TOPIC 1. AGE-RELATED REPRODUCTIVE AND MORTALITY RATES

Reproductive potentials of a population, fundamental considerations in population ecology, are related to three factors. One, there are genetic limits to the rates of reproduction. Two, reproductive potentials depend on the vigor of the females and young as range conditions, pathogens, parasites, and predators exert their influence. Three, reproductive potentials drop as animals age beyond their prime.

The term "reproductive potential" is used here rather than "reproductive rate" to clarify a biological concept. The number of fertilized eggs in relation to the number of females is usually thought of as a conception rate. It is also a reproductive potential; that many young could potentially be born to that many females. The difference between the birth rate and the conception rate represents in utero mortality. The difference between the weaning rate and the birth rate represents mortality during the suckling period. Mortality removes individuals at different periods from conception to maturity. Such removals result in reproductive potentials not being reached. The concept of reproductive potentials should be understood first, and mortality data for different periods during the reproductive cycle used to identify natality and mortality rates.

The reproductive potential of a species is genetically controlled, as there are characteristic numbers of young born to females of different species. The adult females in good physical condition of some wild ruminants characteristically have two young--white-tailed deer, for example--while female elk and moose seldom have two young.

The genetic histories of individual animals in wild ruminant populations are not known, nor can they be controlled by selective breeding. Thus one cannot do much to alter the genetic potential of wild populations. Age structures are affected by hunting pressures, with heavily-hunted populations having younger age structures than lightly or unhunted ones. Animals of the same age, however, may have different reproductive rates if one group is on good range and another on poor range. Those on good range will be heavier and have higher reproductive potentials than those on poor range.

Reproductive data in the literature are almost always presented in relation to age. A general relationship between age and reproductive rate exists as immature females bear no young, first-year reproducers only one, and mature females of some species of wild ruminants bear two or even more young. While there is a general relationship between age and reproductive rate, females of the same age may have very different weights, and these differences are reflections of body condition. Since there is no human-controlled selective breeding in wild populations, reproductive rates of different populations are related to the condition of individual females, which is modified most by range conditions. Yearling white-tailed deer on western New York ranges, for example, have higher reproductive rates than yearlings in the Catskills, and those in the Catskills have higher reproductive rates than those in the central Adirondacks. These differences

are due to the effects of differences in range conditions, and not to age *per se*. Reproductive rates of the different species of wild ruminants are given in the references in the SERIALS list at the end of UNIT 1.1 and also in CHAPTER 1, UNIT 3.4.

Mortality rates are also presented for age classes, though mortality is often modified by the conditions of different ranges. The use of age as the input variable into calculations of population growth, as a reflection of natality and mortality rates, is often necessary due to a lack of data on other input variables. The effects of weights on natality and mortality are usually not given in the literature.

Age-related natality rates are discussed in UNIT 1.1, and age-related mortality rates in UNIT 1.2.

UNIT 1.1. AGE-RELATED REPRODUCTIVE RATES

Reproductive rates generally increase as females grow older, reaching a maximum when the animals are physically mature and all production can be directed to the reproductive process. Smaller ruminants, such as white-tailed deer, reach maximum body size earlier than larger ruminants, such as moose. They also reach potential maximum reproductive rates sooner. Maximum reproductive rates are maintained until old age, when a decline occurs, unless range conditions depress reproduction. Relatively few animals may reach old age in hunted populations, but there could be many in non-hunted populations, depending on the amounts of predation and on the effects of parasites and diseases.

Nearly all of the published data presents natality rates in relation to age classes, usually for hunter-killed animals examined in the fall. They can be aged by one-year intervals beginning with 1/2. The data may be tabulated in the blanks indicated below, where ACMP = age class at the midpoint and CORT = conception rate.

CLASS	ACMP	CORT
ACaa.	1/2	____
ACbb.	1-1/2	____
.	.	.
.	.	.
.	.	.
ACnn.	n-1/2	____

Age-related natality rates may be organized with the format below. Columns are added for recording the fractions of the female population represented by each age class, with the multiplications and summations necessary for determining weighted mean natality and mortality rates. These are used later in the predictions of populations using the table of b values in the exponential predictions discussed in UNIT 4.2.

CLASS	ACMP	NFAC	CORT	x	FFPA	=	WCRA
ACaa.	1/2	____	____	x	____	=	____
ACbb.	1-1/2	____	____	x	____	=	____
.							
.							
.							
ACnn.	n-1/2	____	____	x	____	=	____

SUMS = [____] = TNFP [1.00] [____] = WCRP

Definitions of the column headings are:

ACMP = age class at the midpoint,
NFAC = number of females in the age class,
CORT = conception rate,
FFPA = fraction of the female population in the age class,
WCRA = weighted mean conception rate for each age class,
SUMS = sums,
TNFP = total number of females in the populatin, and
WCRP = weighted mean conception rate of the population.

A sample calculation follows, illustrating the calculation of a single weighted mean conception rate for use in exponential population predictions.

CLASS	ACMP	NFAC	CORT	x	FFPA	=	WCRA
ACaa.	1/2	44	0.12	x	0.44	=	0.05
ACbb.	1-1/2	34	0.95	x	0.34	=	0.32
ACcc.	2-1/2+	22	1.65	x	0.22	=	0.36

SUMS = [100] = TNFP [1.00] [0.73] = WCRP

A similar format may be used to tally birth rates rather than conception rates. The difference in the formats is in the age class heading from ACMP to age class by end of year (ACEY) intervals and in the change in the conception rate (CORT) column to a birth rate (BIRT) heading, and the weighted mean birth rate (WBRA).

CLASS	ACEY	NFAC	BIRT	x	FFPA	=	WBRA
ACaa.	1			x		=	
ACbb.	2			x		=	
.							
.							
.							
ACnn.	n			x		=	

SUMS = [ ] = TNFP [1.00] [ ] = WBRP

Additional definitions are:

ACEY = age class by end of year intervals,
BIRT = birth rate,
WBRA = weighted mean birth rate for each age class, and
WBRP = weighted mean birth rate for the population.

CLASS	ACEY	NFAC	BIRT	x	FFPA	=	WBRA
ACaa.	1	44	0.10	x	0.44	=	0.04
ACbb.	2	34	0.90	x	0.34	=	0.31
ACcc.	3+	22	1.60	x	0.22	=	0.35

SUMS = [100] = TNFP [1.00] [0.70] = WBRP

One more format may be used to tally weaning rates by changing the age class to the midpoint designation with the youngest age class weaning their own young at age 1-1/2, and by changing the CORT or BIRT headings to weaning rate (WERT). The format is:

CLASS	ACMP	NFAC	WERT	x	FFPA	=	WWRA
ACaa.	1-1/2	____	____	x	____	=	____
ACbb.	2-1/2	____	____	x	____	=	____
.							
.							
.							
ACnn.	n-1/2	____	____	x	____	=	____

SUMS = [____] = TNFP [1.00] [____] = WWRP

Additional definitions are:

WERT = weaning rate,
WWRA = weighted mean weaning rate for each age class, and
WWRP = weighted mean weaning rate for the population.

CLASS	ACMP	NFAC	WERT	x	FFPA	=	WWRA
ACaa.	1-1/2	44	0.06	x	0.44	=	0.03
ACbb.	2-1/2	34	0.70	x	0.34	=	0.24
ACcc.	3-1/2+	22	1.30	x	0.22	=	0.29

SUMS = [100] = TNFP [1.00] [0.56] = WWRP

The three formats given above provide different options for recording reproductive rates, depending on the time when the rates were determined. WORKSHEETS follow for each format.

REFERENCES, UNIT 1.1

AGE-RELATED REPRODUCTIVE RATES

SERIALS

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

CAFGA 22--1 43 44 od-- replacement teeth, age det mclean,dd 1936

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

COVEA 39--3 282 291 odvi corpora lutea, ovulat, fer cheatum,el 1949

odvi continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ECOLA	41--4	706	715	odvi	popul ecol, northeast alab	adams,wh jr	1960
JOMAA	23--4	411	421	odvi	analys reprod pattern, tex	illige,d	1951
JOMAA	32--3	267	280	odvi	notes on fecundity, maine	palmer,rs	1951
JOMAA	32--4	411	421	odvi	analy repro patt, so texas	illige,d	1951
JOMAA	40--1	108	113	odvi	breeding, captivity, alaba	haugen,ao	1959
JOMAA	43--1	112	113	odvi	fecundity in a michig w-td	verme,lj	1962
JOMAA	43--3	414	414	odvi	quadruplet fetuses, ontari	trodd,ll	1962
JOMAA	45--1	151	151	odvi	unusual pregnancy	hesselton, wt; t/	1964
JOMAA	56--1	151	159	odvi	repro performance wtd iowa	haugen,ao	1975
JWMAA	10--3	242	248	odvi	region diff, breedng potnl	morton,gh; cheatu	1946
JWMAA	12--1	78	86	odvi	product, yield, george res	o'roke,ec; hamers	1948
JWMAA	14--3	290	295	odvi	breeding records, michigan	haugen,ao; davenp	1950
JWMAA	15--1	73	80	odvi	producti, mortal, coralled	severinghaus,cw	1951
JWMAA	20--3	286	292	odvi	reg diff size & prod, w va	gill,j	1956
JWMAA	26--4	409	411	odvi	x-ray, determining pregnan	verme,lj; fay,ld/	1962
JWMAA	29--1	74	79	odvi	reprod studies, penned w-t	verme,lj	1965
JWMAA	29--3	634	636	odvi	fertility, buck fawn	silver,h	1965
JWMAA	31--1	114	123	odvi	reproductive biol, maintob	ransom,ab	1967
JWMAA	32--1	130	141	odvi	range, ondition, fertility	allen,eo	1968
JWMAA	33--3	708	711	odvi	fertility in male fawns	follmann,eh; klim	1969
JWMAA	33--4	881	887	odvi	reproduct patterns, nutrit	verme,lj	1969
JWMAA	34--1	23	28	odvi	product, crab orch nat ref	roseberry,jl; kli	1970
JWMAA	36--3	868	875	odvi	reproductive physiol, male	lambiase,jt;amann	1972
JWMAA	37--2	179	182	odvi	fertiliza rates, sout texa	barron,jc; harwel	1973
JWMAA	38--4	808	814	odvi	prod, bruce penin, ontario	mansell,wd	1974
JWMAA	41--4	700	708	odvi	natal mortality, michigan	verme,lj	1977
MDCRA	2253-	1	7	odvi	radiog (x-ray), productivi	verme,lj; fay,ld/	1959
NAWTA	15---	170	190	odvi	fertility, range	cheatum,el; sever	1950
NAWTA	26---	448	459	odvi	deer, bad rivr indn reserv	cook,rs; hale,jb	1961
NAWTA	32---	405	420	odvi	experim diets, reproductio	verme,lj	1967
NFGJA	11--1	13	27	odvi	product, growth, adirondac	severinghaus,cw;/	1964
NFGJA	21--2	135	152	odvi	repro rates of wt-d in nys	hesselton,w; jack	1974
NYCOA	1---5	18	18	odvi	white-tail fertility	cheatum,el	1947
OJSCA	71--4	217	225	odvi	productivi of w-td in ohio	nixon,cm	1971
PCGFA	10---	47	51	odvi	ferti, reari succes, virgi	davey,sp	1956
PCGFA	14---	53	60	odvi	wtd produc stud in mississ	noble,re	1960
PCGFA	16---	24	28	odvi	x-ray stud, produc, tennes	lewis,jc	1962
PCGFA	20---	123	130	odvi	breeding season, louisiana	roberson,jh jr; /	1966
PCGFA	21---	62	68	odvi	reproduct studies, alabama	lueth,fx	1967
PCGFA	25---	53	60	odvi	characs reprod in arkansas	wilson,sn; seala/	1971

odvi continued on the next page

CODEN	VO-NO	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
PIAIA	69---	231	238	odvi	ovar anal, corp lutea chng	haugen,ai; traine	1962
QJFAA	35--4	165	170	odvi	repro rates wt-d, florida	harlow,rf	1972
TNWSD	30---	299	326	odvi	status of reprod rates, ny	hesselton,wt; jac	1973
WLMOA	15---	1	62	odvi	ecol, manage, l basin, tex	teer,jg; thomas,/	1965

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ANREA	122--3335		340	odhe	quadruplets in mule deer	sears,hs; browman	1955
BIREB	21--5	1099	1104	odhe	age at frst concepti, b-td	mueller,cc; sadle	1979
CAFGA	34--1	25	31	odhe	br seas, produc, calif, or	chattin,je	1948
CAFGA	39--2	177	186	odhe	reproduction, chaparral	taber,rd	1953
CAFGA	44--3	253	259	odhe	prod, californi deer herds	bischoff,ai	1958
CAFGA	50--3	132	147	odhe	deer study, redw-dougl fir	browning,bm; laup	1964
JOMAA	38-1	116	120	odhe	gestat, breedng fawnng per	golley,fb	1957
JOMAA	39--1	155	155	odhe	failur of to wean offsprng	hanson,wr	1958
JWMAA	14--4	457	469	odhe	prod, breedng, fawning per	robinette,wl; gas	1950
JWMAA	17--2	225	225	odhe	initial proof, fawns breed	crane,hs; jones,d	1953
JWMAA	19--1	115	136	odhe	fertility, utah mule deer	robinette,wl; ga/	1955
JWMAA	19--4	503	503	odhe	rocky mount, high reproduc	jensen,w; robine/	1955
JWMAA	21--1	62	65	odhe	ovarian anal, repr perform	golley,fb	1957
JWMAA	23--2	234	235	odhe	fetal recoveries, mule dee	hudson,p	1959
JWMAA	25--1	54	60	odhe	rela sum rang cond, reprod	julander,o; robin	1961
JWMAA	32--2	344	349	odhe	prod, nat bison rang, mont	nellis,ch	1968
NAWTA	9----	156	161	odhe	studies of productiv, utah	robinette,wl; ol/	1944
NAWTA	15---	589	596	odhe	productiv, mule d, colorad	tolman,cd	1950
SWNAA	15--1	29	36	odhe	ind repro surv fema, n mex	anderson,ae; sny/	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
CAFNA	64--1	40	42	ceel	productiv, survival, banff	green,hu	1950
JBLPA	8....	69	72	ceel	ferti, postnat mort, young	brna,j	1969
JOMAA	18--1	62	66	ceel	life hist, roos elk, calif	orr,rt	1937
JOMAA	44--1	111	112	ceel	evid yrlng pregn, roosevlt	batchelor,r	1963
JOMAA	47--2	332	334	ceel	fetus resorption in elk	haugen,ao	1966

ceel continued on the next page

CODEN	VO-NO	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JRPFA	54--2	325	334	ceel	factrs aff reprod red deer	guinness,fe; alb/	1978
JWMAA	9---4	295	319	ceel	roosevelt elk, washington	schwartz,je; mitc	1945
JWMAA	17--2	177	184	ceel	reproduction of yellowston	kittams,wh	1953
JWMAA	17--2	223	223	ceel	a pregnant yearlng cow elk	coffin,al; reming	1953
JWMAA	24--3	297	307	ceel	ovar char, knwn breed hist	morrison,ja	1960
JWMAA	27--3	411	414	ceel	captive elk herd, missouri	murphy,da	1963
JWMAA	32--2	368	376	ceel	exp stud, controlled repro	greer,kr; hawkin/	1968
JWMAA	38--4	789	791	ceel	wintr preg rt, cow:clf rat	folllis,tb; spill	1974
JWMAA	39--1	92	100	ceel	repro, erly clf mort, norw	wegge,p	1975
NAWTA	20---	560	567	ceel	increas natal, lowered pop	buechner,hk; swan	1955
NAWTA	21---	545	554	ceel	post conception ovulation	halazon,gc; buech	1956
PZESA	9----	31	33	ceel	herd compo, effec reproduc	miers,kh	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
EKIAA	1---2	100	101	alal	fertility, ussr	priklonskii,sg; c	1970
EKIAA	4---1	81	88	alal	dynami, productiv, estonia	ling,hi	1973
JWMAA	22--3	261	268	alal	reproduction in a populatn	edwards,ry; ritce	1958
JWMAA	23--4	381	401	alal	reprod & produc, newfoundl	pimlott,dh	1959
JWMAA	29--4	740	750	alal	reproduc, product, ontario	simkin,dw	1965
JWMAA	37--4	535	544	alal	reproductn, shiras, montan	schladweiler,p; s	1973
JWMAA	38--3	571	572	alal	late pregnancy, alaska	coady,jw	1974
NCANA	101-3	517	526	alal	reproduction, productivity	simkin,dw	1974
NCANA	101-3	527	537	alal	evolut, reproduc potential	geist,v	1974
TISAA	69--2	151	152	alal	triplets, isle-royale	moll,d; moll,bk	1976
VILTA	6---3	127	299	alal	reproduct of moose, sweden	markgren,g	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ATICA	14...	91	100	rata	popul dynam, mach deta her	krebs,cj	1961
CJZOA	50--1	43	46	rata	reproduction	mcewan,eh; whiteh	1972
JOMAA	52--2	479	479	rata	twinning in caribou	mcewan,eh	1971
JOMAA	54--3	781	781	rata	twinning in reindeer	nowasad,rf	1973
JWMAA	28--3	477	480	rata	det partur rates, newfnlnd	bergerud,at	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AJANA	125-2	217	231	anam	reproduction, female	ogara,bw	1969
CAFGA	36--3	328	329	anam	calif reproduct potentials	chattin,je; lasse	1950
JAVMA	134..	562	564	anam	vibriosis, factor, reprodu	trueblood,ms; pos	1959
JOMAA	48--3	489	490	anam	minimum breeding age, pron	mithcell,gj	1967
JWMAA	26--1	100	101	anam	minimum breeding age	wright,pl; dow,sa	1962
JWMAA	34--3	570	582	anam	forage, water, productivit	beale,dm; smith,a	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ISJRA	49--1	1	8	bibi	reproducti in plains bison	haugen,ao	1974
SWNAA	13--1	23	26	bibi	produc, wichi mt ref, okla	halloran,af	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	24--1	1	11	ovca	life hist, tarryall mt, co	spencer,c	1943
JOMAA	46--4	685	687	ovca	records, mount sheep, utah	egoscue,jh	1965
JWMAA	9---2	155	156	ovca	non-breeding in bighorn sh	pulling,ars	1945
JWMAA	30--1	207	207	ovca	twinning in bighorn sheep	spalding,dj	1966
JWMAA	38--4	771	774	ovca	lamb prod, surv, mort, col	woodward,tn; guti	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	92--3	292	293	ovda	twinning in dall sheep	hoefs,m	1978

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	52--1	238	238	obmo	1st verified case twinning	wilkinson,pf	1971
JWMAA	35--1	103	108	obmo	pop characs, nrth wst terr	freeman,mmr	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ECOLA	51...	588	601		age specifici, ecol theory	emlen,jm	1970
JFUSA	50--3	206	207	biga	yiel tabls for big ga hrds	kelker,gh	1952
NAWTA	15---	581	588	biga	vital statistics, big game	cowan,im	1950
TLPBA	2---3	339	354		intrins grow, bir, dea rat	goodman,la	1971
WLMOA	9----	1	60	many	prod, surv, abun, sex, age	hanson,wr	1963

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
VILTA	7---2	121	149	caca	mort, repro, 1948-69, swed	borg,k	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JOMAA	36--3	471	473	dada	releas, disper, repro, neb	packard,rl	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ATRLA	1....	333	376	bibo	reproduc of european bison	jaczewski,z	1958
ATRLA	12-20	333	334	bibo	resul, breed, postwar pola	landowski,j; woli	1967
ATRLA	12-29	407	444	bibo	repro biol on res and free	krasinski,z; racz	1967

CHAPTER 19, WORKSHEET 1.1a

Formats for determining weighted mean conception rates

The nine age classes listed below may be used to tally conception rates for determining the weighted mean conception rate for the population. Note that the age class is designated by the midpoint, the approximate time when conception occurs.

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WCRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WCRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WCRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WCRP

CHAPTER 19, WORKSHEET 1.1b

Formats for determining weighted mean birth rates

The nine age classes listed below may be used to tally birth rates for determining the weighted mean birth rate for the population. Note that the age class is designated by the end of year, the approximate time when birth occurs.

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACEY	NFAC	BIRT	x	FFPA	=	WBRA
ACaa.	1/2	____	____	x	____	=	____
ACbb.	1-1/2	____	____	x	____	=	____
ACcc.	2-1/2	____	____	x	____	=	____
ACdd.	3-1/2	____	____	x	____	=	____
ACee.	4-1/2	____	____	x	____	=	____
ACff.	5-1/2	____	____	x	____	=	____
ACgg.	6-1/2	____	____	x	____	=	____
AChh.	7-1/2	____	____	x	____	=	____
ACii.	8-1/2+	____	____	x	____	=	____

SUMS = [____] = TNFP [1.00] [____] = WBRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACEY	NFAC	BIRT	x	FFPA	=	WBRA
ACaa.	1/2	____	____	x	____	=	____
ACbb.	1-1/2	____	____	x	____	=	____
ACcc.	2-1/2	____	____	x	____	=	____
ACdd.	3-1/2	____	____	x	____	=	____
ACee.	4-1/2	____	____	x	____	=	____
ACff.	5-1/2	____	____	x	____	=	____
ACgg.	6-1/2	____	____	x	____	=	____
AChh.	7-1/2	____	____	x	____	=	____
ACii.	8-1/2+	____	____	x	____	=	____

SUMS = [____] = TNFP [1.00] [____] = WBRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACEY	NFAC	BIRT	x	FFPA	=	WBRA
ACaa.	1/2	____	____	x	____	=	____
ACbb.	1-1/2	____	____	x	____	=	____
ACcc.	2-1/2	____	____	x	____	=	____
ACdd.	3-1/2	____	____	x	____	=	____
ACee.	4-1/2	____	____	x	____	=	____
ACff.	5-1/2	____	____	x	____	=	____
ACgg.	6-1/2	____	____	x	____	=	____
AChh.	7-1/2	____	____	x	____	=	____
ACii.	8-1/2+	____	____	x	____	=	____

SUMS = [____] = TNFP [1.00] [____] = WBRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACEY	NFAC	BIRT	x	FFPA	=	WBRA
ACaa.	1/2	____	____	x	____	=	____
ACbb.	1-1/2	____	____	x	____	=	____
ACcc.	2-1/2	____	____	x	____	=	____
ACdd.	3-1/2	____	____	x	____	=	____
ACee.	4-1/2	____	____	x	____	=	____
ACff.	5-1/2	____	____	x	____	=	____
ACgg.	6-1/2	____	____	x	____	=	____
AChh.	7-1/2	____	____	x	____	=	____
ACii.	8-1/2+	____	____	x	____	=	____

SUMS = [____] = TNFP [1.00] [____] = WBRP

CHAPTER 19, WORKSHEET 1.1c

Formats for determining weighted mean weaning rates

The nine age classes listed below may be used to tally weaning rates for determining the weighted mean weaning rate for the population. Note that the age class is designated by the midpoint, the approximate time when weaning occurs.

SPECIES: _____ _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WWRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WWRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WWRP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

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

SUMS = [____] = TNFP [1.00] [____] = WWRP

UNIT 1.2: AGE-RELATED MORTALITY RATES

There is a general relationship between age and mortality rates, especially at the two extremes. The mortality rates of the very young and the very old are higher than the rates of the age classes betwen these two extremes. This is especially true for factors related to such natural causes as predation and the effects of storms. Very young and very old animals do not have the resources or resiliency to withstand as much stress, and the very young do not have the beneficial effects of a lifetime of learning. They are inexperienced and less able to cope with predators than older animals, for example. On the other hand, old animals have less strength and endurance to escape predators, and lessened neurological capabilities for detecting them in the first place. Thus it is often concluded that predators take the older, diseased, and less fit animals.

Mortality rates given in the published literature are almost always expressed in relation to age classes. Sample formats and definitions for tabulating mortality data are given below.

CLASS	ACYI	NMAC	NBMO	MORT
ACa-.	____	____	____	____
ACb-.	____	____	____	____
.				
.				
.				
ACn-.	____	____	____	____
	SUMS =	____	= TNMP	

Weighted means of age-related mortality may be determined with the format given below. Males and females are kept on separate formats. The male format is:

CLASS	ACYI	NMAC	NBMO	MORT	x	FMPA	=	MWMA
ACa-.	0-1	____	____	____	x	____	=	____
ACb-.	1-2	____	____	____	x	____	=	____
.								
.								
.								
ACn-.		____	____	____	x	____	=	____
	SUMS =	____	= TNMP	[____]	[1.00]		____	= MWMP

where ACYI = age class by yearly intervals,
NMAC = number of males in each age class,
NBMO = number of mortalities,
MORT = mortality rate,
TNMP = total number of males in the population,
FMPA = fraction of the male population in each age class,
MWMA = weighted mean mortality rate of each age class, and
SUMS = sums
MWMP = weighted mean mortality rate of the male population.

A sample calculation is illustrated below.

CLASS	ACYI	NMAC	NBMO	MORT	x	FMPA	=	MWMA
ACa-.	0-1	50	10	0.20	x	0.50	=	0.10
ACb-.	1-2	38	3	0.08	x	0.38	=	0.03
ACc-.	2-3+	12	1	0.08	x	0.12	=	0.01

SUMS = 100 = TNMP [1.00] 0.14 = MWMP

The format for determining the weighted mean mortality for females in each age class is the same as for males, with the appropriate changes in column headings. A sample format is shown below.

CLASS	ACYI	NFAC	NBMO	MORT	x	FFPA	=	FWMA
ACa-.	0-1	____	____	____	x	____	=	____
ACb-.	1-2	____	____	____	x	____	=	____
.								
.								
.								
ACn-.		____	____	____	x	____	=	____

SUMS = ____ = TNMP [1.00] ____ = FWMP

where ACYI = age class by yearly intervals,
NFAC = number of females in each age class,
NBMO = number of mortalities,
MORT = mortality rate,
FFPA = fraction of the female population in each age class,
FWMA = female weighted mortality rate of each age class, and
SUMS = sums
FWMP = weighted mortality rate of the female population.

A sample calculation is illustrated below. WORKSHEETS are given for both males and females.

CLASS	ACYI	NFAC	NBMO	MORT	x	FFPA	=	FWMA
ACa-.	0-1	44	12	0.27	x	0.44	=	0.12
ACb-.	1-2	34	3	0.09	x	0.34	=	0.03
ACc-.	2-3+	22	1	0.05	x	0.22	=	0.01

SUMS = 100 = TNMP [1.00] 0.16 = FWMP

Note that the age class need not be the one-year interval as indicated above. Age classes could be age in days intervals during the year. The five biological periods discussed at the beginning of this CHAPTER 19 are also likely possiblities, resulting in five mortality periods during the year, each with its own rate for each age class. Data are not often available for so many time-periods, however; the option is mentioned because it could be used to trace population changes through the year as well as from year to year.

REFERENCES, UNIT 1.2

AGE-RELATED MORTALITY RATES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
CAFNA	90--1	29	36	odvi	est pop and mort, ce ontar	king,dr	1976
JWMAA	11--4	317	323	odvi	die-offs, edwrds plat, tex	taylor,wp; hahn,h	1947
JWMAA	15--1	73	80	odvi	prod and mort coralled dee	severinghaus,cw	1951
JWMAA	33--4	1027	1028	odvi	longev recrds, femal, mich	ozoga,jj	1969
JWMAA	35--1	47	56	odvi	mort, young fawns, s texas	cook,rs; white,m/	1971
JWMAA	38--4	799	807	odvi	factors, highway mortality	publisi,mj; lind/	1974
JWMAA	40--2	317	325	odvi	deer-car accidents, michig	allen,re; mccullo	1976
JWMAA	41--1	63	69	odvi	fac af neo-na fwn surv, tx	carroll,bk; brown	1977
JWMAA	41--4	700	708	odvi	assess natal mort, up mich	verme,lj	1977
NAWTA	12---	212	223	odvi	weather, winter mort, adir	severinghaus,cw	1947
NFGJA	2--1	1	15	odvi	mort of fwns, senec ar dep	o'pezio,jp	1978
PCGFA	23---	188	191	odvi	fawn mortal, confin va hrd	mcginnes,bs; down	1970
TNWSD	9----	1	12	odvi	anal kil-curvs of fem deer	gill,j	1953
TNWSD	30---	345	361	odvi	eval fawn mort, army depot	o'pezio,jp	1973
WDABB	3---4	160	165	odvi	radiotel, fawn mortal stud	cook,rs; white,m/	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JOMAA	39--1	155	155	odhe	failur of to wean offsprng	hanson,wr	1958
JWMAA	21--1	1	16	odhe	difrtnl mor by age and sex	robinette,w; gas/	1957
JWMAA	24--1	80	88	odhe	natural mortali, se alaska	olson,st	1960
JWMAA	31--4	651	666	odhe	char of herds, range, utah	richens,vb	1967
JWMAA	43--3	657	665	odhe	fac affe surv desert fawns	smith,rh; lecount	1979
MRLTA	35--3	39	42	odhe	summer mort, juvenil, wash	brigham,jh	1954

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JAECA	47--3	817	832	ceel	factors affect calf mortal	guinness,fe; clu/	1978
JOMAA	47--2	332	334	ceel	fetus resorption in elk	haugen,ao	1966
JRPFA	54--2	325	334	ceel	factrs aff reprod red deer	guinness,fe; alb/	1978
JWMAA	39--1	92	100	ceel	repro, erly clf mort, norw	wegge,p	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JWMAA	32--4	953	956	alal	spring-fall calf mort, ala	leresche,re	1968
JWMAA	40--2	336	339	alal	marrow fat, mortal, alaska	franzmann,aw; arn	1976
NCANA	101-5	737	754	alal	num road kil, laur pk, que	grenier,pa	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
CAFNA	87--1	21	25	rata	mater behav, morta, stress	miller,fl; brough	1973
CWRSB	26---	1	25	rata	calf mort, 1970, kaminuria	miller,fl; brough	1974
JOMAA	42--4	550	551	rata	post natal mortal, b-gr ca	pruitt,wd	1961
JWIDA	9---4	311	313	rata	lightning, central alaska	shaw,ge; neiland,	1973
JWIDA	9---4	376	378	rata	mort due to meningeal worm	trainer,do	1973
NOSCA	50--2	97	101	rata	threats to surv, koote, bc	johnson,dr	1976
NPOAA	1976-	249	270	rata	survivorship, svalbard rei	de bie,s	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JWMAA	30--3	488	496	anam	die-off in trans-pecos, tx	hailey,tl; thoma/	1966
JWMAA	31--4	843	843	anam	orphaned pronghorns surviv	bromley,pt; o'gar	1967
JWMAA	37--3	343	352	anam	morta, fawns, western utah	beale,dm; smith,a	1973

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JWMAA	38--4	771	774	ovca	lamb prod, surv, mort, col	woodward,tn; gut/	1974

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	35--3	456	456	obmo	muskox longevity	buckley,jl; spen/	1954
JWMAA	35--1	103	108	obmo	pop characs, nrth wst terr	freeman,mmr	1971

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNTA	105--	137	156		age-specif selection; r, k	king,ce; anderson	1971
AMNTA	106--	14	31		concept of r-, k-selection	gadgil,j; solbrig	1972
JTBIA	12--1	12	45		moulding of senese, nat se	hamilton,wd	1966
SCIEA	206--	1101	1103	ungu	inbreedng, juvenile mortal	ralls,k; brugger/	1979

CHAPTER 19, WORKSHEET 1.2a

Determining weighted mean mortality rate of a population - males

Calculations of the weighted mean mortality rates 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	ACYI	NMAC	NBMO	MORT	x	FMPA	=	MWMA
ACa-.	0-1	____	____	____	x	____	=	____
ACb-.	1-2	____	____	____	x	____	=	____
ACc-.	2-3	____	____	____	x	____	=	____
ACd-.	3-4	____	____	____	x	____	=	____
ACe-.	4-5	____	____	____	x	____	=	____
ACf-.	5-6	____	____	____	x	____	=	____
ACg-.	6-7	____	____	____	x	____	=	____
ACh-.	7-8	____	____	____	x	____	=	____
ACi-.	8-9+	____	____	____	x	____	=	____
	SUMS =	____	= TNMP			[1.00]		____ = MWMP

SPECIES:_____ TIME PERIOD:_____

LOCATION:_____ REFERENCE:_____

CLASS	ACYI	NMAC	NBMO	MORT	x	FMPA	=	MWMA
ACa-.	0-1	____	____	____	x	____	=	____
ACb-.	1-2	____	____	____	x	____	=	____
ACc-.	2-3	____	____	____	x	____	=	____
ACd-.	3-4	____	____	____	x	____	=	____
ACe-.	4-5	____	____	____	x	____	=	____
ACf-.	5-6	____	____	____	x	____	=	____
ACg-.	6-7	____	____	____	x	____	=	____
ACh-.	7-8	____	____	____	x	____	=	____
ACi-.	8-9+	____	____	____	x	____	=	____
	SUMS =	____	= TNMP			[1.00]		____ = MWMP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACYI	NMAC	NBMO	MORT	x	FMPA	=	MWMA
ACa-.	0-1				x		=	
ACb-.	1-2				x		=	
ACc-.	2-3				x		=	
ACd-.	3-4				x		=	
ACe-.	4-5				x		=	
ACf-.	5-6				x		=	
ACg-.	6-7				x		=	
ACh-.	7-8				x		=	
ACi-.	8-9+				x		=	
	SUMS =		= TNMP			[1.00]		= MWMP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACYI	NMAC	NBMO	MORT	x	FMPA	=	MWMA
ACa-.	0-1				x		=	
ACb-.	1-2				x		=	
ACc-.	2-3				x		=	
ACd-.	3-4				x		=	
ACe-.	4-5				x		=	
ACf-.	5-6				x		=	
ACg-.	6-7				x		=	
ACh-.	7-8				x		=	
ACi-.	8-9+				x		=	
	SUMS =		= TNMP			[1.00]		= MWMP

CHAPTER 19, WORKSHEET 1.2b

Determining weighted mean mortality rate of a population - females

Calculations of the weighted mean mortality rates 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	ACYI	NFAC	NBMO	MORT	x	FFPA	=	FWMA
ACaa.	0-1	____	____	____	x	____	=	____
ACbb.	1-2	____	____	____	x	____	=	____
ACcc.	2-3	____	____	____	x	____	=	____
ACdd.	3-4	____	____	____	x	____	=	____
ACee.	4-5	____	____	____	x	____	=	____
ACff.	5-6	____	____	____	x	____	=	____
ACgg.	6-7	____	____	____	x	____	=	____
AChh.	7-8	____	____	____	x	____	=	____
ACii.	8-9+	____	____	____	x	____	=	____
	SUMS =	____	= TNMP			[1.00]		____ = FWMP

SPECIES:_____ TIME PERIOD:_____

LOCATION:_____ REFERENCE:_____

CLASS	ACYI	NFAC	NBMO	MORT	x	FFPA	=	FWMA
ACaa.	0-1	____	____	____	x	____	=	____
ACbb.	1-2	____	____	____	x	____	=	____
ACcc.	2-3	____	____	____	x	____	=	____
ACdd.	3-4	____	____	____	x	____	=	____
ACee.	4-5	____	____	____	x	____	=	____
ACff.	5-6	____	____	____	x	____	=	____
ACgg.	6-7	____	____	____	x	____	=	____
AChh.	7-8	____	____	____	x	____	=	____
ACii.	8-9+	____	____	____	x	____	=	____
	SUMS =	____	= TNMP			[1.00]		____ = FWMP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACYI	NFAC	NBMO	MORT	x	FFPA	=	FWMA
ACaa.	0-1				x		=	
ACbb.	1-2				x		=	
ACcc.	2-3				x		=	
ACdd.	3-4				x		=	
ACee.	4-5				x		=	
ACff.	5-6				x		=	
ACgg.	6-7				x		=	
AChh.	7-8				x		=	
ACii.	8-9+				x		=	
	SUMS =		= TNMP			[1.00]		= FWMP

SPECIES: _____ TIME PERIOD: _____

LOCATION: _____ REFERENCE: _____

CLASS	ACYI	NFAC	NBMO	MORT	x	FFPA	=	FWMA
ACaa.	0-1				x		=	
ACbb.	1-2				x		=	
ACcc.	2-3				x		=	
ACdd.	3-4				x		=	
ACee.	4-5				x		=	
ACff.	5-6				x		=	
ACgg.	6-7				x		=	
AChh.	7-8				x		=	
ACii.	8-9+				x		=	
	SUMS =		= TNMP			[1.00]		= FWMP