc pack had to be revised accordingly. The program
 listing follows.

The variables RMET, TMET, WMET, ATEM, ATEMP, BTEMP, P, ROXJ,
 ACROXJ, and SOXJ, are as defined previously.

```

DIMENSION SOXA(38),ACROXA(38),ROXA(38),ATEM(24)
DIMENSION ATEMP(24),P(38),RTEMP(24),ROXJ(38),ACROXJ(38),SOXJ(38)
DIMENSION RMET(366),SMET(366),TMET(366),VMET(366),WMET(366)
DIMENSION XMET(366),WJ(366),N(38),M(38),JTEMP(24)
REAL*8 TODAY
DATA N/38*0/
DATA M/38*0/
DATA P/38*0.0/
DATA RMET, SMET, TMET, VMET, WMET, XMET/2196*0.0/
CALL DATE (TODAY)
DO 1005 K=1,272
1005 READ(8,1004) KP
1004 FORMAT(A1)
DO 70 J=1,229
DO 6 I=1,38
N(I)=0
M(I)=0
6 CONTINUE
TMAX=35.0+3.0*(SIN((J+89)*0.01745))
TMAXF=TMAX+0.5
MAXT=TMAXF
WJ(J)=0.241 +J*(0.009 )
IF(J.LT.49)X=0.01337
IF(J.GT.48.AND.J.LT.140) X=0.0082
IF(J.GT.139) X=0.05433
IF(J.LT.49) Z=1.1015
IF(J.GT.48.AND.J.LT.140) Z=1.1247
IF(J.GT.139) Z=1.084
IF(J.LT.140) Y=0.679
IF(J.GT.139) Y=0.177
DO 50 I=1,38
ROXJ(I)=X*(WJ(J)**Y)*(Z**I)
ACROXJ(I)=2.5*ROXJ(I)
50 SOXJ(I)=2.0*ROXJ(I)
C=113.8*(EXP(-0.0069*J))
DO 4 I=1,24
4 P(I)=0.0
READ(8,2) ATEM(24),(ATEM(I), I=1,23)
2 FORMAT (8X,24F3.0)
READ(8,3) (P(I),I=5,20)
3 FORMAT (12X,16F4.2)
DO 5 I=1,24
5 ATEMP(I)=5.0*(ATEM(I)-32.0)/9.0
DO 12 I=4,10
L = I
IF(P(I).LT.P(I+1)) GO TO 13
12 CONTINUE
13 NPF=L+1
NPQ=NPF+1
NPZ=NPF-1
DO 15 I=14,20
L = I
IF(P(I).EQ.0.0) GO TO 16
15 CONTINUE

```

```

16 NPL=L-1
   NPY=NPL-2
   NPR=NPL-1
   DO 18 I=NPQ,NPY
18  BTEMP(I)=TMAXF
   DO 20 I=1,NPZ
   BTEMP(I)=ATEMP(I)
20  IF (BTEMP(I).GT.MAXT) BTEMP(I)=MAXT
   DO 21 I=NPL,24
   BTEMP(I)=ATEMP(I)
21  IF (BTEMP(I).GT.MAXT) BTEMP(I)=MAXT
   BTEMP(NPF)=ATEMP(NPZ)+0.5000*(TMAX-ATEMP(NPZ))
   BTEMP(NPR)=ATEMP(NPL)+0.5*(TMAX-ATEMP(NPL))
   DO 22 I=1,24
22  JTEMP(I)=BTEMP(I)
   M(MAXT)=NPY-NPQ+1
   DO 40 I=1,NPZ
   IF (JTEMP(I).LT.4) JTEMP(I)=4
   K=JTEMP(I)
40  N(K)=N(K)+1
   K=0
   DO 41 I=NPL,24
   IF (JTEMP(I).LT.4) JTEMP(I)=4
   K=JTEMP(I)
41  N(K)=N(K)+1
   K=0
   IF (JTEMP(NPF).LT.4) JTEMP(NPF)=4
   K=JTEMP(NPF)
   M(K)=M(K)+1
   K=0
   IF (JTEMP(NPR).LT.4) JTEMP(NPR)=4
   K=JTEMP(NPR)
   M(K)=M(K)+1
   K=0
   DO 60 K=4,8
60  N(K)=N(K)+M(K)
   RMET(J)=0.0
   DO 62 I=1,38
62  RMET(J)= C*N(I)*ROXJ(I)+RMET(J)
   TMET(J)=0.0
   DO 63 I=9,25
63  TMET(J)= C*M(I)*ACROXJ(I)+TMET(J)
   WMET(J)=0.0
   DO 64 I=26,MAXT
64  WMET(J)= C*M(I)*SOXJ(I)+WMET(J)
70  CONTINUE
   RJULY=0.0
   TJULY=0.0
   WJULY=0.0
   DO 84 I=1,17
   RJULY=RMET(I)+RJULY
   TJULY=TMET(I)+TJULY
84  WJULY=WMET(I)+WJULY
   RAUG=0.0

```

```

      TAUG=0.0
      WAUG=0.0
      DO 85 I=18,48
      RAUG=RMET(I)+RAUG
      TAUG=TMET(I)+TAUG
85  WAUG=WMET(I)+WAUG
      RSEPT=0.0
      TSEPT=0.0
      WSEPT=0.0
      DO 86 I=49,78
      RSEPT=RMET(I)+RSEPT
      TSEPT=TMET(I)+TSEPT
86  WSEPT=WMET(I)+WSEPT
      ROCT=0.0
      TOCT=0.0
      WOCT=0.0
      DO 87 I=79,109
      ROCT=RMET(I)+ROCT
      TOCT=TMET(I)+TOCT
87  WOCT=WMET(I)+WOCT
      RNOV=0.0
      TNOV=0.0
      WNOV=0.0
      DO 88 I=110,139
      RNOV=RMET(I)+RNOV
      TNOV=TMET(I)+TNOV
88  WNOV=WMET(I)+WNOV
      RDEC=0.0
      TDEC=0.0
      WDEC=0.0
      DO 89 I=140,170
      RDEC=RMET(I)+RDEC
      TDEC=TMET(I)+TDEC
89  WDEC=WMET(I)+WDEC
      RJAN=0.0
      TJAN=0.0
      WJAN=0.0
      DO 90 I=171,201
      RJAN=RMET(I)+RJAN
      TJAN=TMET(I)+TJAN
90  WJAN=WMET(I)+WJAN
      RFEB=0.0
      TFEB=0.0
      WFEB=0.0
      DO 91 I=202,229
      RFEB=RMET(I)+RFEB
      TFEB=TMET(I)+TFEB
91  WFEB=WMET(I)+WFEB
      ALLJUL=RJULY+SJULY+TJULY+VJULY+WJULY+XJULY
      ALLAUG=RAUG+SAUG+TAUG+VAUG+WAUG+XAUG
      ALLSEP=RSEPT+SSEPT+TSEPT+VSEPT+WSEPT+XSEPT
      ALLOCT=ROCT+SOCT+TOCT+VOCT+WOCT+XOCT
      ALLNOV=RNOV+SNOV+TNOV+VNOV+WNOV+XNOV
      ALLDEC=RDEC+SDEC+TDEC+VDEC+WDEC+XDEC

```

```

ALLJAN=RJAN+SJAN+TJAN+VJAN+WJAN+XJAN
ALLFEB=RFEB+SFEB+TFEB+VFEB+WFEB+XFEB
R= RJULY+RAUG+RSEPT+ROCT+RNOV+RDEC+RJAN+RFEB
T=TJULY+TAUG+TSEPT+TOCT+TNOV+TDEC+TJAN+TFEB
W=WJULY+WAUG+WSEPT+WOCT+WNOV+WDEC+WJAN+WFEB
ACTJUV=T+W
TOTJUV=R+T+W
YEAR=R+T+W
CALJR=4.7*R*0.001
CALJA=4.7*ACTJUV*0.001
CALJT=4.7*TOTJUV*0.001
WRITE(6,100) TODAY
100 FORMAT('1', 50X, 'JUVENILE MALES (JULY 15, 1965)', 30X, A8)
WRITE(6,101)
101 FORMAT('0', 54X, 'RESPIRATION (CC OXYGEN)')
WRITE(6,102)
102 FORMAT('0', 21X, 'RMET', 28X, 'TMET', 28X, 'WMET', 27X, 'MONTHLY TOTALS')
WRITE(6,103) RJULY, TJULY, WJULY, ALLJUL
103 FORMAT('0', 'JULY', 15X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,104) RAUG, TAUG, WAUG, ALLAUG
104 FORMAT('0', 'AUGUST', 13X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,105) RSEPT, TSEPT, WSEPT, ALLSEP
105 FORMAT('0', 'SEPTEMBER', 10X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,106) ROCT, TOCT, WOCT, ALLOCT
106 FORMAT('0', 'OCTOBER', 12X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,107) RNOV, TNOV, WNOV, ALLNOV
107 FORMAT('0', 'NOVEMBER', 11X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,108) RDEC, TDEC, WDEC, ALLDEC
108 FORMAT('0', 'DECEMBER', 11X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,109) RJAN, TJAN, WJAN, ALLJAN
109 FORMAT('0', 'JANUARY', 12X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,110) RFEB, TFEB, WFEB, ALLFEB
110 FORMAT('0', 'FEBRUARY', 11X, 2(F8.2, 24X), F8.2, 28X, F10.2)
WRITE(6,115) R, T, W, YEAR
115 FORMAT('0', 'TOTALS', 13X, 2(F8.2, 24X), F9.2, 27X, F10.2)
WRITE(6,116)
116 FORMAT('1', 43X, 'JUVENILE MALES ANNUAL SUMMARY (JULY 15, 1965)')
WRITE(6,117)
117 FORMAT('0', 46X, 'CC OXYGEN', 30X, 'KILOCALORIES')
WRITE(6,118) R, CALJR
118 FORMAT('0', 'RESTING METABOLISM', 27X, F10.2, 32X, F8.2)
WRITE(6,119) ACTJUV, CALJA
119 FORMAT('0', 'ACTIVE METABOLISM', 28X, F10.2, 32X, F8.2)
WRITE(6,120) TOTJUV, CALJT
120 FORMAT('0', 'TOTAL ANNUAL METABOLISM', 22X, F10.2, 32X, F8.2)
STOP
END

```

B. Estimating elimination (E)

This program calculates the calories lost to the population by the deaths of Uta of varying weights and sexes over various time periods.

Elimination is calculated according to the following function:

$$\text{Elimination (g)} = NW(1 - e^{-Xt}) \pm \frac{kN}{X} [1 - (Xt + 1)e^{-Xt}]$$

where: $e = 2.718...$

N = initial size of group

W = initial mean body weight (g)

X = daily death rate

t = number of days in the interval

k = daily change ($\pm$) in weight (g)

This calculation was performed for 66 time intervals. The number of time intervals required was determined by the patterns of weight change assumed for each age and sex group (given in Tables 1, 2 and 3). Each time the slope of the weight change function for a particular sex or age group changed, a new time interval was begun. For example, consider the pattern of weight change of 8-month-old females in 1967. Between March 1 and April 30, body weight increased. Between May 1 and June 30 body weight declined. After July 1, body weight again increased until the end of the year. The annual elimination for these females involved the calculation of elimination for each of these three time intervals. The program listing follows.


```

DIMENSION W(66), SN(66), X(66), JT(66), G(66), T(66), CAL(66)
DIMENSION A(66), B(66), C(66), D(66), R(66), S(66), Y(66), JC(66)
DATA JC/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,
1 23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,
1 43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,
1 63,64,65,66/
DATA JT/31,153,153,59,365,365,92,245,28,92,122,151,92,122,151,229,
1 229,203,203,181,181,153,212,153,212,153,212,61,92,184,28,61,92,
1 212,61,92,212,229,229,212,212,198,198,181,181,167,167,366,122,
1 244,61,61,244,61,92,213,230,230,213,213,199,199,182,182,168,168/
DATA G/.013,.0059,0.0,.00517,0.0,0.0,.0099,0.0,.0179,.00549,
1 -.00248,0.0,.00549,-.00248,0.0,
1 .009,.0068,.01,.0077,.0114,.0086,.0046,.0014,0,-.0014,0,-.0014,
1 .0183,-.00549,0.0,.0185,.0117,-.00879,0.0,.0117,-.00879,0,.0077,
1 .0055,.0083,.00502,
1 .0089,.0063,.0097,.0069,.0105,.00753,.00575,0.0,.00329,.015,
1 -.0005,.00658,.00333,-.0044,.0047,.01564,.0134,.01682,.01445,
1 .018,.0155,.0197,.0169,.0214,.0184/
DATA SN/149.,149.,88.58,52.6,47.5,3.5,149.,108.92,47.38,47.5,
1 31.11,17.76,3.5,2.13,1.1,113.5,113.5,246.5,246.5,225.,225.,160.,
1 93.28,56.,24.75,14.,8.51,160.,128.96,93.24,48.76,56.,40.43,
1 24.77,14.0,11.47,8.5,170.5,170.5,311.5,311.5,283.5,283.5,265.,
1 265.,178.,178.,268.5,56.5,22.32,268.5,201.11,150.6,56.5,35.48,
1 17.63,71.5,71.5,250.,250.,213.5,213.5,7.,7.,34.5,34.5/
DATA W/1.7,2.4,3.3,3.3,3.6,3.6,1.6,2.5,2.5,2.8,3.3,3.,2.8,3.3,
1 3.0,0.25,0.25,0.25,0.25,0.25,0.25,0.25,2.3,3.0,3.6,3.6,3.6,3.6,1.8,
1 2.9,2.4,2.4,3.0,3.7,2.9,3.0,3.7,2.9,0.25,0.25,0.25,0.25,0.25,
1 0.25,0.25,0.25,0.25,0.25,2.0,3.3,3.3,1.5,2.4,2.1,2.9,3.1,2.7,
1 0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25/
DATA X/.0034,.0034,.0034,.0034,.0046,.0054,.0034,.0034,.0034,
1 .0046,.0046,.0054,.0054,.0054,.0054,.0069,.0069,.0069,.0069,
1 .0069,.0069,.00352,.00352,.00533,.00533,.00325,.00325,.00352,
1 .00352,.00352,.00352,.00533,.00533,.00533,.00325,.00325,.00325,
1 .0071,.0071,.0071,.0071,.0071,.0071,.0071,.0071,.0071,
1 .0047,.0076,.0076,.0047,.0047,.0047,.0076,.0076,.0076,.0081,
1 .0081,.0081,.0081,.0081,.0081,.0081,.0081,.0081,.0081/
WRITE (6,31)
31 FORMAT ('1')
DO 20 J=1,66
A(J)=W(J)*SN(J)
B(J)=ABS(1.0*(EXP(-X(J)*JT(J)))-1.0)
C(J)=G(J)*SN(J)/X(J)
D(J)=(X(J)*JT(J))+1.0
R(J)=A(J)*B(J)
T(J)=1.0*(EXP(-X(J)*JT(J)))
S(J)=C(J)*ABS((T(J)*D(J))-1.0)
Y(J)=R(J)+S(J)
CAL(J)=Y(J)*1.567
20 WRITE(6,30) JC(J), Y(J), CAL(J)
30 FORMAT(' ',5X, I2, 6X, F9.3, 6X, F9.3)
STOP
END

```

The significant variables used in this program, and their relationship to the function set forth above, are as follows:

W	body weight (g) at beginning of interval
SN	size of cohort at beginning of interval (= N above)
X	daily death rate
JT	number of days in the interval (= t above)
G	daily change in weight (g) (= k above)

The other variables were designed to simplify the programming statements and to convert grams to calories.

It was necessary to subdivide total elimination calories on a monthly basis. For juveniles this same function was used, and programs of this form were developed which calculated elimination grams and calories for each month or portion of a month for males and females of each clutch of eggs hatched during each of the three summers in question.

C. Monthly densities and biomass of Uta

This program calculates the density and biomass of Uta in an area of 20 acres (8 ha) as of the end of each month. The calculations involve keeping track of changes in numbers of three age groups of adult Uta (each with its own death rate), the recruitment of three clutches of juveniles during the summer (on July 15, August 10, and September 1), and changes in body weight of individuals of various age and sex categories. At the end of each month, the numbers of individuals in all age categories are summed. Similarly the total weights of all individuals of various age and sex categories are summed at the end of each month. The general program

is illustrated specifically with that pertaining to the year 1965-66.

The "initial" densities of the three groups of juveniles* (585.05, 1513.5, and 1601.78) are the numbers of individuals which would have to be alive on March 1 to yield densities of 227.493, and 450 on July 15, August 10, and September 1, respectively (given a daily death rate of 0.0069).

Since the number of males and females in each age group was always the same, biomass values have been calculated for the various age groups by multiplying the total number of individuals in the group by a mean body weight. The program listing follows.

```

DIMENSION B(12),BA(12),BH(12),A(12),TOT(12),M(12)
DIMENSION YY4(366),YY5(366),WW4(366),WW5(366)
DIMENSION Y8(366),A20(366),A32(366),YY1(366),YY2(366),YY3(366)
DIMENSION WJ(366),WF(366),WX(366),WW1(366),WW2(366),WW3(366)
DIMENSION X(6)
WA=3.6
DATA X/299.0,95.48,7.04,585.05,1513.5,1601.78/
DATA M/31,61,92,122,153,184,214,245,275,306,337,365/
DO 70 J=1,365
Y8(J)=X(1)*(EXP(-0.0034*J))
A20(J)=X(2)*(EXP(-0.0045*J))
A32(J)=X(3)*(EXP(-0.0054*J))
YY1(J)=X(4)*(EXP(-0.0069*J))
YY2(J)=X(5)*(EXP(-0.0069*J))
YY3(J)=X(6)*(EXP(-0.0069*J))
IF(J.LT.153) WJ(J)=2.3941+J*(0.0059)
IF(J.GT.152.AND.J.LT.306) WJ(J)=3.3
IF(J.GT.305) WJ(J)=3.2948+((J-305)*0.00517)
IF(J.LT.92) WF(J)=1.5901+J*(0.0099)
IF(J.GT.91.AND.J.LT.337) WF(J)=2.5
IF(J.GT.336) WF(J)=2.4821+((J-336)*0.0179)
IF(J.LT.92) WX(J)=2.7945+J*(0.0055)
IF(J.GT.91.AND.J.LT.215) WX(J)=3.3025-((J-91)*0.00248)
IF(J.GT.214) WX(J)=3.0
WW1(J)=(((0.009*J)-0.983)+((0.0068*J)-0.6816))*0.5
WW2(J)=(((0.01*J)-1.38)+((0.00767*J)-1.0))*0.5
70 WW3(J)=(((0.0113*J)-1.829)+((0.00856*J)-1.325))*0.5
AX=A20(1)+A32(1)
STOT=Y8(1)+AX
SB=Y8(1)*2.0+AX*3.2
SBA=SB/20.0
SBH=SB/8.0
DO 30 I=1,12
30 A(I)=A20(M(I))+A32(M(I))
DO 31 I=1,4
31 TOT(I)=Y8(M(I))+A(I)
TOT(5)=Y8(153)+A(5)+YY1(153)
TOT(6)=Y8(184)+A(6)+YY1(184)+YY2(184)
DO 32 I=7,12
32 TOT(I)=Y8(M(I))+A(I)+YY1(M(I))+YY2(M(I))+YY3(M(I))
DO 33 I=1,4
33 B(I)=(Y8(M(I))*WJ(M(I))+Y8(M(I))*WF(M(I)))*0.5
1 +(A(I)*WA+A(I)*WX(M(I)))*0.5
B(5)=Y8(153)*WJ(153)*0.5+Y8(153)*0.5*WF(153)
1 +A(5)*WA*0.5+A(5)*WX(153)*0.5+YY1(153)*WW1(153)
B(6)=Y8(184)*WJ(184)*0.5+Y8(184)*WF(184)*0.5
1 +A(6)*WA*0.5+A(6)*WX(184)*0.5
1 +YY1(184)*WW1(184)+YY2(184)*WW2(184)
DO 34 I=7,12
34 B(I)=(Y8(M(I))*WJ(M(I))+Y8(M(I))*WF(M(I)))*0.5
1 +(A(I)*WA+A(I)*WX(M(I)))*0.5
1 +YY1(M(I))*WW1(M(I))+YY2(M(I))*WW2(M(I))
1 +YY3(M(I))*WW3(M(I))
DO 40 J=1,12

```

```

      BA(J)=B(J)/20.0
40  BH(J)=B(J)/8.0
      WRITE(6,50)
50  FORMAT('1',25X,'MONTHLY DENSITY AND BIOMASS ESTIMATES FOR ROCK VAL
      LEY UTA STANSBURIANA, 1965-1966')
      WRITE(6,51)
51  FORMAT('0',2X,'MONTH',5X,'FIRST',3X,'SECOND',4X,'THIRD',3X,
1    '8- TO 12-MONTH', 5X,'OLDER',6X,'TOTAL POPULATION',4X,
1    'TOTAL BIOMASS',4X,'BIOMASS',4X,'BIOMASS')
      WRITE(6,52)
52  FORMAT(' ',12X,'CLUTCH',2X,'CLUTCH',3X,'CLUTCH',5X,'AGE-CLASS',7X,
1    'AGE-CLASS', 7X,'(20 ACRES)',6X,'(G/20 ACRES)',5X,'(G/AC)',
1    '5X,'(G/HA)')
      WRITE(6,20) Y8(1),AX,STOT,SB,SBA,SBH
20  FORMAT('0',      14X,'-',7X,'-',9X,'-', 9X,F4.0,12X,F4.0,12X,
1    F5.0,13X,F5.0,11X,F3.0,8X,F3.0)
      DO 35 I=1,4
      WRITE(6,2)  Y8(M(I)), A(I), TOT(I), B(I), BA(I), BH(I)
2  FORMAT('0',      14X,'-',7X,'-',9X,'-', 9X,F4.0,12X,F4.0,12X,
1    F5.0,13X,F5.0,11X,F3.0,8X,F3.0)
35  CONTINUE
      WRITE(6,17) YY1(153),Y8(153),A(5),TOT(5),B(5),BA(5),BH(5)
17  FORMAT('0',,'JULY',9X,F4.0,5X,'-',9X,'-', 9X,F4.0,12X,F3.0,12X,
1    F5.0,13X,F5.0,11X,F3.0,8X,F3.0)
      WRITE(6,18) YY1(184),YY2(184),Y8(184),A(6),TOT(6),B(6),BA(6),BH(6)
18  FORMAT('0',,'AUGUST',7X,F4.0,4X,F4.0,7X,'-', 9X,F4.0,12X,F3.0,
1    12X,F5.0,13X,F5.0,11X,F3.0,8X,F3.0)
      DO 36 I=7,12
      WRITE(6,3) YY1(M(I)), YY2(M(I)), YY3(M(I)), Y8(M(I)), A(I),
1    TOT(I), B(I), BA(I), BH(I)
3  FORMAT('0',      13X,F4.0,4X,F4.0,6X,F4.0, 7X,F4.0,12X,F3.0,
1    12X,F5.0,13X,F5.0,11X,F4.1,8X,F4.1)
36  CONTINUE
      STOP
      END

```

Some of the variables used in this program are identified as follows:

B	biomass (g) of the population at the end of each month
BA	biomass (g) per acre
BH	biomass (g) per hectare
Y8	number of yearling <u>Uta</u> alive on a given day
A20	number of 20-month-old <u>Uta</u> alive on a given day
A32	number of 32+-month-old <u>Uta</u> alive on a given day
A	number of 20+-month-old <u>Uta</u> alive at the end of each month
YY1	number of juvenile <u>Uta</u> in first clutch alive on a given day
YY2	same for juvenile <u>Uta</u> in second clutch
YY3	same for juvenile <u>Uta</u> in third clutch
WJ	weight of male yearling <u>Uta</u> on a given day
WF	weight of female yearling <u>Uta</u> on a given day
WX	weight of older female <u>Uta</u> on a given day ¹
WW1	mean weight of juvenile <u>Uta</u> born July 15 on a given day
WW2	mean weight of juvenile <u>Uta</u> born August 10 on a given day
WW3	mean weight of juvenile <u>Uta</u> born September 1 on a given day
X	initial size of age cohort
M	number of days elapsed at end of each month (cumulative)

The programs for 1966-67 and 1967-68 were similar to this, but more complex because five clutches of young were involved instead of three.

---

¹In this particular program, WA (the weight of older male Uta) was a constant (3.6 g). In a more general version, WA was calculated on a daily basis.

D. Average daily biomass

This program calculates the average daily biomass (g) for adult Uta stansburiana over the course of a year, and for young-of-the-year over a period of 228 days (from July 15 to the end of February of the next year). The number of individuals alive on a given day is calculated from the initial densities of the various age groups coupled with their respective age-specific mortality rates. The average weight of each age group (mean of weights of males and females) is calculated for each day of the year using the weight change functions discussed previously (see Tables 1, 2, and 3). Weights and densities are combined to give biomass values for each day of the year. Average daily biomass ($\bar{B}$) is calculated for adults by dividing by 365; for juveniles by dividing by 228. The program listing follows.

```

DIMENSION YY4(366),YY5(366), WW4(366), WW5(366),X(8),WA(366)
DIMENSION Y8(366),A20(366),A32(366),YY1(366),YY2(366),YY3(366)
DIMENSION WJ(366), WF(366), WX(366),WW1(366),WW2(366),WW3(366)
DIMENSION DBA(366),A(366),B(366),C(366),D(366),E(366),DBJ(366)
DATA WA/366*3.6/
DATA X/299.0,95.48, 7.04, 585.05,1513.5,1601.78/
DO 70 J=1,366
  Y8(J)=X(1)*(EXP(-0.0034*J))
  A20(J)=X(2)*(EXP(-0.0045*J))
  A32(J)=X(3)*(EXP(-0.0054*J))
  YY1(J)=X(4)*(EXP(-0.0069*J))
  YY2(J)=X(5)*(EXP(-0.0069*J))
  YY3(J)=X(6)*(EXP(-0.0069*J))
  IF(J.LT.153) WJ(J) =2.3941 +J*(0.0059)
  IF(J.GT.152.AND.J.LT.306) WJ(J)=3.3
  IF(J.GT.305) WJ(J) =3.2948+((J-305)*0.00517)
  IF(J.LT.92) WF(J) =1.5901 +J*(0.0099)
  IF(J.GT.91.AND.J.LT.337) WF(J)=2.5
  IF(J.GT.336) WF(J) =2.4821+((J-336)*0.0179)
  IF(J.LT.92) WX(J) =2.7945 +J*(0.0055)
  IF(J.GT.91.AND.J.LT.215) WX(J)=3.3025-((J-91)*0.00248)
  IF(J.GT.214)WX(J)=3.0
  WW1(J)=(((0.009*J)-0.983)+((0.0068*J)-0.6816))*0.5
  WW2(J)=(((0.01*J)-1.38)+((0.00767*J)-1.0))*0.5
  WW3(J)=(((0.0113*J)-1.829)+((0.00856*J)-1.325))*0.5
70 DBA(J)=Y8(J)*((WJ(J)+WF(J))/2.0)+(A20(J)+A32(J))*((WA(J)+WX(J))/
  1 2.0)
  CONTINUE
DO 71 J=137,366
71 A(J)=YY1(J)*WW1(J)
DO 72 J=143,366
72 B(J)=YY2(J)*WW2(J)
DO 73 J=185,366
73 C(J)=YY3(J)*WW3(J)
DO 74 J=137,162
74 B(J)=0.0
DO 75 J=137,184
75 C(J)=0.0
  TOTAB=0.0
DO 80 J=1,365
80 TOTAB=DBA(J)+TOTAB
  AADB=TOTAB/365.0
DO 90 J=137,365
90 DBJ(J)=A(J)+B(J)+C(J)
DO 91 J=1,136
91 DBJ(J)=0.0
  TOTJB=0.0
DO 95 J=1,365
95 TOTJB=DBJ(J)+TOTJB
  AJDB=TOTJB/365.0
WRITE (6,100) TOTAB, TOTJB, AADB, AJDB
100 FORMAT(' ', 4(10X,F10.2))
STOP
END

```


Part II

A. Weight changes in Uta

The following three tables (1, 2 and 3) indicate the sex- and age-specific functions by which daily weights were calculated for various groups of Uta. Among adults, weight change functions were computed for yearlings (8 months old in the spring) and older individuals (20+ months of age in the spring). Among adults these functions represented either weight gains and losses, or constant body weights. The functions are written as Fortran IV statements. The two weight variables are WJ (weight of yearlings) and WA (weight of older individuals). These variables are dimensioned so that they may be calculated for any day of the year (J). The first day of the year (J=1) is March 1 and the last day (J=365 or 366) is February 28 or February 29, 1968.

The first statement (Table 1) may be interpreted as follows. If J (day of the year) is less than 92 (i.e., prior to June 1) the weight of a yearling female Uta is equal to $1.5901 + J(0.0099)g$ (with J equal to the number of days after March 1). Other statements may be similarly interpreted. LT and GT stand for 'less than' and 'greater than', respectively. Asterisks indicate multiplication. Parentheses to the right of the equal sign are read as in any algebraic statement.

B. Seasonal flux in observed maximal body temperatures of Uta

The figure on p.30a illustrates changes in observed maximum body temperatures ($T_{\max}$) of Uta during the year. The points represent

group means and not individual body temperatures. The linear regression of $T_{\max}$ on the sine of the number of days (x) since April 15 (i.e., April 15 = 0) was calculated for the 40 points illustrated in the figure. This yielded the following function:

$$T_{\max} = 35.06 + 2.93x$$

with an associated correlation coefficient (r) of 0.90. For use in the model the function was revised so as to make March 1 equal to day zero and simplified as follows:

$$T_{\max} = 35 + 3(\sin J + 314)$$

with J equal to the number of days after March 1. In the programs decimal values of $T_{\max}$ were rounded to the nearest integer value.

G. Values of X , Y and Z

Table 4 summarizes values of X , Y and Z as published by Roberts (Ecology 49:809-819, 1968). These terms are involved in the calculations of oxygen consumption of Uta:

$$cc\ O_2 = XW^Y Z^T$$

In the programs the value of X is read in as $X/1000$ so that the mm^3 of Roberts are converted to cm^3 . Roberts gave seasonal values of X , Y and Z for the months of January, May, July and September. In the programs the January values are used for the months of December, January and February; May values for March, April and May; July values for June, July and August; and September values for September, October, November.

D. Monthly values of respiration (R)

Monthly values of respiration for adult (Table 5) and juvenile (Table 6) Uta are given in the next two tables. The manner in which

these figures were computed was described earlier. In these tables and in Tables 7-10 the data pertain to populations occupying an area of 8 hectares. Tables 7 and 8 illustrate output from the computer program relating to adult male Uta in 1965-66 (pp. 8-14). Table 9 gives similar output for juvenile males hatched July 15, 1965.

E. Monthly values of elimination (E)

Monthly values of elimination for adult and juvenile Uta are given in Table 10. The manner in which these figures were computed was described earlier. Table 11 gives output for the first 45 of the 66 intervals described previously (Part I, Section B).

F. Results of linear regressions of four energy flow variables on 19 population state variables

Table 12 gives correlation coefficients (r) and values of F for tests of zero slopes for 76 regression analyses. The first 10 of these variables were related to densities. The variable N refers to the mean daily density for the year. The other 9 variables were related to biomass values. The variables involving two months are means of densities and biomasses for the two months in question.

G. Average daily biomass

Table 13 gives average daily biomass (g) values for adult (365 days) and juvenile (228 days) Uta during each of the three years in question.

Age	Sex	Time period	Weight change function
8 months	F	March 1 - May 31	If(J.LT.92) WJ(J)=1.5901 +J*(0.0099)
		June 1 - January 31	If(J.GT.91.AND.J.LT.337) WJ(J)=2.5
		February 1-28	If(J.GT.336) WJ(J)=2.4821 +((J-336)*0.0179)
	M	March 1 - July 31	If(J.LT.153) WJ(J)=2.3941 +J*(0.0059)
		August 1 - December 31	If(J.GT.152.AND.J.LT.306) WJ(J)=3.3
		January 1 - February 28	If(J.GT.305) WJ(J)=3.2948 +((J-305)*0.00517)
20+ months	F	March 1 - May 31	If(J.LT.92) WA(J) = 2.7945 +J*(0.0055)
		June 1 - September 30	If(J.GT.91.AND.J.LT.215) WA(J)=3.3025 - ((J-91)*0.00248)
		October 1 - February 28	If(J.GT.214) WA(J) = 3.0
	M	all year	WA = 3.6
Juveniles	M	July 15 - February 28	WJ(J) = 0.241 + J*(0.009)
	F	" " " "	WJ(J) = 0.2432 +J*(0.0068)
	M	August 10 - February 28	WJ(J) = 0.24 + J*(0.01)
	F	" " " "	WJ(J) = 0.2423 + J*(0.0077)
	M	September 1 - February 28	WJ(J) = 0.2386 + J*(0.0114)
	F	" " " "	WJ(J) = 0.2414 + J*(0.0086)

Table 1. Functions representing weight changes of adult and juvenile Uta stansburiana during 1965-66.

Age	Sex	Time period	Weight change function
1966	F	March 1 - April 30	If(J.LT.61) WJ(J) = 1.7817 + J*(0.0183)
		May 1 - July 31	If(J.GT.60.AND.J.LT.153) WJ(J)=2.905-((J-60)*0.0055)
		August 1 - Jan. 31	If(J.GT.152.AND.J.LT.337) WJ(J) =2.4
	M	February 1 - 28	If(J.GT.336) WJ(J) = 2.3815 + ((J-336)*0.0185)
		March 1 - July 31	If(J.LT.153) WJ(J) = 2.2954 + J*(0.0046)
		August 1 - Feb. 28	If(J.GT.152) WJ(J) = 2.9986 + ((J-152)*0.0014)
20+ months	F	March 1 - April 30	If(J.LT.61) WA(J) = 2.9883 + J*(0.0117)
		May 1 - July 31	If(J.GT.60.AND.J.LT.153) WA(J) = 3.7088 -((J-60)*0.0088)
		August 1 - Feb. 28	If (J.GT.152) WA(J) = 2.9
	M	March 1 - July 31	If(J.LT.153) WA(J) = 3.6
		August 1 - Feb. 28	If (J.GT.152) WA(J) = 3.6014 -((J-152)*0.0014)
Juveniles	M	July 15 - Feb. 28	WJ(J)=0.2423 + J*(0.0077)
	F	" " " "	WJ(J)=0.2445 + J*(0.0055)
	M	Aug. 1 - Feb. 28	WJ(J)=0.2417 + J*(0.0083)
	F	" " " "	WJ(J)=0.2441 + J*(0.00592)
	M	Aug. 15 - Feb. 28	WJ(J)=0.2411 + J*(0.0089)
	F	" " " "	WJ(J)=0.2437 + J*(0.0063)
	M	Sept. 1 - Feb. 28	WJ(J)=0.2403 + J*(0.0097)
	F	" " " "	WJ(J)+0.2431 + J*(0.0069)
	M	Sept. 15 - Feb. 28	WJ(J)=0.2395 + J*(0.0105)
	F	" " " "	WJ(J)=0.2425 + J*(0.00753)

Table 2. Functions representing weight changes of adult and juvenile Uta stansburiana during 1971.

Age	Sex	Time period	Weight change function
1967	8 months	F March 1 - April 30	IF(J.LT.61) WJ(J) = 1.485 + J*(0.015)
		May 1 - June 30	IF(J.GT.60.AND.J.LT.122) WJ(J) = 2.405 - ((J-60)*0.005)
		July 1 - February 29	IF(J.GT.121) WJ(J) = 2.0934 + ((J-121)*0.00658)
	M	March 1 - February 29	WJ(J) = 1.9942 + J*(0.00575)
	20+ months	F March 1 - April 30	IF(J.LT.61) WA(J) = 2.8967 + J*(0.00333)
		May 1 - July 31	IF(J.GT.60.AND.J.LT.153) WA(J) = 3.1044 - ((J-60)*0.0044)
		August 1 - February 29	IF(J.GT.152) WA(J) = 2.6953 + ((J-152)*0.0047)
		M March 1 - June 30	IF(J.LT.123) WA(J) = 3.3
		July 1 - February 29	IF(J.GT.122) WA(J) = 3.2967 + ((J-122)*0.0033)
	Juveniles	M July 15 - February 29	WJ(J) = 0.2344 + J*(0.01564)
		F " " " "	WJ(J) = 0.2366 + J*(0.0134)
		M August 1 - February 29	WJ(J) = 0.2332 + J*(0.01682)
		F " " " "	WJ(J) = 0.23555 + J*(0.01445)
		M August 15 - February 29	WJ(J) = 0.232 + J*(0.018)
		F " " " "	WJ(J) = 0.2345 + J*(0.0155)
		M September 1 - February 29	WJ(J) = 0.2303 + J*(0.0197)
		F " " " "	WJ(J) = 0.2331 + J*(0.0169)
		M September 15 - February 29	WJ(J) = 0.2286 + J*(0.0214)
		F " " " "	WJ(J) = 0.2316 + J*(0.0184)

Table 3. Functions representing weight changes of adult and juvenile *Uta stansburiana* during 1967-68.

	Log X	X	Y	Log Z	Z
Adult males					
January	1.629	42.56	0.177	0.035	1.084
May	1.020	10.47	0.742	0.042	1.102
July	1.020	10.47	0.679	0.042	1.102
September	0.808	6.43	0.679	0.051	1.125
Adult females					
January	1.629	42.56	0.001	0.035	1.084
May	1.124	13.31	0.566	0.042	1.102
July	1.020	10.47	0.503	0.042	1.102
September	0.808	6.43	0.503	0.051	1.125
Juvenile males					
January	1.735	54.33	0.177	0.035	1.084
May	1.126	13.37	0.742	0.042	1.102
July	1.126	13.37	0.679	0.042	1.102
September	0.914	8.20	0.679	0.051	1.125
Juvenile females					
January	1.735	54.33	0.001	0.035	1.084
May	1.230	16.98	0.566	0.042	1.102
July	1.126	13.37	0.503	0.042	1.102
September	0.914	8.20	0.503	0.051	1.125

Table 4. Values of $\bar{X}$, $\log \bar{X}$, $\bar{Y}$, $\bar{Z}$ and $\log \bar{Z}$ used in calculating oxygen utilization by Uta stansburiana. These values were also published by Hertz (Ecology 49:809-819, 1968).

	1965-66			1966-67			1967-68		
	m	f	both	m	f	both	m	f	both
March	308.1	274.0	582.1	353.4	349.6	703.0	429.9	427.8	857.7
April	364.8	336.5	701.3	411.4	441.6	853.0	460.4	488.2	948.6
May	434.4	412.7	847.1	495.8	532.4	1028.2	561.4	585.4	1146.8
June	420.7	315.7	736.4	472.1	376.2	848.3	525.8	403.2	929.0
July	416.4	302.5	718.9	460.2	346.0	806.2	534.3	395.9	930.2
August	350.6	250.1	600.7	395.8	288.6	684.4	443.3	328.4	771.7
September	292.5	213.4	505.9	328.9	244.3	573.2	353.2	269.5	622.7
October	197.1	139.9	337.0	201.6	145.7	347.3	222.7	165.5	388.2
November	125.9	89.4	215.3	133.8	96.1	229.9	149.1	110.9	260.0
December	109.8	88.7	198.5	118.9	96.7	215.6	116.4	92.6	209.0
January	98.5	79.3	177.8	108.1	87.6	195.7	105.5	83.2	188.7
February	90.6	72.5	163.1	99.7	80.9	180.6	101.0	79.0	180.0
Totals	3209.4	2574.7	5784.1	3579.7	3085.7	6665.4	4003.0	3429.6	7432.6

Table 5. Monthly values (Kcal) of respiration (R) for adult Uta stansburiana in Rock Valley.

	1965-66			1966-67			1967-68		
	m	f	both	m	f	both	m	f	both
July	52.4	62.5	114.9	82.6	98.7	181.3	39.7	46.1	85.8
August	247.6	275.7	523.3	558.3	628.1	1186.4	408.4	443.6	852.0
September	637.2	672.8	1310.0	1096.8	1150.0	2246.8	552.7	531.4	1084.1
October	551.0	518.5	1069.5	886.4	838.5	1724.9	436.5	386.1	822.6
November	397.6	348.8	746.4	660.6	581.7	1242.3	320.6	267.6	588.2
December	438.0	407.8	845.8	855.4	815.3	1670.7	312.1	265.9	578.0
January	365.1	327.9	693.0	716.3	659.3	1375.6	258.8	212.9	471.7
February	309.5	270.4	579.9	622.7	557.3	1180.0	235.8	188.4	424.2
Totals	2998.4	2884.4	5882.8	5479.1	5328.9	10808.0	2564.6	2342.0	4906.6

Table 6. Monthly values (Kcal) of respiration (R) for juvenile Uta stansburiana in Rock Valley.

RESPIRATION (CC OXYGEN)

	RMET	SMET	TMET	VMET	WMET	XMET	MONTHLY TOTALS
MARCH	3008.49	1328.25	3054.58	1358.79	39394.04	17412.40	65556.50
APRIL	3981.85	1597.35	2121.55	868.21	49131.03	19913.18	77613.13
MAY	4865.44	1809.05	1720.65	645.62	60746.49	22637.63	92424.81
JUNE	5954.96	2025.04	558.38	192.36	60264.77	20516.45	89511.94
JULY	8839.32	2799.21	0.0	0.0	58462.26	18488.07	88588.81
AUGUST	8474.62	2536.11	0.0	0.0	46926.02	14651.62	74588.31
SEPTEMBER	4251.33	1228.41	406.74	116.94	43611.13	12616.00	62230.54
OCTOBER	3815.41	1066.11	1016.33	282.48	27949.01	7804.16	41933.50
NOVEMBER	1375.33	371.31	1598.56	430.79	16130.55	4686.06	26794.59
DECEMBER	2516.38	627.21	2128.05	530.40	14054.23	3500.34	23356.60
JANUARY	1960.99	469.06	1761.33	421.25	13196.10	3156.29	20965.02
FEBRUARY	1609.10	369.23	1538.55	352.76	12542.75	2873.01	19285.39
TOTALS	50653.20	16226.32	15904.69	5199.60	446408.13	148456.94	682648.81

Table 7. Monthly respiration (cc O₂) by adult male Uta in Rock Valley.

MALE ADULT ANNUAL SUMMARY (1965-1966)

	CC OXYGEN	KILOCALORIES	
RESTING METABOLISM BY 8-MONTH AGE CLASS	50653.20	238.07	
ACTIVE METABOLISM BY 8-MONTH AGE CLASS	462312.81	2172.87	
TOTAL METABOLISM BY 8-MONTH AGE CLASS	512966.00	2410.94	
RESTING METABOLISM BY 20+-MONTH AGE CLASS	16226.32	76.26	60
ACTIVE METABOLISM BY 20+-MONTH AGE CLASS	153656.50	722.19	
TOTAL METABOLISM BY 20+-MONTH AGE CLASS	169882.81	798.45	
TOTAL ANNUAL METABOLISM BY MALES 8+ MONTHS OLD	682848.81	3209.39	

Table 8. Summary of annual respiration by adult male Uta in Rock Valley.

RESPIRATION (CC O₂)

	RMET	TMET	WMET	MONTHLY TOTALS
JULY	1387.56	0.0	9773.59	11161.15
AUGUST	3372.68	0.0	19434.07	22806.75
SEPTEMBER	2016.61	196.37	20688.47	22901.45
OCTOBER	1979.58	532.71	14634.17	17146.46
NOVEMBER	748.96	875.59	9932.62	11557.16
DECEMBER	2000.83	1691.91	11182.96	14875.70
JANUARY	1428.37	1282.63	9610.64	12321.64
FEBRUARY	1073.56	1023.41	8314.59	10411.55
TOTALS	14008.14	5602.63	103571.19	123181.94

Table 9. Monthly respiration (cc O₂) by juvenile male Uta in Rock Valley, 1965-66.

	1965-66			1966-67			1967-68		
	Adults	Juveniles	Total	Adults	Juveniles	Total	Adults	Juveniles	Total
March	130.25	-	130.2	186.4	-	186.4	235.3	-	235.3
April	141.6	-	141.6	207.9	-	207.9	265.9	-	265.9
May	152.9	-	152.9	183.9	-	183.9	225.5	-	225.5
June	125.6	-	125.6	181.1	-	181.1	223.4	-	223.4
July	128.6	11.6	140.2	178.3	17.3	195.6	151.4	9.9	161.3
August	104.4	65.9	170.3	91.5	140.9	232.4	145.0	145.4	290.4
September	104.0	157.9	261.9	91.8	277.1	368.9	153.8	267.4	421.2
October	96.8	203.3	300.1	92.0	365.3	455.3	163.6	346.5	510.1
November	96.8	215.5	312.3	92.3	382.5	474.8	173.7	360.0	533.7
December	96.8	227.3	324.1	92.6	399.5	492.1	183.6	369.5	553.1
January	84.9	222.0	306.9	92.8	387.0	479.8	193.5	351.8	545.3
February	74.3	190.6	264.9	84.2	329.8	414.0	203.3	291.4	494.7
Totals	1336.8	1294.1	2630.9	1574.8	2299.3	3884.1	2318.0	2141.9	4459.9
Kcal/ha			328.9			485.5			557.5

Table Monthly values of elimination (E) for Uta in Rock Valley. All values in Kcal.

Case	E (g)	E (Kcal)	Category
1	28.290	44.331	test
2	169.965	266.334	8-month old males, 1965-6
3	118.562	185.786	
4	32.959	51.647	
5	139.098	217.967	
6	10.845	16.993	
7	81.313	127.417	8-month old females, 1965-6
8	153.919	241.191	
9	11.818	18.518	
10	49.740	77.943	
11	42.258	66.218	
12	29.706	46.549	
13	4.154	6.510	
14	3.253	5.098	
15	1.840	2.883	
16	91.907	144.018	juvenile males born July 15, 1965
17	74.948	117.444	
18	192.342	301.399	
19	158.784	248.814	
20	172.073	269.637	
21	139.662	218.851	juvenile females born Sept. 1, 1965
22	174.591	273.583	
23	153.537	240.593	
24	112.408	176.143	
25	58.289	91.338	
26	19.747	30.943	
27	14.697	23.030	
28	72.290	113.279	
29	94.933	148.759	
30	106.683	167.173	
31	12.150	19.039	
32	51.878	81.293	
33	52.160	81.735	
34	48.628	76.199	
35	8.422	13.197	
36	9.829	15.402	
37	12.274	19.233	
38	123.623	193.717	
39	98.085	153.699	
40	222.239	348.248	
41	175.886	275.613	
42	169.261	312.242	
43	156.679	245.515	
44	181.115	283.807	
45	142.668	223.560	

Table 11. Computer program output illustrating calculation of E for various groups of Uta over different time intervals.

	Energy Flow		Respiration		Production		Elimination	
	<u>r</u>	F	<u>r</u>	F	<u>r</u>	F	<u>r</u>	F
Density								
March	0.00	0.00	-0.19	0.04	0.68	0.87	0.87	3.26
May	0.02	0.00	-0.17	0.03	0.70	0.95	0.88	3.59
July	0.02	0.00	-0.17	0.03	0.70	0.95	0.88	3.59
Sept.	0.98	28.6	0.93	6.14	0.85	2.50	0.64	0.69
Nov.	0.92	5.7	0.98	25.1	0.41	0.21	0.11	0.01
Jan.	0.90	4.4	0.97	16.2	0.37	0.16	0.07	0.00
March-Aug.	0.47	0.3	0.29	0.1	0.95	8.66	1.00	4492**
March-Oct.	0.99	96.8	0.99	105.0	0.66	0.77	0.40	0.19
April-Nov.	0.99	39.8	1.00	590.7*	0.62	0.61	0.34	0.13
$\bar{N}$	0.98	27.4	1.00	8088**	0.59	0.54	0.31	0.11
Biomass								
March	0.35	0.13	0.15	0.02	0.89	3.92	0.99	41.32
May	0.49	0.32	0.31	0.10	0.95	9.78	1.00	81442**
July	0.52	0.37	0.34	0.13	0.96	12.56	1.00	689.9*
Sept.	0.58	0.49	0.40	0.19	0.98	22.10	0.99	92.7
Nov.	0.87	2.97	0.75	1.28	0.98	19.45	0.86	2.83
Jan.	0.90	4.54	0.80	1.82	0.95	9.77	0.81	1.94
March-Aug.	0.41	0.21	0.23	0.05	0.92	5.77	1.00	150.3
March-Oct.	0.67	0.80	0.50	0.34	1.00	114.4	0.98	20.0
April-Nov.	0.72	1.10	0.57	0.49	1.00	5493**	0.96	10.41

*F = 161

** = 4052

Table 12. Results of linear regressions of four energy utilization parameters on various population state variables.

Year	$\bar{B}$, adults	$\bar{B}$, juveniles ¹
1965-66	625	526
1966-67	700	910
1967-68	784	742

¹July 15 to end of February of next year.

Table 13. Average daily biomass ($\bar{B}$, in g) of Uta occupying an area of 8 ha in Rock Valley.