TOPIC 2. POPULATION STRUCTURES

Sex and age structures of populations are very commonly represented in the literature as the two basic parameters of interest when evaluating population dynamics. Sex ratios are very important, of course, because the higher the fraction of parturient members in a population, the greater the potential for population growth The ratio of or fraction of females in the total population is especially important when considering the potential rate of increase.

Ages alone are not always good indicators of reproductive potentials because of the importance of body condition, which is a function of range conditions. Weight, or weight in relation to age is a better indicator of reproductive potentials than age alone. No measured data are available on weight structures of populations, however, so it is necessary to derive the weight structure from age and growth data.

Sex, age, and weight classes will be used in analyses that follow in this CHAPTER 18 and in CHAPTER 19. Terms used are described below, with their definitions and rationale for their use given.

First, classes are labeled with a small letter. The use of a letter avoids confusion with age classes which are represented by numbers. Think of a series of classes as:

a.
b.
c.
.
.
.
n.

This column is always to the left when compiling population data.

The column above may be expanded to include sex indentification by adding a hyphen for males and a second letter for females. Thus:

Males	Females
a-.	aa.
b-.	bb.
c-.	cc.
.	.
.	.
.	.
n-.	nn.

One further indentification may be added by using prefixes for the kind of class being considered: AC = age class and WC = weight class. Thus:

CLASS							
ACa-.	= age	class	of	group	a,	males,	
ACb-.	= "	"	"	"	b,	"	,
ACc-.	= "	"	"	"	c,	"	, and
ACaa.	= age	class	of	group	a,	females,	
ACbb.	= "	"	"	"	b,	"	,
ACcc.	= "	"	"	"	c,	"	.

Also,

CLASS							
WCa-.	= weight	class	of	group	a,	males,	
WCb-.	= "	"	"	"	b,	"	,
WCc-.	= "	"	"	"	c,	"	, and
WCaa.	= weight	class	of	group	a,	females,	
WCbb.	= "	"	"	"	b,	"	,
WCcc.	= "	"	"	"	c,	"	.

Age classes may be identified by the year interval (0-1, 1-2 . . .), by the mid-point (1/2, 1 & 1/2, 2 & 1/2 . . .), or by the age in days (AGDA = 1, 100, 365, 1519, etc.). Thus, using males classes as an example, age classes in year intervals (ACYI) are as follows:

CLASS	ACYI	
ACa-.	0-1	Includes all males from birth to their first birthday.
ACb-.	1-2	Includes all males from their first to second birthdays.
ACc-.	2 +	Includes all males from their second birthday on.

The mid-point age class designation is commonly used in the literature because animals are often aged in the fall at hunter checking stations when the animals are 1/2 year or older by one or more years. Thus, using female classes as an example, age classes by mid-point (ACMP) are as follows:

CLASS	ACMP	
ACaa.	1/2	Females one-half year of age.
ACbb.	1 & 1/2	Females one and one-half years of age.
ACcc.	2 & 1/2 +	Females two and one-half years of age and older.

Age classes divided by age in days (AGDA) may include any age interval selected. Thus:

CLASS	ACAD	
ACa-.	1 - 100	Includes all males age 1 to 100 days.
ACb-.	101 - 200	Includes all males age 101 to 200 days.
ACc-.	201 - 300	Includes all males age 201 to 300 days.
ACaa.	1 - 100	Includes all females age 1 to 100 days.
ACbb.	101 - 200	Includes all females age 101 to 200 days.
ACcc.	201 - 300	Includes all females age 201 to 300 days.

Different age classes will be chosen for different uses in the UNITS that follow. Analyses of populations throughout the year will use the year interval (ACYI), analyses of fall populations only will use the age classes by midpoint (ACMP). The age classes by age in day intervals (ACAD) will be used when estimating weights for the different age classes.

The following examples illustrate possible weight classes for use in later evaluations, where WCKI = weight class interval in kg.

CLASS	WCKI	
WCa-.	0 - 10	Weight class of males weighing 1 - 10 kg.
WCb-.	10 - 20	Weight class of males weighing 10 - 20 kg.
WCc-.	20 - 30	Weight class of males weighing 20 - 30 kg.

Weight classes could be identified by their mid-point weights (WCMP) too.

CLASS	WCMP	
WCaa.	5	Females closest to 5 kg.
WCbb.	25	Females closest to 25 kg.
WCcc.	45	Females closest to 45 kg.

Mid-point designations are really another way to express intervals; if WCMP = 1, 25, 45... , the intervals are 0 - 15, 15 - 35, 35 - 55, etc. Understand the logic of these sex, age, and weight identifications, and then begin using them in UNIT 2.1.

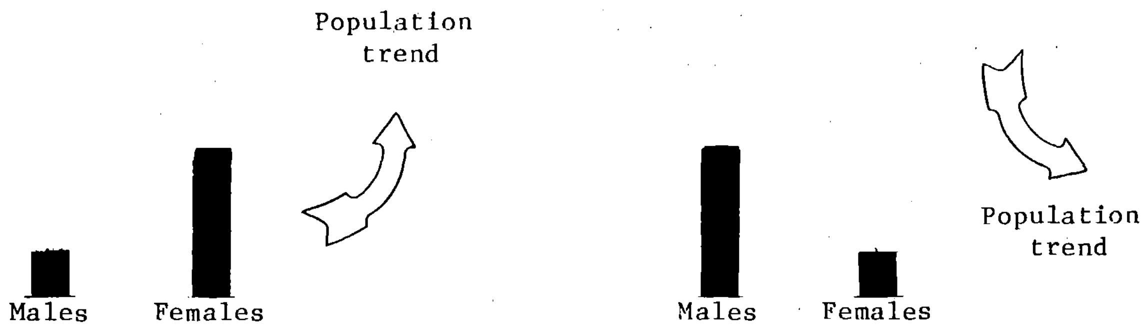
Sex and age structures, discussed in UNIT 2.1, form the bases for conversions to weight structures of populations. Different kinds of weight structures of populations are determined from estimates of individual weights and the distribution of weights in each sex and age class in a population in UNITS 2.2, 2.3, and 2.4. Metabolic structures are discussed in UNIT 2.5.

The several references to life tables of different wild ruminants in the literature are listed in UNIT 2.6. Life tables are discussed only briefly, however.

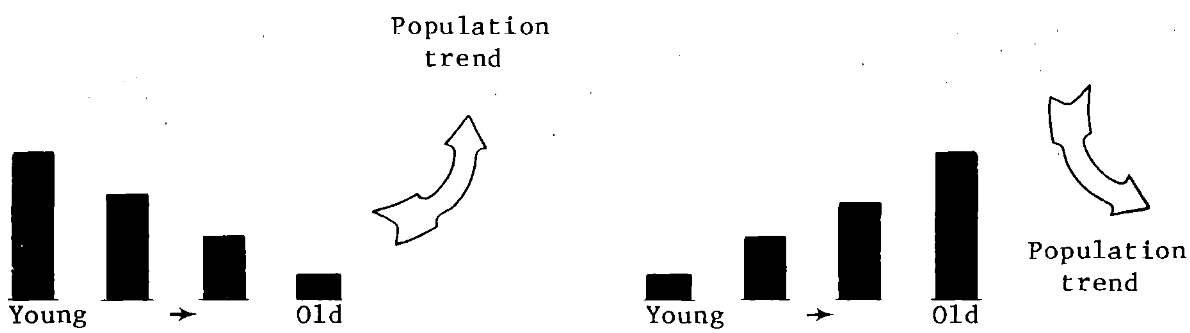
The discussions in the UNITS illustrate basic concepts and formats. Users are urged to consult the literature on selected species for specific data for WORKSHEET calculations.

UNIT 2.1: SEX AND AGE STRUCTURES

The breakdown of a population into sex and age classes reveals information that can be used to calculate the sex ratio, which is of importance when evaluating the potential parturient component of the population, and age ratios, which are of importance when evaluating the reproductive potential of a population over time. A sex ratio in favor of females indicates that a higher fraction of the population could produce young than when a sex ratio is in favor of males.



Age ratios in favor of the younger age groups indicate high reproduction in the immediate past. If sex and age ratios are in favor of young females, then a high reproductive potential exists for the near future when the young females mature and reproduce. Conversely, age ratios favoring the older classes indicate that reproduction has been depressed and as the animals age further, will likely go down even more. These relationships are illustrated below.



The representation of a population according to its sex and age structure, the usual population structures given in the literature, is fairly straight-forward if accurate sexing and aging techniques are available. Sex determination is straightforward in wild ruminants if the carcass is available for examination.

Sex may also be determined from skeletons; Taber (1956) examined the pelvic girdle of black-tailed and white-tailed deer, noting suspensary tuberosities for the attachment of penis ligaments in the male, but not in the female. Sexing of fetuses early in the gestation period before the external genetalia are present requires microscopic examination. Sex chromatin particles were found in nuclei of extra-embryonic membranes of female embryos, but not in those of males (Segelquist 1966).

Aging techniques for wild ruminants have been given considerable attention for many years because of the importance of age frequencies and distributions in population gowth. Some species--sheep and goats--may be conveniently aged by counting the "rings" that result from annualy-occurring periods of rapid horn growth (smooth areas) and of slower growth (ridges). Mountain goat horns are illustrated by Brandborg (1955) and Taber (1969:399). This technique offers the advantage of being able to determine age at death from skeletal remains.

Tooth replacement as a means of age determination of young deer was described by McLean in 1936. C. W. Severinghaus (1949) described and photographed jaws and teeth of known-age white-tailed deer and this effort resulted in the use of tooth-wear as a standard aging technique for many wild ruminants. Illustrations are included in the wildlife management techniques manual (Giles 1969). The extent of interest in teeth characteristics is indicated by the number of references in the SERIALS list in CHAPTER 2, UNIT 1.4.

Aging by tooth wear is not always accurate. Other methods have been tried in recent years. Eye lens weights have been evaluated in relation to age, especially in white-tailed deer and mule deer (see CHAPTER 2, UNIT 1.5). The relationship is good enough to be used as a predictor of age, but is not a very practical one. Aging is almost always done at hunter checking stations, and the removal of an eye lens is not an accepted practice.

Teeth may not only be examined but extracted at checking stations. A recently developed aging method, and apparently the most reliable one known at this time, involves microscopic examination of the annuli in a cross section of a tooth. The annuli are responses to seasonal metabolic rhyuthms, synchonized with changes in range conditions.

Comparisons of tooth-wear and annuli show that white-tailed deer aged by tooth wear are often thought to be younger than when aged by the more accurate annuli method (Moen and Sauer 1977). This has significant implications in predicting population dynamics since underaging does not give an individual credit for being in the population for the time between real age and estimated age, and also eliminates consideration of her offspring produced during that missing time. Thus the aging error has a multiplicative effect. In fact, underaging of deer at the Seneca Army Depot in New York resulted in too few deer estimated present to reproduce enough to even keep up with known mortality from controlled hunts (Moen and Sauer 1977).

Absolute numbers in sex and age classes are of interest with respect to a given population. If N is estimated or known, then N males and N females should also be estimated, if not known. If N is not known as an absolute number, and it seldom is, then estimated N's should be used to calculate ratios and weighted means for use in analyses and predictions.

A format for recording numbers in each sex and age class is shown on the next page. Mid-point data are used in this example. Numbers given are for the number in a prehunt population (NPHP) (see CHAPTER 19 - Page 1).

CLASS	ACMP	NMAC
ACa-.	1/2	50
ACb-.	1 1/2	38
ACc-.	2 1/2+	12
	SUM =	100 = TNMP

CLASS	ACMP	NFAC
ACaa.	1/2	44
ACbb.	1-1/2	34
ACcc.	2-1/2+	22
	SUM =	100 = TNFP

The male to female sex ratio may be added as shown below.

CLASS	ACMP	NMAC
ACa-.	1/2	50
ACb-.	1-1/2	38
ACc-.	2-1/2+	12
	SUM =	100 = TNMP

CLASS	ACMP	NFAC	NMAC/NFAC	=	MFSR
ACaa.	1/2	44	50 / 44	=	1.14
ACbb.	1-1/2	34	38 / 34	=	1.12
ACcc.	2-1/2+	22	12 / 22	=	0.55
	SUMS =	100 = TNFP			

Male and female fractions in each age class of the male and female populations may be added as shown below.

CLASS	ACMP	NMAC	NMAC/TNMP	=	FMPA
ACa-.	1/2	50	50 / 100	=	0.50
ACb-.	1-1/2	38	38 / 100	=	0.38
ACc-.	2-1/2+	12	12 / 100	=	0.12
	SUMS =	100 = TNMP			[1.00]

CLASS	ACMP	NFAC	NFAC/TNFP	=	FFPA
ACaa.	1/2	44	44 / 100	=	0.44
ACbb.	1-1/2	34	34 / 100	=	0.34
ACcc.	2-1/2+	22	22 / 100	=	0.22
	SUMS =	100 = TNFP			[1.00]

Population estimates may also be made from the numbers removed by hunting. In New York State, Age-Sex Multipliers are used to estimate the number of deer per square mile of each age and sex class from the buck take per square mile (Free et al. 1964). These multipliers have been determined empirically from calculated gains and losses in deer populations over a number of years. Thus, the number of deer in any age and sex class can be estimated by multiplying the buck take by the appropriate multiplier. An example is given below for Steuben County in western New York.

MULTIPLIERS

Males		Females		Total
Fawns	Adults	Fawns	Adults	Population
1.35	1.47	1.28	2.29	6.39

Steuben County buck take = 4775. Therefore:

4775 x 1.35 = 6447 = male fawn population,
4775 x 1.47 = 7019 = male adult population,
4775 x 1.28 = 6112 = female fawn population,
4775 x 2.29 = 10935 = female adult population, and
4775 x 6.39 = 30512 = total population.

Another method for estimating populations from numbers removed by hunting is a change-in-ratio (CIR) procedure (Shope 1978), developed from a paper by Selleck and Hart (1957). This method has an advantage over the multiplier method in that it incorporates annually all losses which alter age and sex ratios, not just average losses during several sample years. The method can be used only when there is differential mortality for sex and age groups, resulting in changes in the sex or age ratios of the population as a result of the loss.

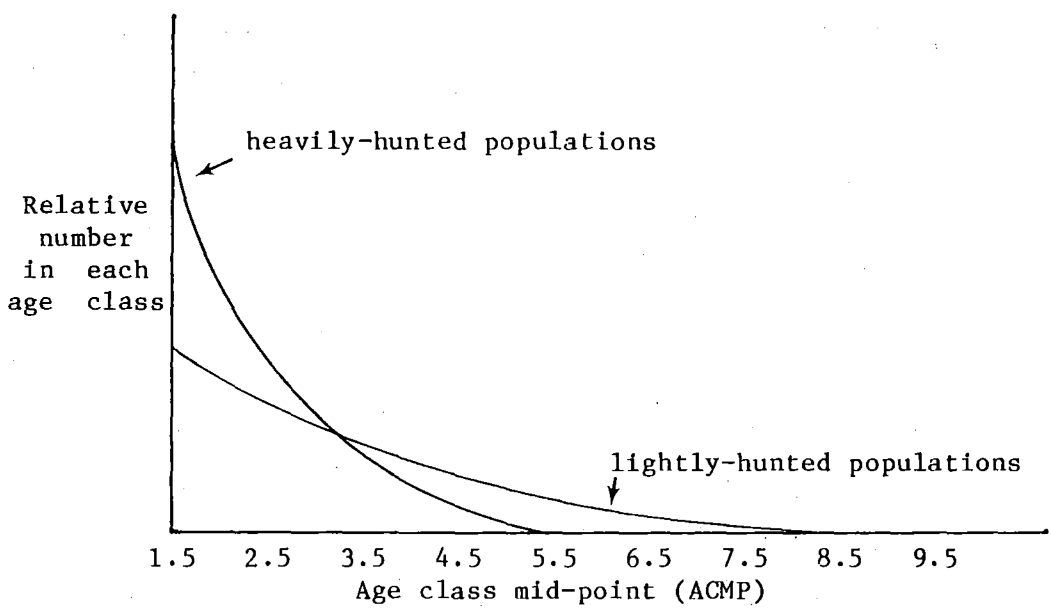
Seven steps are given by Shope (1978) for estimating a series of deer populations from which estimates of adult survival rates and minimum fawn production may be made. The estimations require the following information:

a. Prehunt adult males per 100 adult females,
b. Adult males harvested per 100 adult females, and
c. Posthunt adult males per 100 adult females.

The use of this information in making population estimates is described in WORKSHEET 2.1d.

Estimations of populations based on hunter kill data have a disadvantage in only accounting for losses from the calculated legal take, thereby underestimate the actual populations in the field. Severinghaus (1981) has estimated that actual populations may be at least 25% larger than those estimated by both the Age-Sex Multiplier and the Shope methods.

Suppose the age composition of a population was entirely unknown. There is evidence indicating that white-tailed deer age compositions can be represented with exponential equations, thereby permitting first approximations of the age composition when field data are not available. C. W. Severinghaus at Cornell's Wildlife Ecology Laboratory showed that the exponential curve was the best fit or very close to the best fit for deer populations in 10 different ecological zones in New York State. Variations in the intercept and slope depended on the hunting regimes in the different zones. Heavily-hunted populations had more younger and less older animals, and lightly-hunted populations had less younger and more older animals. The basic relationship is illustrated below.



First approximations of the age-structure may be made by estimating the relative number of yearlings and the maximum age; the exponential curve fills in the rest. Better estimates of the age structures of local populations are made by curve-fitting the numbers in each of the age classes.

The formats for dividing populations into any number of age classes are given as WORKSHEETS for your use in making population predictions in CHAPTER 19. There are several references in the SERIALS list for most species for use in these WORKSHEETS, or you may use your local or state data. Be sure to build the population tabulations in these step-wise fashions so you are familiar with the groups that may be used in both the arithmetic and exponential predictions in CHAPTER 19.

LITERATURE CITED

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Free, S., W. T. Hesselton, and C. W. Severinghaus. 1964. The gains and losses in a deer population for five sections of New York State. Proc. Northeast Wildl. Conf. 37 p.

Giles, R. H., Jr., Ed. 1969. Wildlife Mangement Techniques. Third Edition: Revised. The Wildlife Society, Washington, D. C. 623 p.

McLean, D. D. 1936. The replacement of teeth in deer as a means of age determination. Calif. Fish and Game 28(1):43-44.

Moen, A. N. and P. Sauer. 1977. Population predictions and harvest simulations. Pages 26-36 <u>In</u>: Proc. Joint Northeast-Southeast Deer Study Group Mtg.

Segelquist, C. A. 1966. Sexing white-tailed deer embryos by chromatin. J. Wildl. Manage. 30(2):414-417.

Selleck, D. M. and C. M. Hart. 1957. Calculating the percentage of kill from sex and age ratios. Calif. Fish and Game 43(4):309-316.

Severinghaus, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Manage. 13(2):195-216.

Severinghaus, C. W. 1981. Calculated deer populations for western New York and two Catskill counties. Unpublished report 81-27, Wildlife Ecology Laboratory, Cornell University. 17 p.

Shope, W. K. 1978. Estimating deer populations using CIR procdures and age structure data and harvest management decisions from CIR estimates. Trans. Annual Northeast Deer Study Group Meeting 14:28-35.

Taber, R. D. 1956. Characteristics of the pelvic girdle in relation to sex in black-tailed and white-tailed deer. Calif. Fish and Game 42(1):5-21.

Taber, R. D. 1969. Criteria of sex and age. Chapter 20, Pages 325-401 <u>In</u>: R. H. Giles, Jr. (Ed.); Wildlife Management Techniques. The Wildlife Society, Washington, D. C. 623 p.

REFERENCES, UNIT 2.1

SEX AND AGE STRUCTURES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
JWMAA	17--1	95	97	od--	secondar sex ratio, odocoi	taber,rd	1953

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
CNSVA	24--2	18	19	odvi	incredible white deer herd	hesselton,wt	1969
JWMAA	18--4	482	495	odvi	deer management study: mud	hunt,rw; mangus,l	1954
JWMAA	29--4	884	885	odvi	unusual sex ratio, w-t dee	downing,rl	1965
JWMAA	38--3	563	565	odvi	seas diff sex ratio, trapp	mattfeld,gf; sag/	1974
JWMAA	40--3	454	463	odvi	group size, comp, flor key	hardin,jw; silv,/	1976
JWMAA	41--4	709	714	odvi	accur, sex, age ratio coun	downing,rl; mich/	1977
MDCRA	2282.	1		odvi	estim vital statistcs herd	eberhardt,l	1960
NAWTA	28---	422	430	odvi	10 yr obs, encl herd, mich	arnold,da; verme,	1963
NFGJA	1---1	98	109	odvi	warines, age comp hunt kil	maguire,hf; sever	1954
NFGJA	2---2	242	246	odvi	age compo data, sex ratios	severinghaus,cw;/	1955
NFGJA	16--1	19	26	odvi	minimum pop, moose riv, ny	severinghaus,cw	1969
NFGJA	26--1	14	19	odvi	sex ratios among fawns	clarke,sh; severi	1979
PMACA	47---	289	316	odvi	valid age determ mich deer	ryel,la; fay,ld;/	1961
TNWSD	1959.	1	6	odvi	rel matrn age, pren sex ra	mcdowell,rd	1959
WLMOA	15---	1	62	odvi	ecol, mgt llano basin, tex	teer,jg; thomas,/	1965

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
CAFGA	38--2	211	224	odhe	food hab, prod, cond, cali	lassen,rw; ferre/	1952
CAFGA	39--2	177	186	odhe	reprod on 3 chapar cov typ	taber,rd	1953
CAFGA	40--3	215	234	odhe	de fora relat lassen-washo	dasmann,w; blaisd	1954
JWMAA	18--3	309	315	odhe	sex diff, mortal, young de	taber,rd; dasmann	1954
JWMAA	20--1	78	83	odhe	determ struct in populatio	dasmann,rf; taber	1956
JWMAA	21--1	1	16	odhe	diff mortal by sex and age	robinette,wl; ga/	1957
JWMAA	31--4	651	666	odhe	charac, herds, range, utah	richens,vb	1967
NAWTA	13---	409	430	odhe	ceel, sexing, airpla, colo	riordan,le	1948

odhe continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
NEXAA	567--	1	32	odhe	ft stanton hrd, ecol, n mx	wood,je; bickle,/	1970
SWNAA	15--1	29	36	odhe	ind surv, repro fem, n mex	anderson,ae; sny/	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
CAFNA	64...	40	42	ceel	produc, sex survi, alberta	green,hu	1950
CWRSB	11---	1	71	ceel	caus, impli sex diff, surv	flook,dr	1970
JWMAA	32--3	553	5457	ceel	differ distri by sex & age	peek,jm; lovaas,a	1968
JWMAA	38--4	789	791	ceel	preg rt; fall cow/clf rati	follis,tb; spille	1974
MRLTA	32--2	19	22	ceel	tech for age determination	swanson,cv	1951
NATUA	177--	488	489	ceel	propor fawns to hinds, n z	riney,t	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
EKPOA	17-37	709	718	alal	reprod, dynam, pop, poland	serafinski,w	1969
ELPLB	23--3	493	506	alal	pop char, range use, polan	morow,k	1975
JWMAA	24--1	162	170	alal	foo habs, mvmt, pops, mont	knowlton,ff	1960
JWMAA	26--4	360	365	alal	studies, mountns in montan	peek,jm	1962
JWMAA	34--3	645	646	alal	aerial sex, antlerless, bc	mitchell,hb	1970
NCANA	101-3	539	558	alal	annu yield sex, age, ontar	cumming,hg	1974
WLMOA	48---	1	65	alal	habitat select, forest mgt	peek,jm; urich,d/	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
BPURD	3----	1	30	rata	sympos, caribou popul ecol	klein,dr; white,r	1978
CWRSB	31---	1	88	rata	dentition, age and sex com	miller,fl	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
CAFGA	36--3	328	329	anam	calif antel repro potentia	chattin,je; lasse	1950
NAWTA	15---	627	644	anam	rang ecol, wichita mt, kan	buechner,hk	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				bibi			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ovca			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ovda			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
JWMAA	35--1	103	108	obmo	pop char, jones sound, nwt	freeman,mmr	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
JOMAA	29--2	185	185	oram	mt goat age ratios, montan	petrides,ga	1948

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
AMNTA	112--	381	388		sex rat adj under food str	myers,jh	1978
JWMAA	7---1	11	13	biga	bag rec, sex rat, pop dens	baker,rh; siegler	1943
JWMAA	29--1	185	192		sex ratio, prod, surv data	wight,hm; heath,/	1965
JWMAA	34--4	690	703		det param, pop, struct mod	henny,cj; overto/	1970
SCIEA	179--	90	92	many	nat sel on par, sx rt offs	trivers,rl; willa	1973
UASPA	20...	189	198		sex ratio equatns, formula	kelker,gh	1944
WLMOA	9----	1	60	many	prod, abun, sex, age ratio	hanson,wr	1963

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
DRGBA	2---2	127	155	caca	analys danish pop, extermi	andersen,j	1953
LYNXA	14...	14	19	caca	sex indx in yg pops, ecosy	novakova,e; hanzl	1973
ZEJAA	1---2	65	69	caca	mark fawns, field id ag cl	wettstein,o	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
ATRLA	23--1	3	48	bibo	dyn, strc of pop in poland	krasinski,za	1978

CHAPTER 18, WORKSHEET 2.1a

Calculations of male to female sex ratios in each age class

The following format may be used to calculate male to female sex ratios (MFSR) in each age class. Space is provided for nine age classes, and an additional set of blanks is provided on the back of this page.

SPECIES: ____________________ REFERENCE: ____________________

LOCATION: ____________________ TIME PERIOD: ____________________

CLASS	ACMP	NMAC
ACa-.	1/2	____
ACb-.	1-1/2	____
ACc-.	2-1/2	____
ACd-.	3-1/2	____
ACe-.	4-1/2	____
ACf-.	5-1/2	____
ACg-.	6-1/2	____
ACh-.	7-1/2	____
ACi-.	8-1/2+	____

SUM = ____ = TNMP

CLASS	ACMP	NFAC	NMAC/NFAC	=	MFSR
ACaa.	1/2	____	____/____	=	____
ACbb.	1-1/2	____	____/____	=	____
ACcc.	2-1/2	____	____/____	=	____
ACdd.	3-1/2	____	____/____	=	____
ACee.	4-1/2	____	____/____	=	____
ACff.	5-1/2	____	____/____	=	____
ACgg.	6-1/2	____	____/____	=	____
AChh.	7-1/2	____	____/____	=	____
ACii.	8-1/2+	____	____/____	=	____

SUM = ____ = TNFP

SPECIES: ______________________ REFERENCE: ______________________

LOCATION: ______________________ TIME PERIOD: ______________________

CLASS	ACMP	NMAC
ACa-.	1/2	____
ACb-.	1-1/2	____
ACc-.	2-1/2	____
ACd-.	3-1/2	____
ACe-.	4-1/2	____
ACf-.	5-1/2	____
ACg-.	6-1/2	____
ACh-.	7-1/2	____
ACi-.	8-1/2+	____

SUM = ____ = TNMP

CLASS	ACMP	NFAC	NMAC/NFAC	=	MFSR
ACaa.	1/2	____	____/____	=	____
ACbb.	1-1/2	____	____/____	=	____
ACcc.	2-1/2	____	____/____	=	____
ACdd.	3-1/2	____	____/____	=	____
ACee.	4-1/2	____	____/____	=	____
ACff.	5-1/2	____	____/____	=	____
ACgg.	6-1/2	____	____/____	=	____
AChh.	7-1/2	____	____/____	=	____
ACii.	8-1/2+	____	____/____	=	____

SUM = ____ = TNFP

CHAPTER 18, WORKSHEET 2.1b

Calculations of the male and female fractions in each age class of the total male and female populations

Calculations of the male and female fractions in nine age classes in relation to the total male and female populations may be made in the space provided below. A second set of spaces is provided on the back of this page.

SPECIES: ____________________ REFERENCE: ____________________

LOCATION: ____________________ TIME PERIOD: ____________________

CLASS	ACMP	NMAC	NMAC/TNMP	=	FMPA
ACa-.	1/2	____	____/____	=	____
ACb-.	1-1/2	____	____/____	=	____
ACc-.	2-1/2	____	____/____	=	____
ACd-.	3-1/2	____	____/____	=	____
ACe-.	4-1/2	____	____/____	=	____
ACf-.	5-1/2	____	____/____	=	____
ACg-.	6-1/2	____	____/____	=	____
ACh-.	7-1/2	____	____/____	=	____
ACi-.	8-1/2+	____	____/____	=	____
	SUMS =	____	= TNMP		[1.00]

CLASS	ACMP	NFAC	NFAC/TNFP	=	FFPA
ACaa.	1/2	____	____/____	=	____
ACbb.	1-1/2	____	____/____	=	____
ACcc.	2-1/2	____	____/____	=	____
ACdd.	3-1/2	____	____/____	=	____
ACee.	4-1/2	____	____/____	=	____
ACff.	5-1/2	____	____/____	=	____
ACgg.	6-1/2	____	____/____	=	____
AChh.	7-1/2	____	____/____	=	____
ACii.	8-1/2+	____	____/____	=	____
	SUMS =	____	= TNFP		[1.00]

SPECIES: ____________ REFERENCE: ____________

LOCATION: ____________ TIME PERIOD: ____________

CLASS	ACMP	NMAC	NMAC/TNMP	=	FMPA
ACa-.	1/2	____	____/____	=	____
ACb-.	1-1/2	____	____/____	=	____
ACc-.	2-1/2	____	____/____	=	____
ACd-.	3-1/2	____	____/____	=	____
ACe-.	4-1/2	____	____/____	=	____
ACf-.	5-1/2	____	____/____	=	____
ACg-.	6-1/2	____	____/____	=	____
ACh-.	7-1/2	____	____/____	=	____
ACi-.	8-1/2+	____	____/____	=	____
	SUMS =	____	= TNMP		[1.00]

CLASS	ACMP	NFAC	NFAC/TNFP	=	FFPA
ACaa.	1/2	____	____/____	=	____
ACbb.	1-1/2	____	____/____	=	____
ACcc.	2-1/2	____	____/____	=	____
ACdd.	3-1/2	____	____/____	=	____
ACee.	4-1/2	____	____/____	=	____
ACff.	5-1/2	____	____/____	=	____
ACgg.	6-1/2	____	____/____	=	____
AChh.	7-1/2	____	____/____	=	____
ACii.	8-1/2+	____	____/____	=	____
	SUMS =	____	= TNFP		[1.00]

CHAPTER 18, WORKSHEET 2.1c

First approximations of age class distributions

A first approximation of the age structure may be made by fitting two points, fraction of yearlings in the population and the fraction in the oldest age class present, with an exponential curve.

1. Determine the yearling fraction of the yearling and adult population and tabulate below.

2. Determine the oldest age class expected to have a minimum fraction of animals worth considering in the total population, add 1.0* to that number, and record 0.01 in that last age class. Tabulate below.

ACMP	FYAP
1.5	___
___*	0.01

*This is the oldest age class plus 1.0.

3. Use an exponential curve-fitting program for the above table to derive a first-approximation equation for age class distribution. Calculate the fraction in each age class.
   Review the concepts presented on Page 39 in relation to heavily-hunted and lightly-hunted populations.

Space is provided on the next page for tabulated (TBLD) fractions of the yearling and adult populations for data of your choosing for nine age classes. Derive the equation and determine the calculated (CALC) fractions of the yearling and adult populations in each age class. Then determine the differencee (DIFF) between tabulated and calculated values.

ACMP	TBLD FYAP	CALC FYAP	DIFF
1.5	____	____	____
2.5	____	____	____
3.5	____	____	____
4.5	____	____	____
5.5	____	____	____
6.5	____	____	____
7.5	____	____	____
8.5	____	____	____
9.5	____	____	____
SUM =	1.00	____	

The equation for your data is:

ACMP	TBLD FYAP	CALC FYAP	DIFF
1.5	____	____	____
2.5	____	____	____
3.5	____	____	____
4.5	____	____	____
5.5	____	____	____
6.5	____	____	____
7.5	____	____	____
8.5	____	____	____
9.5	____	____	____
SUM =	1.00	____	

The equation for your data is:

CHAPTER 18, WORKSHEET 2.1d

Estimations of sex and age ratios based on prehunt and posthunt change-in-ratios

A method described by Shope and modified by Severinghaus (1981) may be used to determine sex and age compositions of prehunt populations. The basic data needed are age ratios and harvest data from two consecutive years. The method is described below.

I. Inputs

1. PYM1 = percent of yearling males in the total yearling and adult male population, year 1.
2. PYF1 = percent of yearling females in the total yearling and adult female population, year 1.
3. PAM2 = percent of adult males in the total yearling and adult male population, year 2.
4. PAF2 = percent of adult females in the total yearling and adult female population, year 2.
5. PYM2 = percent of yearling males in the total yearling and adult male population, year 2.
6. PYF2 = percent of yearling females in the total yearling and adult female population, year 2.
7. NAMH = number of adult and yearling males harvested, year 1.
8. NAFH = number of adult and yearling females harvested, year 1.
9. NFFH = number of fawn females harvested, year 1.
10. MFSR = number of males per 1 female.

II. Other Symbols Used

1. PRAM = number of prehunt adult males/100 adult females. See equation #1.
2. AMHF = number of adult males harvested/100 adult females. See equation #2.
3. PSAM = number of posthunt adult males/100 adult females. See equation #3.
4. MHRT = male harvest rate. See equation #4.
5. NMAC = number of males in each age class.
6. TMFP = number of males and females in the population.
7. NFAC = number of females in each age class.

III. Outputs

NAMP = number of adult (2-1/2+ years) males in the population.
NYMP = " " yearling " " " ".
NFMP = " " fawn " " " ".
NAFP = " " adult (2-1/2+ years) females in the population.
NYFP = " " yearling " " " ".
NFFP = " " fawn " " " ".

IV. Equations

1. PRAM = (PYF1/PYM1) x MFSR x 100

2. AMHF = (NAMH/NAFH) x 100

3. PSAM = [(PAM2 x PYF2)/(PAF2 x PYM2)] x 100

4. MHRT = [AMHF x (PRAM - PSAM)]/[PRAM x (AMHF - PSAM)]

5. NYAM = NAMH/MHRT =
   number of yearling and adult males in the prehunt population

   a. NYMP = (PYM2 x NYAM)/100 = number of yearling males
   b. NAMP = (PAM2 x NYAM)/100 = number of adult males

6. NYAF = (NYAM x 100)/PRAM =
   number of yearling and adult females in the prehunt population

   a. NYFP = (PYF2 x NYAF)/100 = number of yearling females
   b. NAFP = (PAF2 x NYAF)/100 = number of adult females

7. NFFP = [(PYF2/PAF2) (NYAF - NAFH)] + NFFH =
   number of fawn females in the prehunt population

8. NFMP = NFFP X MFSR = number of fawn males in the prehunt population

9. The total number of males and females in the population (TMFP) equals:

TMFP = NYMP + NAMP + NFMP + NYFP + NAFP + NFFP

A sample calculation is shown in the next WORKSHEET, and a format to be used for your calculations is given on page 44ee.

The number of individuals per square mile in each class or the total population can be determined by dividing the number in each class or the total population by the number of square miles of deer habitat (AREA).

The age compositions of the population or sex group may be determined by dividing the number in each age class by the total number in the population or sex group.

LITERATURE CITED

Shope, W. K. 1978. Estimating deer populations using CIR procedures and age structure data and harvest management decision making from CIR estimates. p. 28-35 In Trans. 14th Ann. NE Deer Study Group Meeting.

Severinghaus, C. W. 1981. Unpublished report #81-27 of the Wildlife Ecology Laboratory, Cornell University.

CHAPTER 18, WORKSHEET 2.1e

Sample calculation of sex and age ratios
based on prehunt and posthunt change-in-ratios

A sample calculation for Allegany County, N.Y., 1978 and 1979, is shown below. Each blank is filled with the data indicated by the symbol in brackets underneath it. Input data are given at the top.

INPUT DATA	Age Ratio Data				Harvest Data			
	PYM	PAM	PYF	PAF	NAMH	NAFH	NFFH	MFSR
year 1	75		35		2555	266	209	1.15
year 2	79	21	38	62				

1. (35 [PYF1] / 75 [PYM1]) x 1.15 [MFSR] x 100 = 53.67 = PRAM

2. (2555 [NAMH] / 266 [NAFH]) x 100 = 960.53 = AMHF

3. [(21 [PAM2] x 38 [PYF2]) / (62 [PAF2] x 79 [PYM2])] x 100 = 16.29 = PSAM

4. [960.53 [AMHF] x (53.67 [PRAM] - 16.29 [PSAM])] / [53.67 [PRAM] x (960.53 [AMHF] - 16.29 [PSAM])] = 0.71 = MHRT

5. 2555 [NAMH] / 0.71 [MHRT] = 3598.59 = NYAM

6. (3598.59 [NYAM] x 100) / 53.67 [PRAM] = 6705.03 = NYAF

7. [(38 [PYF2] / 62 [PAF2]) (6705.03 [NYAF] - 266 [NAFH])] + 209 [NFFH] = 4155.50 = NFFP

ACMP	MALE	NMAC	FEMALE	NFAC
1/2	(4155.50 [NFFP] x 1.15 [MFSR])	= 4779 = NFMP		4156 = NFFP
1-1/2	(3598.59 [NYAM] x 79 [PYM2]) / 100	= 2843 = NYMP	(6705.03 [NYAF] x 38 [PYF2]) / 100	= 2548 = NYFP
2-1/2+	(3598.59 [NYAM] x 21 [PAM2]) / 100	= 756 = NAMP	(6705.03 [NYAF] x 62 [PAF2]) / 100	= 4157 = NAFP
Totals:	# OF MALES	= 8378 = TNMP	# OF FEMALES	= 10861 = TNFP

Total Population = 8378 [TNMP] + 10861 [TNFP] = 19239 = TMFP

Fill in the blanks as indicated by the symbols in brackets underneath. If only one year of data is available, use it twice. Input data are to be tabulated at the top.

INPUT DATA	Age Ratio Data PYM	PAM	PYF	PAF	Harvest Data NAMH	NAFH	NFFH	MFSR
year 1	______		______		______	______	______	______
year 2	______	______	______	______				

1. (______ / ______) x ______ x 100 = ______ = PRAM
   [PYF1] [PYM1] [MFSR]

2. (______ / ______) x 100 = ______ = AMHF
   [NAMH] [NAFH]

3. [(______ x ______) / (______ x ______)] x 100 = ______ = PSAM
   [PAM2] [PYF2] [PAF2] [PYM2]

4. [______ x (______ - ______)] / [______ x (______ - ______)] = ______ = MHRT
   [AMHF] [PRAM] [PSAM] [PRAM] [AMHF] [PSAM]

5. ______ / ______ = ______ = NYAM
   [NAMH] [MHRT]

6. (______ x 100) / ______ = ______ = NYAF
   [NYAM] [PRAM]

7. [(______ / ______) (______ - ______)] + ______ = ______ = NFFP
   [PYF2] [PAF2] [NYAF] [NAFH] [NFFH]

ACMP	MALE	NMAC	FEMALE	NFAC
1/2	(______ x ______) [NFFP] [MFSR]	=______=NFMP		______ =NFFP
1-1/2	(______ x ______) / 100= [NYAM] [PYM2]	______=NYMP	(______ x ______) / 100= [NYAF] [PYF2]	______=NYFP
2-1/2+	(______ x ______) / 100= [NYAM] [PAM2]	______=NAMP	(______ x ______) / 100= [NYAF] [PAF2]	______=NAFP
Totals:	# OF MALES=	______=TNMP	# OF FEMALES=	______=TNFP

Total Population = ______ + ______ = ______ = TMFP
[TNMP] [TNFP]

UNIT 2.2. LIVE-WEIGHT STRUCTURES

Compilation of the weight structures of populations is important for those species which have the potential for major ecological impacts on the range. All wild ruminants have this potential as their number, biomass, and metabolic requirements may build up to levels that affect the stability of the forage resources necessary to support them. Populations of many other organisms--song birds, for example--do not build up to levels that have such potentially major, long-term, widespread impacts on the ecosystem.

Weights generally increase as animals grow older, with seasonal variations contributing to a sequence of weights through time for each individual as well as differences between individuals. Weight equations were presented in CHAPTER 1, and the results of calculations with those equations, using information on the sex and age structures discussed in UNIT 1.1, can now be used to determine the weight structure of a population.

The basic format for displaying the weight structure of a population is the same as that for the age structure. Weight classes replace age classes for each sex, and the numbers in each, fractions of the total number in each, and the weighted mean for a population are all recorded and determined as described for age structures in UNIT 2.1.

The format for determining weight structures follows for both females and males. Be sure to work through the simplified example to verify your ability to represent a population by its weight structure.

CLASS	WCKI	NMWC	
WCa-.	40-50	____	
WCb-.	50-60	____	
WCc-.	60-70+	____	
	SUM =	____	= TNMP

CLASS	WCKI	NFWC	
WCaa.	40-50	____	
WCbb.	50-60	____	
WCcc.	60-70+	____	
	SUM =	____	= TNFP

Ratios may be added to the format as shown below.

CLASS	WCKI	NMWC
WCa-.	40-50	35
WCb-.	50-60	44
WCc-.	60-70+	21
	SUM =	100 = TNMP

CLASS	WCKI	NFWC	NMWC/NFWC	=	MFSR
WCaa.	40-50	50	35 / 50	=	0.70
WCbb.	50-60	43	44 / 43	=	1.02
WCcc.	60-70+	7	21 / 7	=	3.00
	SUM =	100 = TNFP			

Ratios could also be derived for each class as a fraction of the total if that sex. Thus the male fraction of the total number of both males and females (TNMF) in each ACMP could be determined as follows:

CLASS	WCKI	NMWC	NMWC/TNMP	=	FMPW
WCa-.	40-50	35	35 / 100	=	0.35
WCb-.	50-60	44	44 / 100	=	0.44
WCc-.	60-70+	21	21 / 100	=	0.21
	SUMS =	100 =	TNMP		[1.00]

CLASS	WCKI	NFWC	NFWC/TNFP	=	FFPW
WCaa.	40-50	50	50 / 100	=	0.50
WCbb.	50-60	43	43 / 100	=	0.43
WCcc.	60-70+	7	7 / 100	=	0.07
	SUMS =	100 =	TNFP		[1.00]

The above formats for weight classes are used when weights are available and frequency-tabulations can be made. The occurrence of individuals in different weight classes are evaluated just as the age classes were, resulting in the number of animals in each of the weight classes, after which ratios of males to females or of males or females in relation to the total number in each age class can be calculated.

Measured weights of live or field-dressed animals (field-dressed weights can be converted to live weights) are seldom available throughout the year. Age class data may be used to estimate age in days (AGDA), and AGDA used to calculate live weights (See CHAPTER 1, TOPIC 1). The resulting calculated live weights in kg (CLWK) represent estimated average weights for each age class rather than weight distributions in the population. The weights may be used, however, in calculating reproductive rates, ecological metabolism, weights of forage reached, and other weight-dependent variables.

The formats for tabulating calculated live weights in kg for males and females in each of the age classes are shown below.

CLASS	ACYI	JDAY	AGDA	CLWK
ACa-.	0-1	___	___	___
ACb-.	1-2	___	___	___
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
ACn-.	___	___	___	___

CLASS	ACYI	JDAY	AGDA	CLWK
ACaa.	0-1	___	___	___
ACbb.	1-2	___	___	___
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
ACnn.	___	___	___	___

Weighted mean live weights for male and female populations (WLMP and WLFP) are calculated next by multiplying the class weight by the fraction of the males or females in that class. The sums of the weighted mean weights for each age class are the weighted mean population weights.

MALES

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	x	FMPA	=	WMLA
ACa-.	___	___	___	___	___	x	___	=	___
ACb-.	___	___	___	___	___	x	___	=	___
.	.	.	.	.	.		.		.
.	.	.	.	.	.		.		.
.	.	.	.	.	.		.		.
ACn-.	___	___	___	___	___	x	___	=	___
			SUMS =	[___] TNMP			[1.00]		[___] WLMP

Definitions of the symbols are:

AGCL = age class,
JDAY = julian day,
AGDA = age in days,
NMAC = number of males in each age class,
CLWK = calculated live weight in kg,
FMPA = fraction of the male population in each age class (NMAC/TNMP),
WMLA = weighted mean live weight of the age class,
SUMS = sums,
TNMP = total number of males in the population, and
WLMP = weighted-mean live weight of the male population.

A sample calculation is shown below. All the blanks are filled in to demonstrate the sequence of the calculations. The format is repeated in WORKSHEET 2.2a for your use with a species of your choice.

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	x	FMPA	=	WMLA
ACa-.	1/2	310	160	50	45	x	0.50	=	22.5
ACb-.	1-1/2	310	525	38	70	x	0.38	=	26.6
ACc-.	2-1/2+	310	890	12	85	x	0.12	=	10.2
			SUMS =	[100] TNMP			[1.00]		[59.3] WLMP

The format for determining the weighted-mean live weight of the female population is shown below.

FEMALES

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	x	FFPA	=	WMLA
ACaa.	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	x	____	=	____
.	.	.	.	.	.		.		.
.	.	.	.	.	.		.		.
.	.	.	.	.	.		.		.
ACnn.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP			[1.00]		[____] WLFP

Definitions of the symbols are:

AGCL = age class,
JDAY = julian day,
AGDA = age in days,
NFAC = number of females in each age class,
CLWK = calculated live weight in kg,
FFPA = fraction of the female population in each age class (NFAC/TNFP),
WMLW = weighted mean live weight of the age class,
SUMS = sums,
TNFP = total number of females in the population, and
WLFP = weighted-mean live weight of the female population.

Sample calculations are shown below. All the blanks are filled in to demonstate the sequence of the calculations, and the format is repeated in WORKSHEET 2.2b for your use with a species of your choice.

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	x	FFPA	=	WMLW
ACaa.	1/2	310	160	44	42	x	0.44	=	18.5
ACbb.	1-1/2	310	525	34	56	x	0.34	=	19.0
ACcc.	2-1/2+	310	890	22	62	x	0.22	=	13.6
			SUMS =	[100] TNFP			[1.00]		[51.2] WLFP

The calculation of WEIGHT STRUCTURES in this UNIT 2.2 leads to calculations of METABOLIC WEIGHT STRUCTURES in UNIT 2.4. This is useful for calculating ecological metabolism (see CHAPTER 7), with the use of metabolic weight in the equations for ELMD.

The metabolic weight structure of the population is determined by adding a few columns to the right side of the format for the weight structure.

REFERENCES, UNIT 2.2

LIVE-WEIGHT STRUCTURES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
NFGJA	20--2	77	107	odvi	comp physc cond, sev indic	hesselton,wt; sau	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				odhe			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ceel			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
ECOLA	52--1	147	152	alal	biomass dynamics, populati	jordan,pa; botki/	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				rata			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				anam			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				bibi			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ovca			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ovda			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				obmo			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				oram			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
MAMLA	34--3	363	393	herb	est biomass large herbivor	mentis,mt	1970

CHAPTER 18, WORKSHEET 2.2a

Determining live weight population structures - males

Calculations of the live weight structures of populations of males in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	x	FMPA	=	WMLA
ACa-.	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP			[1.00]		[____] WLMP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	x	FMPA	=	WMLA
ACa-.	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP			[1.00]		[____] WLMP

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	x	FMPA	=	WMLA
ACa-.	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP			[1.00]		[____] WLMP

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	x	FMPA	=	WMLA
ACa-.	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP			[1.00]		[____] WLMP

CHAPTER 18, WORKSHEET 2.2b

Determining live weight population structures - females

Calculations of the live weight structures of populations of females in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	x	FFPA	=	WMLA
ACaa.	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	x	____	=	____
ACcc.	____	____	____	____	____	x	____	=	____
ACdd.	____	____	____	____	____	x	____	=	____
ACee.	____	____	____	____	____	x	____	=	____
ACff.	____	____	____	____	____	x	____	=	____
ACgg.	____	____	____	____	____	x	____	=	____
AChh.	____	____	____	____	____	x	____	=	____
ACii.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP			[1.00]		[____] WLFP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	x	FFPA	=	WMLA
ACaa.	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	x	____	=	____
ACcc.	____	____	____	____	____	x	____	=	____
ACdd.	____	____	____	____	____	x	____	=	____
ACee.	____	____	____	____	____	x	____	=	____
ACff.	____	____	____	____	____	x	____	=	____
ACgg.	____	____	____	____	____	x	____	=	____
AChh.	____	____	____	____	____	x	____	=	____
ACii.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP			[1.00]		[____] WLFP

SPECIES: ______________________ TIME PERIOD: ______________________

LOCATION: ______________________ REFERENCE: ______________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	x	FFPA	=	WMLA
ACaa.	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	x	____	=	____
ACcc.	____	____	____	____	____	x	____	=	____
ACdd.	____	____	____	____	____	x	____	=	____
ACee.	____	____	____	____	____	x	____	=	____
ACff.	____	____	____	____	____	x	____	=	____
ACgg.	____	____	____	____	____	x	____	=	____
AChh.	____	____	____	____	____	x	____	=	____
ACii.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP			[1.00]		[____] WLFP

SPECIES: ______________________ TIME PERIOD: ______________________

LOCATION: ______________________ REFERENCE: ______________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	x	FFPA	=	WMLA
ACaa.	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	x	____	=	____
ACcc.	____	____	____	____	____	x	____	=	____
ACdd.	____	____	____	____	____	x	____	=	____
ACee.	____	____	____	____	____	x	____	=	____
ACff.	____	____	____	____	____	x	____	=	____
ACgg.	____	____	____	____	____	x	____	=	____
AChh.	____	____	____	____	____	x	____	=	____
ACii.	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP			[1.00]		[____] WLFP

UNIT 2.3: INGESTA-FREE WEIGHT STRUCTURES

Ingesta-free weight structures are determined from the live-weight structures by multiplying live weights by the appropriate fractions representing ingesta-free weights (See CHAPTER 1, UNIT 1.5). The formats below look very familiar; they are identical to those in UNIT 2.2, with the addition of a column for IFWK. The formats are presented separately because some calculations are based on live weight (height of forage reached, for example), some on ingesta-free weight (body composition, for example), and some on metabolic weights (See UNIT 2.4).

MALES

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	x	FMPA	=	WMIA
ACa-.	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	x	____	=	____
.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.		.		.
ACn-.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP				[1.00]		[____] WIMP

Definitions of the symbols are:

AGCL = age class,
JDAY = julian day,
AGDA = age in days,
NMAC = number of males in each age class,
CLWK = calculated live weight in kg,
IFWK = ingesta-free weight in kg,
FMPA = fraction of the male population in each age class (NMAC/TNMP),
WMIA = weighted mean ingesta-free weight of the age class,
SUMS = sums,
TNMP = total number of males in the population, and
WIMP = weighted mean ingesta-free weight of the population.

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	x	FMPA	=	WMIA
ACa-.	1/2	310	160	50	45	40.5	x	0.50	=	20.3
ACb-.	1-1/2	310	525	38	70	63.0	x	0.38	=	23.9
ACc-.	2-1/2+	310	890	12	85	76.5	x	0.12	=	9.2
			SUMS =	[100] TNMP				[1.00]		[53.4] WIMP

FEMALES

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	x	FFPA	=	WMIA
ACaa.	____	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	____	x	____	=	____
.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.		.		.
ACnn.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP				[1.00]		[____] WIFP

Definitions of the symbols are:

AGCL = age class,
JDAY = julian day,
AGDA = age in days,
NFAC = number of females in each age class,
CLWK = calculated live weight in kg,
IFWK = ingesta-free weight in kg,
FFPA = fraction of the female population in each age class (NFAC/TNFP),
WMIA = weighted mean ingesta-free weight of the age class,
SUMS = sums,
TNFP = total number of females in the population, and
WIFP = weighted mean ingesta-free weight of the population.

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	x	FFPA	=	WMIA
ACaa.	1/2	310	160	44	42	37.8	x	0.44	=	16.6
ACbb.	1-1/2	310	525	34	56	50.4	x	0.34	=	17.1
ACcc.	2-1/2+	310	890	22	62	55.8	x	0.22	=	12.3
			SUMS =	[100] TNFP				[1.00]		[46.0] WIFP

REFERENCES, UNIT 2.3

INGESTA-FREE WEIGHT STRUCTURES

SERIALS

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

odvi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

odhe

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

ceel

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

alal

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

rata

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

anam

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

bibi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

ovca

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

ovda

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

obmo

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

oram

CHAPTER 18, WORKSHEET 2.3a

Determining ingesta-free weight population structures - males

Calculations of the ingesta-free weight structures of populations of males in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	x	FMPA	=	WMIA
ACa-.	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP				[1.00]		[____] WIMP

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	x	FMPA	=	WMIA
ACa-.	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP				[1.00]		[____] WIMP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	x	FMPA	=	WMIA
ACa-.	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP				[1.00]		[____] WIMP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	x	FMPA	=	WMIA
ACa-.	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP				[1.00]		[____] WIMP

Determining ingesta-free weight population structures - females

Calculations of the ingesta-free weight structures of populations of females in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	x	FFPA	=	WMIA
ACaa.	____	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	____	x	____	=	____
ACcc.	____	____	____	____	____	____	x	____	=	____
ACdd.	____	____	____	____	____	____	x	____	=	____
ACee.	____	____	____	____	____	____	x	____	=	____
ACff.	____	____	____	____	____	____	x	____	=	____
ACgg.	____	____	____	____	____	____	x	____	=	____
AChh.	____	____	____	____	____	____	x	____	=	____
ACii.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP				[1.00]		[____] WIFP

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	x	FFPA	=	WMIA
ACaa.	____	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	____	x	____	=	____
ACcc.	____	____	____	____	____	____	x	____	=	____
ACdd.	____	____	____	____	____	____	x	____	=	____
ACee.	____	____	____	____	____	____	x	____	=	____
ACff.	____	____	____	____	____	____	x	____	=	____
ACgg.	____	____	____	____	____	____	x	____	=	____
AChh.	____	____	____	____	____	____	x	____	=	____
ACii.	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP				[1.00]		[____] WIFP

SPECIES: ________ TIME PERIOD: ________

LOCATION: ________ REFERENCE: ________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	x	FFPA	=	WMIA
ACaa.							x		=	
ACbb.							x		=	
ACcc.							x		=	
ACdd.							x		=	
ACee.							x		=	
ACff.							x		=	
ACgg.							x		=	
AChh.							x		=	
ACii.							x		=	
			SUMS =	[____] TNFP				[1.00]		[____] WIFP

SPECIES: ________ TIME PERIOD: ________

LOCATION: ________ REFERENCE: ________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	x	FFPA	=	WMIA
ACaa.							x		=	
ACbb.							x		=	
ACcc.							x		=	
ACdd.							x		=	
ACee.							x		=	
ACff.							x		=	
ACgg.							x		=	
AChh.							x		=	
ACii.							x		=	
			SUMS =	[____] TNFP				[1.00]		[____] WIFP

UNIT 2.4: METABOLIC WEIGHT STRUCTURES

Metabolic weight structures are used when estimating metabolism. The formats below include a column for metabolic weight in kg (MWKG) in addition to those included in UNIT 2.3. The weighted mean metabolic weights derived in the samples below will be used when calculating the weighted mean metabolic structure illustrated in UNIT 2.5.

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	x	FMPA	=	WMMA
ACa-.	___	___	___	___	___	___	___	x	___	=	___
ACb-.	___	___	___	___	___	___	___	x	___	=	___
.	.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.	.		.		.
ACn-.	___	___	___	___	___	___	___	x	___	=	___
		SUMS =		[___] TNMP					[1.00]		[___] WMMP

Definitions of the symbols are:

AGCL = age class,
JDAY = julian day,
AGDA = age in days,
NMAC = number of males in each age class,
CLWK = calculated live weight in kg,
IFWK = ingesta-free weight in kg,
MWKG = metabolic weight in kg,
FMPA = fraction of the male population in each age class (NMAC/TNMP),
WMMA = weighted mean metabolic weight of the age class,
SUMS = sums,
TNMP = total number of males in the population, and
WMMP = weighted mean metabolic weight of the population.

A sample calculation follows.

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	x	FMPA	=	WMMA
ACa-.	1/2	310	160	50	45	40.5	16.1	x	0.50	=	8.1
ACb-.	1-1/2	310	525	38	70	63.0	22.4	x	0.38	=	8.5
ACc-.	2-1/2+	310	890	12	85	76.5	25.9	x	0.12	=	3.1
		SUMS =		[100] TNMP					[1.00]		[19.7] WMMP

FEMALES

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	x	FFPA	=	WMMA
ACaa.	____	____	____	____	____	____	____	x	____	=	____
ACbb.	____	____	____	____	____	____	____	x	____	=	____
.	.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.	.		.		.
.	.	.	.	.	.	.	.		.		.
ACnn.	____	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNFP					[1.00]		[____] WMFP

Definitions of the symbols are:

AGCL = age class,
JDAY = julian day,
AGDA = age in days,
NFAC = number of females in each age class,
CLWK = calculated live weight in kg,
IFWK = ingesta-free weight in kg,
MWKG = metabolic weight in kg,
FFPA = fraction of the female population in each age class (NFAC/TNFP),
WMMA = weighted mean ingesta-free weight of the age class,
SUMS = sums,
TNFP = total number of females in the population, and
WMFP = weighted mean ingesta-free weight of the population.

A sample calculation follows.

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	x	FFPA	=	WMMA
ACaa.	1/2	310	160	44	42	37.8	15.2	x	0.44	=	6.7
ACbb.	1-1/2	310	525	34	56	50.4	18.9	x	0.34	=	6.4
ACcc.	2-1/2+	310	890	22	62	55.8	20.4	x	0.22	=	4.5
			SUMS =	[100] TNFP					[1.00]		[17.6] WMFP

The reasons for determining weighted mean weights and weighted mean metabolic weights are probably not apparent yet. Completion of weighted mean live weights and ingesta-free weights greatly simplifies predictions of populations in CHAPTER 19. Weighted mean metabolic weights are used in calculating metabolic structures in the next UNIT (2.5), which is used in calculations of carrying capacity in CHAPTER 20.

Select species for which the necessary age and weight data are available and complete WORKSHEETS on the weight structures of the populations. The simplicity of population predictions and carrying capacity calculations will then be demonstrated in the next two chapters.

REFERENCES, UNIT 2.4

METABOLIC WEIGHT STRUCTURES

SERIALS

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

odvi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

odhe

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

ceel

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

alal

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

rata

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS----------- YEAR

anam

CODEN VO-NU BEPA ENPA ANIM KEY WORDS--------------- AUTHORS----------- YEAR

bibi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS--------------- AUTHORS----------- YEAR

ovca

CODEN VO-NU BEPA ENPA ANIM KEY WORDS--------------- AUTHORS----------- YEAR

ovda

CODEN VO-NU BEPA ENPA ANIM KEY WORDS--------------- AUTHORS----------- YEAR

obmo

CODEN VO-NU BEPA ENPA ANIM KEY WORDS--------------- AUTHORS----------- YEAR

oram

Determining metabolic weight population structures - males

Calculations of the metabolic weight structures of populations of males in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	x	FMPA	=	WMMA
ACa-.	____	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP					[1.00]		[____] WMMP

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	x	FMPA	=	WMMA
ACa-.	____	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP					[1.00]		[____] WMMP

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	x	FMPA	=	WMMA
ACa-.	____	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP					[1.00]		[____] WMMP

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	x	FMPA	=	WMMA
ACa-.	____	____	____	____	____	____	____	x	____	=	____
ACb-.	____	____	____	____	____	____	____	x	____	=	____
ACc-.	____	____	____	____	____	____	____	x	____	=	____
ACd-.	____	____	____	____	____	____	____	x	____	=	____
ACe-.	____	____	____	____	____	____	____	x	____	=	____
ACf-.	____	____	____	____	____	____	____	x	____	=	____
ACg-.	____	____	____	____	____	____	____	x	____	=	____
ACh-.	____	____	____	____	____	____	____	x	____	=	____
ACi-.	____	____	____	____	____	____	____	x	____	=	____
			SUMS =	[____] TNMP					[1.00]		[____] WMMP

CHAPTER 18, WORKSHEET 2.4b

Determining metabolic weight population structures - females

Calculations of the metabolic weight structures of populations of females in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	x	FFPA	=	WMMA
ACaa.								x		=	
ACbb.								x		=	
ACcc.								x		=	
ACdd.								x		=	
ACee.								x		=	
ACff.								x		=	
ACgg.								x		=	
AChh.								x		=	
ACii.								x		=	
			SUMS =	[____] TNFP					[1.00]		[____] WMFP

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	x	FFPA	=	WMMA
ACaa.								x		=	
ACbb.								x		=	
ACcc.								x		=	
ACdd.								x		=	
ACee.								x		=	
ACff.								x		=	
ACgg.								x		=	
AChh.								x		=	
ACii.								x		=	
			SUMS =	[____] TNFP					[1.00]		[____] WMFP

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	x	FFPA	=	WMMA
ACaa.								x		=	
ACbb.								x		=	
ACcc.								x		=	
ACdd.								x		=	
ACee.								x		=	
ACff.								x		=	
ACgg.								x		=	
AChh.								x		=	
ACii.								x		=	
			SUMS =	[____] TNFP					[1.00]		[____] WMFP

SPECIES: ____________ TIME PERIOD: ____________

LOCATION: ____________ REFERENCE: ____________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	x	FFPA	=	WMMA
ACaa.								x		=	
ACbb.								x		=	
ACcc.								x		=	
ACdd.								x		=	
ACee.								x		=	
ACff.								x		=	
ACgg.								x		=	
AChh.								x		=	
ACii.								x		=	
			SUMS =	[____] TNFP					[1.00]		[____] WMFP

UNIT 2.5: METABOLIC STRUCTURES

Metabolic structures of populations are calculated from the JDAY and from the sex, age, weight, and reproductive-rate structures presented earlier by using equations for ecological metabolism (ELMD) given in CHAPTER 7. ELMD is easily determined by multiplying base-line metabolism (a function of weight; CHAPTER 1) by the multiple of base-line metabolism (MBLM), a function of sex, JDAY, and reproductive rate. The previous tabulations of population characteristics are used in determining the metabolic structure of a population, and the format for tabulating the necessary parameters is an extension of the formats used before. The formats for both males and females are shown here, along with sample with calculations, and are also set up as WORKSHEETS for different species at the end of this UNIT.

MALES

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	MBLMx	BLMD=	ELMDx	FMPA=	WEMA
ACa-.	____	____	____	____	____	____	____	____x	____=	____x	____=	____
ACb-.	____	____	____	____	____	____	____	____x	____=	____x	____=	____
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.
ACn-.	____	____	____	____	____	____	____	____x	____=	____x	____=	____
		SUMS =		[____] TNMP							[1.00]	[____] WEMP

Definitions are:

- AGCL = age class,
- JDAY = julian day,
- AGDA = age in days,
- NMAC = number of males in each age class,
- CLWK = calculated live weight in kg,
- IFWK = ingesta-free weight in kg,
- MWKG = metabolic weight in kg,
- MBLM = multiple of base-line metabolism,
- BLMD = base-line metabolism per day,
- ELMD = ecological metabolism per day,
- FMPA = fraction of the male population in each age class (NMAC/TNMP),
- WEMA = weighted mean ecological metabolism of the age class,
- SUMS = sums,
- TNMP = total number of males in the population, and
- WEMP = weighted mean ecological metabolism of the population.

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	MBLMx	BLMD=	ELMDx	FMPA=	WEMA
ACa-.	1/2	310	160	50	45	40.5	16.1	2.5 x	1127 =	2818 x	0.50 =	1409
ACb-.	1-1/2	310	525	38	70	63.0	22.4	2.5 x	1568 =	3920 x	0.38 =	1490
ACc-.	2-1/2+	310	890	12	85	76.5	25.9	2.5 x	1813 =	4533 x	0.12 =	544
		SUMS =		[100] TNMP							[1.00]	[3443] WEMP

FEMALES

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	RERT	MBLMx	BLMD=	ELMDx	FFPA=	WEMA
ACaa.	____	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACbb.	____	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
ACnn.	____	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
		SUMS =		[____] TNFP								[1.00]	[____] WEFP

Definitions are:

- AGCL = age class,
- JDAY = julian day,
- AGDA = age in days,
- NFAC = number of females in each age class,
- CLWK = calculated live weight in kg,
- IFWK = ingesta-free weight in kg,
- MWKG = metabolic weight in kg,
- RERT = reproductive rate,
- MBLM = multiple of base-line metabolism,
- BLMD = base-line metabolism per day,
- ELMD = ecological metabolism per day,
- FFPA = fraction of the female population in each age class (NFAC/TNFP),
- WEMA = weighted mean ecological metabolism of the age class,
- SUMS = sums,
- TNFP = total number of females in the population, and
- WEFP = weighted mean ecological metabolism of the population.

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	RERT	MBLMx	BLMD=	ELMDx	FFPA=	WEMA
ACaa.	1/2	310	160	44	42	37.8	15.2	0.10	2.5 x	1064 =	2660 x	0.44 =	1170
ACbb.	1-1/2	310	525	34	56	50.4	18.9	0.90	3.0 x	1323 =	3969 x	0.34 =	1349
ACcc.	2-1/2+	310	890	22	62	55.8	20.4	1.60	3.2 x	1428 =	4570 x	0.22 =	1005
		SUMS =		[100] TNFP								[1.00]	[3525] WEFP

REFERENCES, UNIT 2.5

METABOLIC STRUCTURES

SERIALS

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------------- AUTHORS---------- YEAR

odvi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------------- AUTHORS---------- YEAR

odhe

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------------- AUTHORS---------- YEAR

ceel

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------------- AUTHORS---------- YEAR

alal

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------------- AUTHORS---------- YEAR

rata

CODEN VO-NU BEPA ENPA ANIM KEY WORDS----------------- AUTHORS---------- YEAR

anam

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS---------- YEAR

bibi

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS---------- YEAR

ovça

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS---------- YEAR

ovda

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS---------- YEAR

obmo

CODEN VO-NU BEPA ENPA ANIM KEY WORDS---------------- AUTHORS---------- YEAR

oram

CHAPTER 18 - WORKSHEET 2.5a

Determining the weighted mean ecological metabolism of a population - males

Calculations of the weighted mean ecological metabolism of populations of males in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	MBLMx	BLMD=	ELMDx	FMPA=	WEMA
ACa-.								x	=	x	=	
ACb-.								x	=	x	=	
ACc-.								x	=	x	=	
ACd-.								x	=	x	=	
ACe-.								x	=	x	=	
ACf-.								x	=	x	=	
ACg-.								x	=	x	=	
ACh-.								x	=	x	=	
ACi-.								x	=	x	=	

SUMS = [____] TNMP [1.00] [____] WEMP

SPECIES: ______________ TIME PERIOD: ______________

LOCATION: ______________ REFERENCE: ______________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	MBLM	BLMD	ELMDx	FMPA=	WEMA
ACa-.								x	=	x	=	
ACb-.								x	=	x	=	
ACc-.								x	=	x	=	
ACd-.								x	=	x	=	
ACe-.								x	=	x	=	
ACf-.								x	=	x	=	
ACg-.								x	=	x	=	
ACh-.								x	=	x	=	
ACi-.								x	=	x	=	

SUMS = [____] TNMP [1.00] [____] WEMP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	MBLMx	BLMD=	ELMDx	FMPA=	WEMA
ACa-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACb-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACc-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACd-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACe-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACf-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACg-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACh-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACi-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
			SUMS =	[____] TNMP							[1.00]	[____] WEMP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NMAC	CLWK	IFWK	MWKG	MBLMx	BLMD=	ELMDx	FMPA=	WEMA
ACa-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACb-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACc-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACd-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACe-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACf-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACg-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACh-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
ACi-.	____	____	____	____	____	____	____	____ x	____ =	____ x	____ =	____
			SUMS =	[____] TNMP							[1.00]	[____] WEMP

CHAPTER 18 - WORKSHEET 2.5b

Determining the weighted mean ecological metabolism of a population - females

Calculations of the weighted mean ecological metabolism of populations of females in nine age classes may be made in the spaces provided below. Two more sets of spaces are provided on the back of this page.

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	RERT	MBLMx	BLMD=	ELMDx	FFPA=	WEMA
ACaa.									x	=	x	=	
ACbb.									x	=	x	=	
ACcc.									x	=	x	=	
ACdd.									x	=	x	=	
ACee.									x	=	x	=	
ACff.									x	=	x	=	
ACgg.									x	=	x	=	
AChh.									x	=	x	=	
ACii.									x	=	x	=	

SUMS = [____] TNFP   [1.00] [____] WEFP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	RERT	MBLMx	BLMD=	ELMDx	FFPA=	WEMA
ACaa.									x	=	x	=	
ACbb.									x	=	x	=	
ACcc.									x	=	x	=	
ACdd.									x	=	x	=	
ACee.									x	=	x	=	
ACff.									x	=	x	=	
ACgg.									x	=	x	=	
AChh.									x	=	x	=	
ACii.									x	=	x	=	

SUMS = [____] TNFP   [1.00] [____] WEFP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	RERT	MBLMx	BLMD=	ELMDx	FFPA=	WEMA
ACaa.									x	=	x	=	
ACbb.									x	=	x	=	
ACcc.									x	=	x	=	
ACdd.									x	=	x	=	
ACee.									x	=	x	=	
ACff.									x	=	x	=	
ACgg.									x	=	x	=	
AChh.									x	=	x	=	
ACii.									x	=	x	=	

SUMS = [____] TNFP [1.00] [____] WEFP

SPECIES: ____________________ TIME PERIOD: ____________________

LOCATION: ____________________ REFERENCE: ____________________

CLASS	AGCL	JDAY	AGDA	NFAC	CLWK	IFWK	MWKG	RERT	MBLMx	BLMD=	ELMDx	FFPA=	WEMA
ACaa.									x	=	x	=	
ACbb.									x	=	x	=	
ACcc.									x	=	x	=	
ACdd.									x	=	x	=	
ACee.									x	=	x	=	
ACff.									x	=	x	=	
ACgg.									x	=	x	=	
AChh.									x	=	x	=	
ACii.									x	=	x	=	

SUMS = [____] TNFP [1.00] [____] WEFP

UNIT 2.6: LIFE TABLES

The tables here have been prepared for many different populations, so this unit includes a brief description of a life table and lists of references in SERIALS that may be consulted by the interested user.

Life tables deal with mortality and survival. The traditional life table consists of a series of columns giving the age at the beginning of intervals, the number of survivors of the cohorts at each age, the number of mortalities in each age class, the mortality rate of each age class, the survival rate of each class (1.0 - mortality rate), and the average life expectancy at each age. The columns are often arranged as shown below.

x	l_x	d_x	q_x	L_x	e_x

Column headings are:

x = age at beginning of interval.
l_x = number of survivors of the cohort at age X.
d_x = number of individuals dying between ages X and (X + 1).
q_x = probability of the L_x individuals dying before age (X + 1).
L_x = average number of survivors between ages X and (X + 1).
e_x = expectation of further life at age X.

The customary age-classes used are years; X = 1. The age-specific mortality rate, (q_x) is the ratio of the number of deaths of individuals between the ages of x and (x+1) to the number alive at age X. It is the probability that an individual attaining age X will die within the next year. Such probabilities are of direct interest to persons working with human populations.

Life tables were originally devised by actuaries calculating insurance and annuity premiums, reserves, and dividends. Such tables are based on averages, with rates reflecting long-term mortality and survivorship curves for members of the human population dying of ordinary natural causes. The effects of catastrophes are not included; insurance policies often exclude payments of benefits to survivors if the deceased died as a result of large-scale perturbations, such as war, or singular catastrophes, such as airplane crashes. The exclusion of such deviations from the calculations used to derive human life tables illustrates that the usefulness of life tables is limited to the factors considered in deriving the average values in the table.

When life tables are adapted by ecologists for use on free-ranging populations, the effects of transient perturbations, which can affect population dynamics for years to come, should be included. Ecological life tables are used for accurately describing population characteristics and probabilities of survival for different classes. Insurance-oriented life tables for humans are designed for accurately predicting payments to survivors so the firm can show a profit, or at least remain solvent. This subtle difference is very important when using, interpreting, and applying the life-table format in population analyses.

Life tables provide a format for recording some essential characteristics of classes in a population, but natality rates, which are of distinct ecological importance and they are also available, are omitted. They are most useful for human populations with constraints on the individuals considered (war casualities not considered, for example), and Allee et al. (1949) use known data to illustrate life tables, even though the book is directed toward animal ecology. Life tables are most useful when working with known populations over time, with individuals followed from birth to death. This is an unlikely situation for most wildlife biologists to find themselves in. Some populations may be studied intensively enough to construct a life table describing what happens. Controlled deer hunts in enclosures make this possible. Rather than direct more efforts here to the characteristics and uses of life tables, descriptions in Allee et al. (1949), Eberhardt (1969), and Tanner (1978) should be consulted for further information.

The discussion now turns to predicting populations in CHAPTER 19, while there are many problems involved in sampling, estimating, and describing populations, the need for these evaluations must be emphasized. Working with population data, especially in predictive ways, helps one understand the factors contributing to population dynamics, thereby increasing understanding of what is possibly occurring in the field.

LITERATURE CITED

Allee, W. C., A. E. Everson, O. Park, T. Park, and K. P. Schmidt. 1949. Principles of Animal Ecology. W. B. Saunders Company, Philadelphia. 837 p.

Eberhardt, L. L. 1969. Population Analysis. Chapter 22 In R. H. Giles, Jr. (Ed.), Wildlife Management Techniques. The Wildlife Society, Washington, D. C. 625 p.

Tanner, J. T. 1978. Guide to the Study of Animal Populations. The University of Tennessee Press. Knoxville, TN. 186 p.

REFERENCES, UNIT 2.6

LIFE TABLES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
JWMAA	11--2	177	183	od--	computing rate of increase	kelker,g	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
JWMAA	33--4	1027	1028	odvi	longevity records, female	ozoga,jj	1969
VIWIA	29--5	8	9	odvi	vital statistics, dee herd	carpenter,m	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				odhe			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ceel			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
FUNAA	25...	84	96	alal	the moose in norway, 1970	myrberget,s	1972

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
CJZOA	33...	143	147	rata	provis life table, b g car	banfield,awf	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				anam			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				bibi			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ovca			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				ovda			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
MUOXD	17...	32	37	obmo	musk-ox on baffin island	harington,cr	1975
NPOAA	1976-	159	174	obmo	musk-ox pop, svalbard, nor	alendal,e	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
				oram			

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS-----------------	AUTHORS----------	YEAR
EVOLA	19--3	395	420		F-stats, mating sys, struc	wright,s	1965
JWMAA	35--4	658	663		rate of increase	caughley,g; birch	1971
NAWTA	23---	426	442		est eff exploit by lif tab	quick,hf	1963
QRBIA	22--4	283	314	anim	life tables, naturl populs	deevey,es,jr	1947

CLOSING COMMENTS - CHAPTER EIGHTEEN

Population structures are very important when analyzing population dynamics. The sequential approach illustrated in CHAPTER 18 makes it easy to compile population structures and to derive weighted-mean values for different population characteristics. Uses of these weighted-means are illustrated in CHAPTERS 19 and 20; the utility of weighted-means will be evident as population predictions and calculations of carrying capacity are made.

Aaron N. Moen
June 2, 1981

GLOSSARY OF SYMBOLS USED - CHAPTER EIGHTEEN

ACa- = Age class - males
ACaa = Age class - females
ACAD = Age class by age in day intervals
ACMP = Age class by mid-point
ACYI = Age class in year intervals
AGCL = Age class
AGDA = Age in days
AMHF = Number of adult males harvested per 100 females
APGP = Average number of pellet groups per plot

BLMD = Base-line metabolism per day

CALC = Calculated
CLWK = Calculated live weight in kilograms

DIFF = Differencae
DPSM = Deer per square mile
DYLF = Days since leaf fall

ELMD = Ecological metabolism per day

*FFP = Number of female fawns
FFPA = Fraction of the female population in each age class
FFPO (2) = Fraction of adult females in 2-1/2+ year age class, year 2
FFPW = Fraction of the female population in each weight class
FFPY (1) = Fraction of adult females in 1-1/2 year age class, year 1
FFPY (2) = Fraction of adult females in 1-1/2 year age class, year 2
*FMP = Number of male fawns
FMPA = Fraction of the male population in each age class
FMPO (2) = Fraction of adult males in 2-1/2+ year class, year 2
FMPW = Fraction of the male population in each weight class
FMPY (1) = Fraction of adult males in 1-1/2 year class, year 1
FMPY (2) = Fraction of adult males in 1-1/2 year class, year 2
FYAP = Fraction of yearlings and adults in the population

IFWK = Ingesta-free weight in kilograms

JDAY = Julian day

KNPL = Known population

MBLM = Multiple of base-line metabolism
MFSR = Male to female sex ratio
MWKG = Metabolic weight in kilograms

NAFH = Number of adult females harvested
NAMH = Number of adult males harvested
NFAC = Number of females in each age class
NFWC = Number of females in each weight class
NMAC = Number of males in each age class
NMPO = Number in the population
NMWC = Number of males in each weight class
NPHP = Number in the prehunt population
NUAC = Number in the age class

*OFP = Number of females in 2-1/2+ year class
*OMP = Number of males in 2-1/2+ year class

PAFP = Prehunt adult female population
PAMF = Prehunt adult males per 100 females
PAMP = Prehunt adult male population
PECO = Pellet-count estimates
PSMF = Post-hunt adult males per 100 females

RERT = Reproductive rate
RTIO = Ratio of PECO/KNPL

SERA = Sex ratio at birth (number of males per 1 female)
SUMS = Sums

TBLD = Tabulated
TNFP = Total number of females in the population
TNMF = Total of both males and females
TNMP = Total number of males in the population

WCa- = Weight class - males
WCaa = Weight class - females
WCKI = Weight class in kilogram intervals
WCMP = Weight class by mid-point
WEMA = Weighted mean ecological metabolism of the age class
WEFP = Weighted mean ecological metabolism of the female population
WEMP = Weighted mean ecological metabolism of the male population
WIFP = Weighted mean ingesta-free weight of the female population
WIMP = Weighted mean ingesta-free weight of the male population
WLFP = Weighted mean live weight of the female population
WLMP = Weighted mean live weight of the male population
WMIA = Weighted mean ingesta-free weight of the age class
WMLA = Weighted mean live weight of the age class
WMFP = Weighted mean metabolic weight of the female population
WMMA = Weighted mean metabolic weight of the age class
WMMP = Weighted mean metabolic weight of the male population

*YFP = Number of females in 1-1/2 year class
*YMP = Number of males in 1-1/2 year class

GLOSSARY OF CODENS - CHAPTER EIGHTEEN

AJZOA Australian Journal of Zoology
AMBOC Ambio
AMFOA American Forests
AMNAA American Midland Naturalist
AMNTA American Naturalist
ATICA Arctic (Canada)
ATLPA Arctic and Alpine Research
ATRLA Acta Theriologica (Poland)

BFRNA British Columbia Forest Service Research Notes
BICOB Biological Conservation
BIOKA Biometrika
BISNA Bioscience
BPURD Biological Papers of the University of Alaska Special Report
BYMOA Byulletin Moskovskago Obshchestva Ispyrtatalei Prirody Otdel Biologicheskii (USSR)

CAFGA California Fish and Game
CAFNA Canadian Field Naturalist
CAGRA California Agriculture
CFGGA California Department of Fish and Game, Game Bulletin
CGFPA Colorado Division of Game, Fish, and Parks Special Report
CJZOA Canadian Journal of Zoology
CNSVA Conservationist
CWLSB Canadian Wildlife Service
CWOPA Canadian Wildlife Service Occassional Paper
CWPNB Canadian Wildlife Service Progress Notes
CWRSB Canadian Wildlife Service Report and Management Bulletin Series

DRCWD Colorado Division of Wildlife Division Report
DRGBA Danish Review of Game Biology

ECOLA Ecology
EKPOA Ekologia Polska Seria A
EVOLA Evolution (US)
EXJOA Explorer's Journal

FLSCA Florida Science
FPWTA Transactions of the Federal-Provincial Wildlife Conference
FUNAA Fauna (Oslo)

ICNSA Iowa Conservationist
INHNA Illinois Natural History Survey, Biological Notes

JAECA Journal of Animal Ecology
JAZAA Journal of the Arizona Academy of Science
JEVSB Journal of Environmental Systems
JFUSA Journal of Forestry

JOMAA Journal of Mammalogy
JRMGA Journal of Range Management
JWMAA Journal of Wildlife Management

LYNXA Lynx (Czechoslovakia)

MABIA Mathematical Biosciences
MAMLA Mammalia
MANJA Malayan Nature Journal
MDCRA Michigan Department of Conservation Game Division Report
MFNOA Minnesota Forestry Notes
MGQPA Minnesota Department of Natural Resources Game Research Project Quarterly Progress Report
MOCOA Missouri Conservationist
MRLTA Murrelet, The
MRYCA Maryland Conservationist
MUOXD Musk-ox

NATUA Nature (England)
NAWTA North American Wildlife and Natural Resources Conference, Transactions of the,
NCANA Naturaliste Canadien, Le
NEXAA New Mexico Agricultural Experiment Station Bulletin
NFGJA New York Fish and Game Journal
NOSCA Northwest Science
NPMEA Norsk Polarinstitutt Meddelelser
NPOAA Norsk Polarinstituut Arbok
NYCOA New York State Conservationist
NZFSA New Zealand Journal of Forest Science

OFBIA Ontario Field Biologist
OUOKA Outdoor Oklahoma

PASCC Proceedings of the Alaskan Scientific Conference
PCGFA Proceedings of the Southeastern Association of Game and Fish Commissioners
PCZOA Proceedings of the International Congress of Zoology
PMACA Papers of the Michigan Academy of Sciences, Arts and Letters
PNSIA Proceedings of the Nova Scotian Institute of Science
PSAFA Proceedings of the Society of American Foresters
PZESA Proceedings of the New Zealand Ecological Society

QRBIA Quarterly Review of Biology
QSFRA Quebec Service de la Faune Rapport

RRFBA Report Reelfoot Lake Biological Station of the Tennessee Academy of Science

SCBUB Sierra Club Bulletin
SCIEA Science
SGGMA Scottish Geographical Magazine
SLUMA Southern Lumberman
SWNAA Southwestern Naturalist
SYLVA Sylva

TISAA	Transactions of the Illinois State Academy of Science
TNWSD	Transactions of the Northeast Section, The Wildlife Society
TRVIA	Terre Vie (La Terre et la Vie)
TSASA	Transactions of the Kansas Academy of Science
TWASA	Transactions Wisconsin Academy of Sciences, Arts, and Letters
UASPA	Proceedings of the Utah Academy of Sciences, Arts and Letters
UKMPA	University of Kansas Museum of Natural History Miscellaneous Publication
VILTA	Viltrevy
VIWIA	Virginia Wildlife
VJSCA	Virginia Journal of Science
WCDBA	Wisconsin Department of Natural Resources Technical Bulletin
WLMOA	Wildlife Monographs
WMBAA	Wildlife Management Bulletin (Ottowa) Series 1 (Canada)
WSCBA	Wisconsin Conservation Bulletin
XARRA	U S Forest Service Research Note RM
XFNCA	U S Forest Service Research Paper NC
XFWLA	U S D I Fish and Wildlife Service, Wildlife Leaflet
ZEJAA	Zeitschrift fuer Jagdwissenschaft
ZOLZA	Zoologicheskii Zhurnal
ZOOLA	Zoologica (New York)

LIST OF PUBLISHERS - CHAPTER EIGHTEEN

amel	American Elsevier Publ. Co., Inc.	New York	nyny
hapr	Hafner Press	New York	nyny
jwis	John Wiley and Sons, Inc.	New York, NY	nyny
olbo	Oliver and Boyd	Edinburgh, Scotland	edsc
psup	Pennsylvania State University Press	University Park, PA	uppa
saco	Saunders Publishing Co.	Philadelphia, PA	phpa
uchp	Univ. of Chicago Press	Chicago, IL	chil
utnp	Univ. Tennesse Press	Knoxville, TN	kntn
whfr	W. H. Freeman Co.	San Francisco, CA	sfca
wiso	Wildlife Society, The	Washington, D.C.	wadc

LIST OF WORKSHEETS - CHAPTER EIGHTEEN