PART II. BEHAVIOR OF WILD RUMINANTS

The behavior of wild ruminants is a fundamental consideration when evaluating ecological relationships and making management decisions. Some of behavior is based on a genetic memory, and some of it is learned. Examples of the former include maternal behavior, rutting behavior, and changes in activity levels with seasons. Examples of the latter include responses to snowmobiles, fences, pipelines, and artificial feeding.

Communications between animal and environment include the recognition of cues or stimuli that may or may not result in responses. When all of these are integrated by the animal, movement and activity patterns result. These are subject to absolute limitations imposed by the animal's physical and metabolic capabilities. These limits, plus other limitations imposed by behavioral traits, result in variable daily and seasonal ranges, depending on species, sex, time of year, and habitat characteristics. These considerations are discussed in CHAPTER 3.

Different species, ages, and sexes of wild ruminants exhibit different behavioral traits and patterns that are fairly consistant and predictable. Foraging behavior, reproductive behavior, play, and other behavior patterns are characteristic of different groups within a population. These patterns change with time, however, and both daily and seasonal rhythms may often be recognized. Transient changes in behavior also occur, of course, due to changes in the weather and local stimuli. Behavior patterns are described and, when possible, represented mathematically in CHAPTER 4.

Interactions within and between species result in a high degree of organization in animal societies. Such organization is not easily detected by occasional observations. Rather, prolonged study of a population and its functional groups is necessary to evaluate differences due not only to sex and age effects, but also to different population levels and different amounts of resources, especially food. Members of the same species and even members of different species, such as predator and prey, have abilities to communicate cues or stimuli that illicit different responses under different circumstances. Interactions within and between species are discussed in CHAPTER 5.

All behavioral acts must occur within the physical, physiological, and genetic limits characteristic of the individual's organism-environment relationships. Descriptions of behavioral acts and patterns are included in this PART II, but ecological analyses of their effects on populations and on management deisions come later, after discussions of PHYSIOLOGY AND METABOLISM (PART III), FORAGE CHARACTERISTICS AND RANGE RELATIONSHIPS (PART IV), and METEOROLOGY AND THERMAL RELATIONSHIPS (PART V). For now, it is important to remember that the physical, behavioral and physiological characteristics of wild ruminants are fundamental considerations in ecological analyses and in management decisions, and an understanding of these three major biological categories of animal characteristics is part of the foundation for further ecological analyses.

GLOSSARY OF ANIMAL CODE NAMES

Wild ruminants are referred to in this PART by a 4-character abbreviation from the family, genus and genus-species. These are listed below under Abbreviation.

Scientific names of North American wild ruminants are those used in BIG GAME OF NORTH AMERICA, edited by J.C. Schmidt and D. L. Gilbert (1979: Stackpole Books, Harrisburg, PA 17105, 494 p.), and may be different from the scientific names given in the original literature.

The abbreviations used for North American wild ruminants are listed below.

CLASS: MAMMALIA

ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: Odocoileus (deer)	od--
SPECIES: O. virginianus (white-tailed deer)	odvi
O. hemionus (mule deer)	odhe
GENUS: Cervus (Wapiti, elk)	ce--
SPECIES: C. elaphus	ceel
GENUS: Alces (moose)	
SPECIES: A. alces	alal
GENUS: Rangifer (caribou)	
SPECIES: R. tarandus	rata
FAMILY: ANTILOCAPRIDAE	
GENUS: Antilocapra	
SPECIES: A. americana (pronghorn)	anam
FAMILY: BOVIDAE	bovi
GENUS: Bison (bison)	bi--
SPECIES: B. bison	bibi
GENUS: Ovis (sheep)	ov--
SPECIES: O. canadensis (bighorn sheep)	ovca
O. dalli (Dall's sheep)	ovda
GENUS: Ovibos	
SPECIES: O. moschatus (muskox)	obmo
GENUS: Oreamnos	
SPECIES: O. americanus (mountain goat)	oram

The abbreviations used for European wild ruminants are listed below.

CLASS: MAMMALIA

ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: *Capreolus* (roe deer)	ca--
SPECIES: *C. capreolus*	caca
GENUS: *Dama* (fallow deer)	da--
SPECIES: *D. dama*	dada
GENUS: *Cervus* (Wapiti, elk)	ce--
SPECIES: *C. elaphus* (red deer)	ceel
GENUS: *Alces* (moose)	
SPECIES: *A. alces*	alal
GENUS: *Rangifer* (caribou)	
SPECIES: *R. tarandus*	rata
FAMILY: BOVIDAE	
GENUS: *Bison* (bison)	
SPECIES: *B. bonasus*	bibo
GENUS: *Capra* (ibex, wild goat)	cp--
SPECIES: *C. aegagrus* (Persian ibex)	cpae
C. siberica (Siberian ibex)	cpsi

OTHERS

Abbreviations for a few other species and groups of species may appear in the reference lists. These are listed below.

Axis axis (axis deer)	axax
Elaphurus davidianus (Pere David's deer)	elda
Cervus nippon (Sika deer)	ceni
Hydropotes inermis (Chinese water deer)	hyin
Muntiacus muntjac (Indian muntjac)	mumu
Moschus moschiferus (musk deer)	momo
Ovis nivicola (snow sheep)	ovni
Ovis musimon (moufflon)	ovmu
Ovis linnaeus (Iranian sheep)	ovli
Rupicapra rupicapra (chamois)	ruru
big game	biga
domestic sheep	dosh
domestic cattle	doca
domestic goat	dogo
domestic ruminant	doru
herbivore	hrbv
mammals	mamm
three or more species of wild ruminants	many
ruminants	rumi
ungulates	ungu
vertebrates	vert
wildlife	wldl
wild ruminant	wiru

ORGANIZATION OF REFERENCE LISTS

Extensive reference lists, based on computer-assisted searches back to 1970 and manual searches of literature published prior to 1970, are included in each of the PARTS. The lists are organized in a functional way for use in the library rather than in the conventional alpabetized-by-author way, with the information necessary for locating the references in libraries given in abbreviated, one-line form. The reference books listed after each PART, CHAPTER, and TOPIC contain background information for the material covered, and may contain specific information for several of the UNITS and WORKSHEETS.

The headings for the lists of BOOKS are:

TYPE PUBL CITY PGES ANIM KEY WORDS---------- AUTHORS/EDITORS-- YEAR

The TYPE of book could have either an author (aubo) or an editor (edbo). Publishers (PUBL) and CITY of publication are given with four-letter mnemonic symbols defined in the GLOSSARY. The PAGE column gives the number of pages in the book; ANIM refers to the species discussed in the book (given as a four-letter abbreviation of genus and species), and KEY WORDS lists key words from the title. The AUTHORS/EDITORS' names and YEAR of publication are given in the last two columns. Thus all of the essential information for finding each book in the library is given on just one line.

Serial publications that pertain to each division are listed with a slightly different format. (Serials are identified by a five-character, generally mnemonic code called CODEN, published in 1977 BIOSIS, LIST OF SERIALS (BioSciences Information Service, 2100 Arch Street, Philadelphia, PA 19103).

The headings for the lists of SERIALS are:

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

The volume and issue numbers (VO-NU) are given after the CODEN entry, followed by beginning page (BEPA), ending page (ENPA), species discussed (ANIM), key words from the title (KEY WORDS), AUTHORS, and YEAR.

Specific authors and dates of publication can be located quickly by scanning the two right-hand columns. If the author's name fits in the 17 characters, some character spaces are left blank. If there are two authors and all of the first author's name and part of the second author's name fits in the 17 character spaces, the second author's name is truncated at the right margin of the author column. If there are more authors that do not appear in the author column due to lack of space, a slash (/) is added inthe 17th space of the column.

References cited in the text material and in the WORKSHEETS are given under LITERATURE CITED in the traditional format (author, date, title of article, journal, volume, issue number, and page numbers).

A third category, OTHER PUBLICATIONS, may be included at the beginning of PARTS or in the CHAPTERS. This category contains references to publications that are not authored or edited books or serials listed by BioSciences Information Service. Examples are "Transactions of the Northeastern Deer Study Group Meetings" and "Biannual Pronghorn Antelope Workshop, Proceedings." Both of these contain many articles on deer and pronghorns, respectively, but are not included in the one-line abbreviated form. Such publications are listed by titles, which should make it possible to locate the publications in libraries.

HOW TO USE THIS SYSTEM

The one-line format used to list references makes it possible to list several thousand references in a minimum amount of space. The logic of the one-line entries in the reference lists is based on the order of decision-making when finding literature. First, the references are grouped according to biological functions and relationships discussed in this book. Second, species of interest are selected. Third, journals containing references to be read are located in the library. Fourth, the publications are located in the journals. The use of this reference list format in the library will confirm the logic of this arrangement. Call numbers and stack levels should be added in the margins so references may be quickly located in a particular library.

CODEN entries are identified by the full title of the serial publication and its country, territory, or commonwealth of origin in the APPENDIX. CODEN entries in the serial lists are alphabetized. This results in some of the full titles being out of alphabetical order. Since the user of this book will usually work from CODEN to consult the list of full titles in the APPENDIX, this disorder will result in nothing more than occasional inconvenience. Most of the full titles will be near alphabetized, so the CODEN for a specific serial can be quickly found by scanning the appropriate part of the list.

Serials, including journals and report literature, constitute the major portion of the literature on wild ruminants. Scientists are urged to publish their findings in recognized journals so the results of their work are readily available.

REFERENCES, PART II

BEHAVIOR OF WILD RUMINANTS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	dodo	nyny	1220	----	lives of game animals	seton,et	1929
aubo	dipr	nyny	276	----	problems of relative growt	huxley,js	1932
aubo	meth	loen	150	----	social behavior in animals	tinbergen,n	1953
aubo	ccth	spil	250	----	animal visn: what anim see	smyth,rh	1961
aubo	prha	ecnj	171	----	behavio aspects of ecology	klopfer,ph	1962
aubo	anth	nyny	305	----	the sense of animals & men	milne,l; milne,mj	1962
aubo	olbo	edsc	653	----	animal dispersion, soc beh	wynne-edwards,vc	1962
edbo	elpu	nyny	933	----	acoustic behavior of anima	busnel,rg	1963
aubo	phli	nyny	240	----	the senses of animals	matthews,lh; knig	1963
edbo	jwis	nyny	349	----	maternal care in mammals	rheingold,lh,ed	1963
aubo	jwis	nyny	771	----	mechanisms of animal behav	marler,p; hamilto	1966
edbo	acpr	nyny	159	----	natural hist of aggression	carthy,jd; ebling	1964
edbo	uchp	chil	307	----	soc behav, organiza, verte	etkin,w	1964
aubo	blai	nyny	204	----	animal communication	frings,h; frings,	1964
aubo	cnha	loen	132	----	vision in vertebrates	tansley,k	1965
aubo	meth	loen	150	----	soci behav, animals, verte	tinbergen,n	1965
aubo	macm	nyny	113	----	sensory mechanisms	case,j	1966
aubo	macm	nyny	118	----	integral animal behavior	davis,d	1966
aubo	jwis	nyny	432	----	pattern, animal communitie	elton,cs	1966
aubo	mhbc	nyny	534	----	anim behav: ethol, com psy	hinde,ra	1966
aubo	wile	nyny	771	----	mechanisms of anim behavio	marler,p; hamilto	1966
aubo	isup	amia	277	----	of predation and life	errington,pl	1967
aubo	prha	ecnj	297	----	introdu to animal behavior	klopfer,ph; hailm	1967
aubo	hill	loen	760	----	the chemical senses	moncrieff,rw	1967
aubo	thcr	nyny	182	----	communi in the animl world	evans,wf	1968
aubo	plpr	nyny	418	----	ethology of mammals	ewer,rf	1968
edbo	saco	phpa	563	----	abnormal behavior in anima	fox,mw	1968
aubo	dove	nyny	166	----	pschol, behav, zoos,circus	hediger,h	1968
aubo	epdu	nyny	298	----	the magic of the senses	droscher,vb	1969
edbo	botc	loen	647	----	the behav of domestic anim	hafez,ese	1969
aubo	tapl	nyny	183	----	animal senses	burton,r	1970
edbo	apcc	nyny	412	----	comm, chem sig: advan chem	johnston,jw,jr; /	1970
aubo	wbsc	phpa	601	----	the vertebrate body	romer,as	1970
edbo	acpr	nyny	336	----	chemical ecology	simeone,jb; sondh	1970
aubo	wbsc	phpa	574	----	fundamentals of ecology	odum,ep	1971
aubo	uchp	chil	349	----	animal behavior	scott,jp	1972
aubo	whfr	sfca	458	----	wildlife ecology	moen,an	1973
edbo	dohr	stpa	416	----	territory	stokes,aw	1974
edbo	dohr	stpa	401	----	social hierarch, dominance	schein,mw	1975
aubo	bhup	cama	607	----	sociobiol, the new synthes	wilson,eo	1975
edbo	acpr	nyny	344	----	mamm olfact, reprod, behav	doty,rl	1976
edbo	wiwi	bama	532	----	behavior of domestic anima	hafez,ese	1976

continued on the next page

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS EDITORS--	YEAR
aubo	dohr	stpa	361	----	biblio of quantita ecology	schultz,vll; ebe/	1976
edbo	dohr	stpa	411	----	vertebrt social organizatn	banks,em	1977
edbo	plpc	nyny	609	----	chemical signals, vertebra	muller-schwarze,/	1977
edbo	jwis	nyny	364	----	quantitative ethology	colgon,pw	1978
aubo	mhbc	nyny	452	----	comparative anim behavior	devisbury,da	1978
edbo	plpr	nyny	183	----	aggress, domnce,indv spcng	krames,l; /	1978
edbp	dohr	stpa	369	----	evolution of play behavior	muller-schwarze,d	1978
edbo	wiso	wadc	206	----	animal behavior	teague,rd,ed; moe	1979
edbo	acpr	nyny	540	----	biochemistry taste, olfctn	cagan,rh; kare,mr	1980
aubo	oxup	loen	688	----	animal play behavior	fagen,rm	1981
aubo	fost	nyny	426	cerv	antlope, deer of n america	caton,jd	1877
aubo	rokp	loen	597	cerv	deer,great britain, irelnd	whitehead,gk	1964
aubo	huho	nyny	426	od--	deer, antelope of america	caton,jd	1877
edbo	stac	hapa	668	od--	deer of north america	taylor,wp	1956
aubo	stac	hapa	128	od--	if deer are to survive	dasmann,w	1971
aubo	vipr	nyny	194	od--	deer of the world	whitehead,gk	1972
aubo	omcc	eail	107	odvi	the white-tailed deer	madson,j	1961
edbo	nhfg	conh	256	odvi	the white-tai deer, new ha	siegler,hr	1968
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
edbo	unbp	line	605	odhe	mule, black-tailed, n amer	wallmo,oc	1981
aubo	oxup	loen	215	ceel	herd, red deer,stud, behav	darling,ff	1937
aubo	stac	hapa	386	ceel	elk of north america	murie,oj	1959
aubo	wiwe	eail	125	ceel	the elk	madson,j	1966
aubo	ucap	beca	209	ceel	tule elk	mccullough,dr	1971
aubo	cite	oxen	74	ceel	ecology of red deer	mitchell,b; stai/	1977
edbo	wimi	wadc	....	ceel	ecology, mngmnt,n amer elk	thomas,jw; towei	in pr
aubo	uwyp	lawy	294	ceel	n amer elk: ecol,behav,mgt	boyce,ms; hayden-	1979
aubo	utop	toon	280	alal	north american moose	peterson,rl	1955
aubo	macm	nyny	300	rata	bar-gr car of north canada	pike,w	1892
aubo	ukap	laka	163	rata	bar-ground carib, keewatin	harper,f	1955
aubo	qupr	oton	339	rata	migratory, barren-ground c	kelsall,jp	1968
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,a	1948
aubo	stac	hapa	225	anam	hunting pronghorn antelope	popowski,b	1959
aubo	rowa	loen	....	bovi	wild oxen, sheep, goats of	lydekker,r	1898
aubo	utop	toon	991	bibi	n amer buffalo, wild state	roe,fg	1970
aubo	thcr	nyny	242	bibi	the buffalo	haines,f	1970
aubo	aakn	nyny	339	bibi	the time of the buffalo	mchugh,t	1972
aubo	swap	atoh	374	bibi	the buffalo book, saga ani	dary,d	1974
aubo	ucap	beca	316	bibi	n amer bison, evol, classi	mcdonald,jn	1981

continued on the next page

TYPE	PUBL	CITY	PGES	KEY WORDS----------	AUTHORS EDITORS--	YEAR
aubo	uopr	nook	247	ov-- great ark of the wld sheep	clark,jl	1964
aubo	uchp	chil	383	ov-- mt sheep, behavior, evolut	geist,v	1971
aubo	coup	itny	248	ov-- mt sheep, man, norther wil	geist,v	1975
aubo	uchp	chil	383	ovca mount sheep: behavi, evolu	geist,v	1971
aubo	usgp	wadc	242	ovca the bighorn of death valley	welles,re; welle	1961
aubo	qupr	oton	166	obmo muskoxen in canada	tener,js	1965
aubo	haho	nyny	85	obmo oomingmak, expedi, nunivak	matthiessen,p	1967
aubo	doup	nyny	318	many americ anim; popular guide	stone,w; cram,we	1902
aubo	cscs	nyny	347	many our big game	huntington,d	1904
aubo	cscs	nyny	1267	many life hist northern animals	seton,et	1909
aubo	ropr	nyny	129	many wildlife in alaska, ecolog	leopold,as; darli	1953
edbo	holt	nyny	264	many records of n a big game an	boone & crockett	1958
aubo	ropr	nyny	547	many mammals of north america	hall,er; kelson,k	1959
aubo	ucap	beca	586	many wildlife of mexico	leopold,as	1959
aubo	vipr	nyny	304	many wildlife in america	matthiessen,p	1959
aubo	repu	nyny	335	many principals of mammalogy	davis,de; golley,	1963
aubo	blsp	loen	308	many guide, study of productivi	golley,fb; buechn	1968
aubo	jhpr	bamd	769	many mammals of the world	walker,ep; paradi	1968
aubo	whfr	sfca	458	many wildlife ecology	moen,an	1973
aubo	utop	toon	438	many the mammals of canada	banfield, awf	1974
edbo	iucn	mosw	940	many behav & its rela to mngmnt	geist,v; walther,	1974
edbo	stac	hapa	494	many big game, n amer, ecol,mgt	schmidt,jl; gilbe	1978
aubo	dalt	laen	271	dada fal de: histor, distr, bio	chapman,d; chapma	1975
aubo	repu	nyny	1023	dome bioenergetics and growth	brody,s	1945
edbo	coup	itny	1463	dome duke's physiol domest anim	swenson,mj	1970
aubo	acpr	nyny	202	ungu reproductive behav, ungula	fraser,af	1968

OTHER PUBLICATIONS

Proceedings of the White-tailed Deer in the Southern Forest Habitat Symposium (First meeting in 1962)

Transactions of the Annual Meeting of the Northeast Deer Study Group (Annual meeting beginning 1964)

Proceedings of the North American Moose Conference (Fifth conference in 1968)

Proceedings of the International Reindeer/Caribou Symposium (First meeting in 1977, second in 1980)

Proceedings of the Biennial Antelope States Workshop

Mace, R. U. 1954. Oregon's Pronghorn Antelope. Oregon State Game Comm., Corvallis, OR. 25 p.

Skinner, M. P. 1924. The American Antelope in Yellowstone National Park. Roosevelt Wildl. Forest Exp. Sta., Syracuse, N.Y. 32 p.

Transactions of the Interstate Antelope Conference

Transactions of the North American Wild Sheep Conference (Second meeting in 1976)

Transactions of the Desert Bighorn Council (Annual meeting beginning 1957)

Proceedings of the International Mountain Goat Symposium

Proceedings of the Annual Conference of Western Association of State Game & Fish Commissioners (Annual conference beginning 1921)

LIST OF PUBLISHERS - PART II

The headings for the lists of BOOKS are:

TYPE PUBL CITY PAGE ANIM KEY WORDS---------- AUTHORS/EDITORS-- YEAR

All essential information for finding each book in the library is given on just one line. The TYPE of book could have either AUTHORS (aubo) or EDITORS (edbo). Publishers (PUBL) and CITY of publication are given with four-letter mnemonic symbols defined below. The PAGE column gives the number of pages in the book; ANIM refers to the species discussed in the book (given as a four-letter abbreviation of genus and species), and KEY WORDS listed are from the title. The AUTHORS/EDITORS and YEAR of publication are given in the last two columns.

aakn	Alfred A. Knopf	New York, NY	nyny
acpr	Academic Press	New York, NY	nyny
anth	Antheneum	New York, NY	nyny
apcc	Appleton-Century-Crofts	New York, NY	nyny
bhup	Belknap Press of Harvard University	Cambridge, MA	cama
blai	Blaisdell	New York, NY	nyny
blsp	Blackwell Scientific Publications	London, England	loen
botc	Bouilliere, Tindall & Cassell	London, England	loen
ccth	Charles C. Thomas	Springfield, IL	spil
cite	Cambridge Institute of Terrestrial Ecology	Cambridge, England	caen
cnha	Chapman & Hall	London, England	loen
coup	Cornell University Press	Ithaca, NY	itny
cscs	Charles Scribner's Sons	New York, NY	nyny
dalt	Dalton	Lavenheim, England	laen
dipr	Dial Press, The	New York, NY	nyny
dodo	Doubleday Doran	New York, NY	nyny
dohr	Dowden, Hutchinson, & Ross	Stroudsburg, PA	stpa
doup	Doubleday, Pace, & Co.	New York, NY	nyny
dove	Dover Pub. Co.	New York, NY	nyny
elpu	Elsevier Press	New York, NY	nyny
epdu	E. P. Dutton	New York, NY	nyny
fost	Forest and Stream Publishing Co.	New York, NY	nyny
haho	Hastings House Publishers	New York, NY	nyny
hill	Hill	London, England	loen
holt	Holt	New York, NY	nyny
huho	Hurd Houghton	New York, NY	nyny

isup	Iowa State University Press	Ames, IA	amia
iucn	International Union for the Conservation of Nature and Natural Resources	Morges, Switzerland	mosw
jhpr	John Hopkins Press	Baltimore, MD	bamd
jwis	John Wiley and Sons, Inc.	New York, NY	nyny
macm	MacMillan Co.	New York, NY	nyny
meth	Methuen & Co., Ltd.	London, England	loen
mhbc	McGraw-Hill Book Company, Inc.	New York, NY	nyny
nhfg	New Hampshire Fish & Game Dept.	Concord, NH	conh
olbo	Oliver & Boyd	London, England	loen
omcc	Olin Mathieson Chem. Corp.	East Alton, IL	eail
oxup	Oxford University Press	London, England	loen
phli	Philosophical Library	New York, NY	nyny
plpc	Plenum Publishing Corporation	New York, NY	nyny
plpr	Plenum Press	New York, NY	nyny
prha	Prentice-Hall, Inc.		
qupr	Queen's Printer	Ottowa, Ontario	oton
repu	Reinhold Publishing	New York, NY	nyny
rokp	Routledge & K. Paul	London, England	loen
ropr	Ronald Press	New York, NY	nyny
rowa	Rowland Ward	London, England	loen
saco	Saunders Publishing Co.	Philadelphia, PA	phpa
stac	Stackpole Company, The	Harrisburg, PA	hapa
swap	Swallow Press	Athens, OH	atoh
tapl	Taplinger	New York, NY	nyny
thcr	Thomas Crowell Company	New York, NY	nyny
ucap	University of California Press	Berkeley, CA	beca
uchp	University of Chicago Press	Chicago, IL	chil
ukap	University of Kansas Press	Lawrence, KA	laka
unbp	University of Nebraska	Lincoln, NE	line
uopr	University of Oklahoma Press	Norman, OK	nook
usgp	United States Goverment Printing Office	Washington, DC	wadc
utop	University of Toronto Press	Toronto, Ontario	toon
uwyp	University of Wyoming Press	Laramie, WY	lawy
vipr	Viking Press	New York, NY	nyny

wbsc	W. B. Saunders Company	Philadelphia, PA	phpa
whfr	W. H. Freeman Company	San Francisco, CA	sfca
wile	Wiley	New York, NY	nyny
wimi	Wildlife Management Institute	Washington, DC	wadc
wiso	Wildlife Society, The	Washington, DC	wadc
wiwe	Winchester-Western Press	East Alton, IL	eail
wiwi	Williams and Wilkins	Baltimore, MD	bama

THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS

CHAPTER THREE

SENSES, COMMUNICATIONS, AND THE USE OF SPACE

by

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CHAPTER 3. SENSES, COMMUNICATIONS, AND THE USE OF SPACE

The abilities of animals to receive and interpret stimuli from their environment are prime determinants of the potentials for the animal's responses. It is obvious that animals which cannot see are unable to respond to visual stimuli, and the same can be said for other senses. Animals do not detect and respond in an "all or none" way however; sight and other sensory capabilities vary between individuals and change due to environmental factors.

A functional approach to the concept environment, discussed in Moen (1973), considers the environment as a complex of dynamic interactions, different from the habitat of an animal, which is a descriptive term for the place where a species is found. Thus deer habitat is the kind of a place where deer live. A deer's environment, however, includes the whole array of functional stimuli that may illicit a response by the animal.

Functional organism-environment relationships may be divided into four groups discussed in Moen (1973; 18). They are:

1. Stimulus does not reach organism. There is no functional relationship.

2. Stimulus reaches organism but is not detected. There is no functional relationship.

3. Stimulus reaches organism and is detected, but causes no response aside from detection. This relationship is of little importance to either the organism or the ecologist.

4. Stimulus reaches organism, is detected neurologically or physiologically, and organism responds to stimulus. This is the most important kind of relationship for the ecologist to consider.

There are important time dimensions to the organism-environment relationships, including those that are operational at a given moment, those that have been operational, called the historical environment, and those that could become operational, called the potential environment (Mason and Langenheim 1957 and Moen 1973; 21).

Operational environments are constantly changing, yet remain fairly stable unless some particularly important stimulus is detected. A bedded moose may hear the intermittent calls of blue jays, but pays little or no attention to them. Such stimuli are detected but do not cause a response; they are not really operational because they are filtered out. A pack of wolves, however, will alert the moose and possibly cause flight behavior. The operational effects are different due to the historical environment of the moose, which includes potential responses that could be both genetically determined and learned.

Historical environments, which consist of both genetically-determined and learned responses, determine what and how animals respond to operational stimuli. A newborn must rely on its genetically-determined historical environment, and the young of some wild ruminants do just that as they lie prostrate and remain motionless when approached. This hiding behavior is also accompanied by alarm bradycardia (Moen et al. 1978), which occurs even when members of their own species approach them. As experience is gained, learning occurs, individual deer are recognized, and the responses of the fawns to other deer are different. The fawn recognizes its mother, and may move toward her as she approaches. A fox, however, would be avoided rather than approached, especially after learning encounters had occurred.

Potential environments include all that animals can respond to when future environmental stimuli are received. The basic neurological senses of animals, plus their physiological sensitivity to environmental factors not detected neurologically, determine what components of their habitat become part of their functional environment.

It is important to recognize that environments are only partially defined by animals' senses. Those environmental influences that are not detected neurologically but do have physiological impacts can be very important parts of an animal's environment. Radioactivity, for example, is not detected by the senses, but it may cause genetic changes that become a part of the historical genetic environment, with significant potential effects on offspring.

Since functional environments are so dependent on the neurological and physiologial capabilities of animals to respond, it is unfortunate that so little is known about these capabilities in wild ruminants. The behavior of most wild ruminants has been described quite well, but there have been few experiments to test sensory perception and responses under different conditions.

CHAPTER THREE includes discussions and reference lists for the basic sensory capabilities of wild ruminants (TOPIC I), communications (TOPIC 2), and descriptions of their use of space (TOPIC 3).

LITERATURE CITED

Mason, H. L., and J. H. Langenheim. 1957. Language analysis and the concept environment. Ecology. 38(2):325-340.

Moen, A. N. 1973. Wildlife Ecology: An analytical approach. W. H. Freeman and Co., San Francisco. 458 p.

Moen, A. N., M. A. DellaFera, A. L. Hiller, and B. A. Buxton. 1978. Heart rates of white-tailed deer fawns in response to recorded wolf howls. Can. J. Zool. 56(5):1207-1210.

REFERENCES, CHAPTER 3

COMMUNICATIONS AND THE USE OF SPACE

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	dodo	nyny	1220	----	v 3, lives of game animals	seton,et	1929
aubo	ccth	spil	250	----	animal visi: what anim see	smythe,rh	1961
aubo	prha	ecnj	171	----	behavio aspects of ecology	klopfer,ph	1962
aubo	anth	nyny	305	----	the sense of animas & men	milne,l; milne,mj	1962
aubo	olbo	edsc	653	----	animal dispersion, soc beh	wynne-edwards,vc	1962
edbo	elpu	nyny	933	----	acoustic behavior of anima	busnel,rg,	1963
aubo	phli	nyny	240	----	the senses of animals	matthews,lh; knig	1963
edbo	acpr	nyny	159	----	natural hist of aggression	carthy,jd; ebling	1964
edbo	uchp	chil	307	----	soc behav, organiza, verte	etkin,w	1964
aubo	blai	nyny	204	----	animal communication	frings,h; frings,	1964
aubo	cnha	loen	132	----	vision in vertebrates	tansley,k	1965
aubo	meth	loen	150	----	soci behav, animals, verte	tinbergen,n	1965
aubo	macm	nyny	113	----	sensory mechanisms	case,j	1966
aubo	macm	nyny	118	----	integral animal behavior	davis,d	1966
aubo	jwis	nyny	432	----	pattern of animal communit	elton,cs	1966
aubo	mhbc	nyny	534	----	anim behav: ethol, com psy	hinde,ra	1966
aubo	jwis	nyny	771	----	mechanisms of animal behav	marler,p; hamilto	1966
aubo	prha	ecnj	297	----	introdu to animal behavior	klopfer,ph; hailm	1967
aubo	hill	loen	760	----	the chemical senses	moncrieff,rw	1967
aubo	thcr	nyny	182	----	communi in the animl world	evans,wf	1968
aubo	plpr	nyny	418	----	ethology of mammals	ewer,rf	1968
edbo	saco	phpa	563	----	abnormal behavior in anima	fox,mw	1968
aubo	epdu	nyny	298	----	the magic of the senses	droscher,vb	1969
aubo	tapl	nyny	183	----	animal senses	burton,r	1970
edbo	apcc	nyny	412	----	comm, chem sig: advan chem	johnston,jw,jr; /	1970
edbo	acpr	nyny	336	----	chemical ecology	simeone,jb; sondh	1970
aubo	uchp	chil	349	----	animal behavior	scott,jp	1972
aubo	whfr	sfca	458	----	wildlife ecology	moen,an	1973
edbo	dohr	stpa	416	----	territory	stokes,aw	1974
edbo	acpr	nyny	344	----	mamm olfact, reprod, behav	doty,rl	1976
edbo	wiwi	bama	532	----	the behav of domestic anim	hafez,ese	1976
edbo	plpc	nyny	609	----	chemical signals, vertebra	muller-schwarze,/	1977
edbo	jwis	nyny	364	----	quantitative ethology	colgon,pw	1978
aubo	mhbc	nyny	452	----	comparative animl behavior	devisbury,da	1978
edbo	wiso	wadc	206	----	animal behavior	teague,rd,ed; moe	1979
edbo	acpr	nyny	540	----	biochemistry taste, olfctn	cagan,rh; kare,mr	1980
aubo	fost	nyny	426	cerv	antelope, deer, north amer	caton,jd	1877
edbo	stac	hapa	668	od--	deer of north america	taylor,wp	1956
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
edbo	unbp	line	605	odhe	mule, black-tailed, no ame	wallmo,oc	1981

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS EDITORS	YEAR
aubo	oxup	loen	215	ceel	herd, red dee, stud, behav	darling,ff	1937
aubo	cite	oxen	74	ceel	ecology of red deer	mitchell,b; stai/	1977
edbo	wimi	wadc	....	ceel	ecology,mngmnt, n amer elk	thomas,jw; towei in pr	
aubo	uwyp	lawy	294	ceel	n amer elk: ecol,behav,mgt	boyce,ms; hayden-	1979
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	stac	hapa	225	anam	hunting pronghorn antelope	popowski,b	1959
aubo	uopr	nook	247	ov--	the great ark of the wild	clark,jl	1964
aubo	uchp	chil	383	ovca	mount sheep: behavi, evolu	geist,v	1971
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965
edbo	iucn	mosw	940	many	behav & its rela to mangmt	geist,v; walther,	1974
edbo	stac	hapa	494	many	big game, n amer, ecol,mgt	schmidt,jl; gilbe	1978
aubo	acpr	nyny	202	ungu	reproductive behav, ungula	fraser,af	1968

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOBEA	12--2	219	250	cerv	ethologi obsrvatns, n amer	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MDCBA	5----	1	64	odvi	w-tailed deer of minnesota	erickson,ab; gunv	1961
MDCRA	14---	1	80	odvi	michigan white-tailed deer	jenkins,dh; bartl	1959
RWLBA	6---2	153	325	odvi	w-t deer of the adirondcks	townsend,mt; smit	933
RWLBA	6---2	327	385	odvi	wntr, spr obsrv, adirndcks	spiker,cj	1933
WCDBA	14---	1	282	odvi	white-tailed deer, wiscons	dahlberg,bl; guet	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZWBA	3----	1	109	odhe	in arizona chaparral	swank,wg	1958
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CFGGA	8----	1	163	odhe	life hist, managemt, calif	taber,rd; dasmann	1958
CGFPA	4----	1	39	odhe	lit review, mvmnts & captr	siglin,rj	1965
CGFPA	7----	1	26	odhe	literature review on behav	dorrance,mj	1967
JOMAA	37--2	143	164	odhe	behavior, populatn ecology	dasmann,rf; taber	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
UCPZA	88---	1	209	ceel	tule elk: hist, behav, eco	mccullough,dr	1969
WLMOA	16---	1	49	ceel	status, ecol, roosevel elk	harper,ja; harn/	1967
WLMOA	24---	1	66	ceel	the sun river elk herd	knight,rr	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observ in yellowstone park	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavi in british columbia	geist,v	1963
FUNAA	8....	40	43	alal	moose habits and habitat	rush,wm	1946
JOMAA	39--1	128	139	alal	summr obsrvtns, behv,ontar	de vos,a	1958
MUZPA	25---	1	44	alal	the moose of isle royale	murie,a	1934
NCANA	101--	1	436	alal	ecol, proc inter sym, pt 1	bedard,j	1974
NCANA	101--	437	735	alal	ecol, proc inter sym, pt 2	bedard,j	1974
VLUBB	22-15	74	82	alal	[elk behav, leningr, russ]	timofeeva,ek	1967
ZOOLA	41-14	105	118	alal	ecol behav popula dynamics	denniston,rh	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BPURD	2----	1	215	rata	ecol, caribou, prudhoe bay	white,rg; thomso/	1975
CWRSB	38---	1	71	rata	biology, kaminuriak popula	dauphine,tc,jr	1976
UABPA	3----	1	44	rata	behav of barren-ground car	pruitt,wo	1960
UABPA	8----	1	82	rata	ecology, managment, sweden	skunke,f	1969
WMBAA	10A--	1	79	rata	prelim investigation, pt 1	banfield,awf	1954
WMBAA	10B--	1	112	rata	prelim investigation, pt 2	banfield,awf	1954
WMBAA	12---	1	148	rata	caribou, continued studies	kelsall,jp	1957
WMBAA	15---	1	145	rata	barrn gr carib, coop study	kelsall,jp	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	43--2	257	354	anam	life hist,ecol,rng use,tex	buechner,hk	1947
CAFGA	30--4	221	241	anam	prong-hornd antlp in calif	mclean,dd	1944

anam continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	litera revi on prong behav	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behav patterns of the	prenzlow,ej; gil/	1968
JOMAA	3----	82	105	anam	the prong-horn	skinner,mp	1922

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NPSMD	161--	1	161	bibi	bison, yellowston nat park	meagher,mm	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	24--3	505	580	ov--	distribut, variat, no amer	cowan,imct	1940
AZWBA	1----	1	153	ov--	desert bighorn	russo,jp	1956
WLMOA	4----	1	174	ov--	united sta, past to future	buechner,hk	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of mountain sheep	mccann,lj	1956
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
CJZOA	46--5	899	904	ovca	ovda,delay soc, phys matur	geist,v	1968
IGWBA	1----	1	154	ovca	stat, life hist, mgt, idah	smith,dr	1954
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	20--4	440	455	ovca	bighorn sheep of texas	davis,wb; taylor,	1939
JOMAA	24--1	1	11	ovca	notes on life histor, colo	spencer,cc	1943
SCBUB	35--6	29	76	ovca	survey, sierra nevada bigh	jones,fl	1950
WGFBA	1----	1	127	ovca	wyoming bighorn study	honess,rf; frost,	1942
WLMOA	4----	1	174	ovca	bighorn sheep in the u s	buechner,hk	1960
XNFSA	6----	1	242	ovca	bighorn of death valley	welles,re; welles	1961

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
WMBAA	9----	1	34	obmo	prelim stud,ellesmr is,nwt	tener,js	1954

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, mgtmt, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
SCZFA	113--	660	668	caca	[obs behav roe dee; germa]	eiberle,k	1962
ZEJAA	8---2	61	81	caca	behavior of roe bucks	hennig,r	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOGAA	33...	65	78	momo	behav of moschus moschifer	fradich,h	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MRLTA	41--3	34	40	dogo	feral goats, british colum	geist,v	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
PZSLA	142-1	129	163	dosh	study, feral pop, st kilda	boyd,m; doney,jm/	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JTBIA	2---1	63	68	----	environments of anim, plan	browning,to	1962
QRBIA	22---	283	314	----	life tabls, natrl pop anim	deevey,es	1947

OTHER PUBLICATIONS

Proceedings of the White-tailed Deer in the Southern Forest Habitat Symposium (First meeting in 1962)

Transactions of the Annual Meeting of the Northeast Deer Study Group (Annual meeting beginning 1964)

Proceedings of the North American Moose Conference (Fifth conference in 1968)

Proceedings of the International Reindeer/Caribou Symposium (First meeting in 1977, second in 1980)

Proceedings of the Biennial Antelope States Workshop

Transactions of the Interstate Antelope Conference

Transactions of the North American Wild Sheep Conference (Second meeting in 1976)

Transactions of the Desert Bighorn Council (Annual meeting beginning 1957)

Proceedings of the International Mountain Goat Symposium

Proceedings of the Annual Conference of Western Association of State Game & Fish Commissioners (Annual conference beginning 1921)

TOPIC 1. SENSES

It is traditional to think of animals as having five senses. Elementary school children learn them as seeing, hearing, smelling, tasting, and touching. These are senses, to be sure, but they should be taught as five of the senses. Additional ones include a thermal sense, sense of pain, sense of hunger, and a gravitational sense.

An important conceptual base for defining the dimensions of the sensory environments of animals, given in Moen (1973; 19), is that the dimensions or geometries of functional environments are determined by the sensory capabilities of the animal and the characteristics of stimuli sensed. Visual environments are not spherical; an animal cannot see in all directions at the same time. Sound environments may be nearly spherical.

Taste and smell are related senses. It is difficult for humans to relate to the taste and smell capabilities of wild ruminants because their sensory capabilities cannot be described with well-defined units of measurement, and our discriminating capabilities, especially of smell, are very inferior to those of wild ruminants.

Sensory capabilities are such obvious determinants of certain dimensions of the environments of wild ruminants that the lack of knowledge of these capabilities can only be explained by the difficulties and costs associated with experiments on these animals. Their large sizes, large home ranges, and the difficulties associated with controlled experiments on wild ruminants result in the selection of smaller, easier to handle species by experimental ethologists. Subjective descriptions of wild ruminant behavior responses and patterns will have to provide the basis for most of the estimates of their sensory capabilities.

Capabilities for touch, thermal sensing, pain, hunger, and gravity are also not only difficult to measure because of the lack of suitable transducers and units of measurements, but also because animals, as living organisms, are constantly integrating all of their sensory capabilities into larger behavioral responses. We should, however, try to determine the framework within which the sensory capabilities fall.

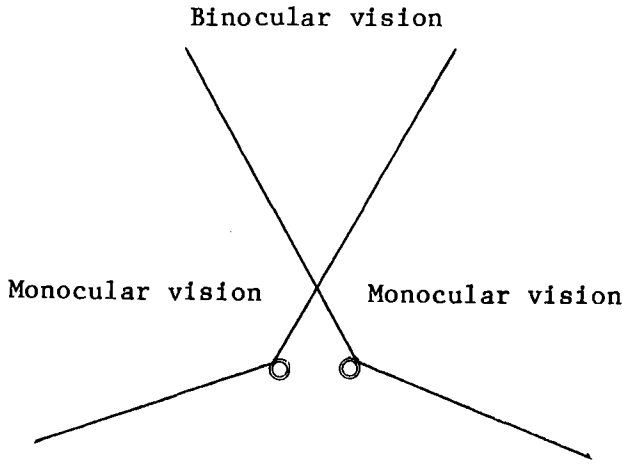
The five traditional senses plus others are discussed in UNITS 1.1 through 1.7.

LITERATURE CITED

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman and Co., San Francisco. 458 p.

UNIT 1.1: VISION

The functional visual environment of ruminants includes a central area where the vision of both eyes overlaps, the area of binocular vision, and the lateral areas seen by only one eye, areas of monocular vision. The outer limits of the visual environment can be described by angles that describe the limits to peripheral vision.



Visual capabilities are dependent on the abilities of animals to detect certain wavelengths in the electromagnetic spectrum (see CHAPTER 14 for information on the electromagnetic spectrum) with their eyes. Visual discriminations are based on wavelengths, resulting in detection of color, and on movement. Movement is detected with or without color discrimination.

Neural processing of different wavelengths is dependent on the characteristics of the receptors in the retina, or light-sensitive part of the eye. Two kinds of receptors--rods and cones--are found in mammals. The rods are sensitive to lower light illuminations but not to color. The cones are sensitive to higher illuminations and to color (Prince 1970; 1144). Further, there are three types of cone cells (Droscher 1969). Cone types A, B, and C are sensitive to deep blue-violet, dark green, and deep yellow, respectively.

Different species have different ratios of rods and cones, and different numbers of types A, B, and C cones. The general rule given by Prince (1970, p.1145) is that those animals that are more active during the night tend to have more light-sensitive rods, and those that are more active during the day, more color-sensitive cones. Wild ruminants, especially deer, appear to be quite capable of seeing in low light. They are active during both night and day, and their color vision may be better than generally believed to be. Red deer are listed by Dröscher (1969) as one of several species of mammals with color perception.

Bighorn sheep and mountain goats are thought to have good color vision but poor night vision (Geist 1971). Geist used the technique of moving with tame or habituated sheep in order to approach wild sheep more closely, and

noted that the sheep were able to spot predators "vastly better" than he was able to, especially if the predator, such as a coyote, was in shrubby habitat. Wild animals in general appear to be much better than humans in spotting moving objects in terrain. Those of us that do a large amount of field work also note improvement in our abilities to detect animals and other natural objects as our experience increases.

Think of the field of vision to consist of a near-field and far-field. The near-field includes those objects and stimuli which the animal sees nearby which allow the animal to feel secure and comfortable in its surroundings. If danger is seen nearby, the animal flees, making the source of danger in the far-field. The far-field includes those objects and visual stimuli which are distant, and which do not cause immediate concern. The line of demarcation between the near- and far-field is not absolute, and varies in time and space.

The visual environment becomes less detailed as distances from the viewer increase. There are differences in the depth of the field of vision of different wild ruminants. Pronghorns are well-known for their visual acuity at great distances, while moose have less depth of field. The former is an animal of the plains where vision is unobstructed for great distances, and the latter is much more at home in forest and brushland.

Thresholds of responses to visual stimuli vary. I have found in my field work with white-tailed deer that on some days the slightest movement some distance away triggers flight behavior, while on other days the animals can be approached much more closely. I do not know why this apparent difference exists. It may be related to both daily physiological rhythms and to transient environmental conditions. Differences in response thresholds have been especially noticable in my work in western Minnesota farmland where deer could be seen and deer could see me at distances up to a mile or more. Meagher (1973) writes that a skier in dark clothing may be detected by bison at distances of a mile or more; a far-field response.

One general conclusion concerning vision that seems to be applicable to all wild ruminants is that moving objects are quickly detected, causing alertness in the recipient animal and sometimes flight behavior, and non-moving objects are less easily detected.

LITERATURE CITED

Dröscher, V. B. 1969. The Magic of the Senses. E. P. Dutton & Co., Inc., N.Y. 298 p.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

Meagher, M. M. 1973. The Bison of Yellowstone National Park. National Park Service, Scientific Monograph Series, Number 1. 161 p.

Prince, J. H. 1970. The eye and vision. Chapter 50 In Swenson, M. J. (Ed.). Duke's Physiology of Domestic Animals. Cornell Univ. Press, Ithaca. 1463 p.

REFERENCES, UNIT 1.1

VISION

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ccth	spil	250	----	animal visi: what anim see	smythe,rh	1961
aubo	cnha	loen	132	----	vision in vertebrates	tansley,k	1965
aubo	whfr	sfca	458	----	wildlife ecology	moen,an	1973
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AVCSA	18--2	152	158	cerv	the structure of cornea in	rehbinder,c; winq	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AJVRA	39--4	699	702	odvi	cone, rod photo receptors	witzel,da; sprin/	1978
AMNTA	3---1	28	30	odvi	senses of sight, smell	caton,jd	1869

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
AMNAA	52--2	392	399	alal	observa in yellowstone prk	mcmillan,jf	1954
AVCSA	18--2	159	167	alal	lens lesions, elk, sweden	kronevi,t; holmb/	1977
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	30--4	221	241	anam	prnghrn antelp, california	mclean,dd	1944
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965

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
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	1---2	167	176	dosh	sight, hear, locat, discrm	arnold,gw; bound/	1975
APANE	1---4	369	377	dosh	compr visn, hearing, lambs	shillito,ee	1975
APANE	3---1	65	81	dosh	audi & visual clues, recog	alexander,g	1977
APANE	3---2	127	136	dosh	import odor, apprnce, voic	alexander,g; shil	1977
APANE	3---2	137	144	dosh	impor, vis cl matern recog	alexander,g; shil	1977
APANE	4---1	71	80	dosh	vis, hrng, ewes fndg lambs	walser,ees	1978
APANE	4---1	81	85	dosh	vis discrm of ewes by lamb	alexander,g; wals	1978
APANE	5---3	215	232	dosh	discrim color, grey shades	alexander,g; stev	1979
APANE	6---3	221	231	dosh	maternl recog, breed ident	walser,ees	1980

CHAPTER 3, Worksheet 1.1a

Visual responses of wild ruminants

Visual responses of wild ruminants are difficult to evaluate in the field. This WORKSHEET may help you become more aware of their visual environment by calling attention to specific field observations.

Find an animal or group of animals and record the following, using a stopwatch, binoculars, and clipboard.

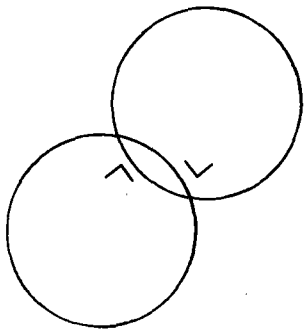
	Near-field	Objects?	Far-field	Objects?
Time:				

	Near-field	Objects?	Far-field	Objects?
Time;				

UNIT 1.2: HEARING

Hearing is a response to vibrations in air, followed by very rapid data-processing of the signal as organisms attempt to identify the kind and source of the sound. I have been quickly detected by deer as a result of a single snapping of a twig when such a noise seemed to be just one of many natural sounds. Their hearing and data-processing are acute and quick.

The dimensions of the sound environment are dependent on the loudness and frequency of the sound in relation to the animal's hearing capabilities. The geometry of the sound environment is not limited to particular angles; sounds can be heard from all directions. The shape and orientation of the ears may increase the dimension of the sound environment in one general direction, however. Ear orientation is shown rather dramatically in a photo by Paul Kelsey in Moen (1973; 1) as one deer has its ears oriented backward and other deer have theirs oriented forward.



Hearing capabilities and sound identifications include discriminations between different frequencies or wavelengths of sound energy (pitch), between different levels or intensities of sound energy (loudness), and directions relative to the receiving organism. Some frequencies are too high (wavelengths too short) and some are too low (wavelengths too long) to cause sympathetic vibrations in the auditory mechanisms of the inner ear and subsequent transmission of nerve impulses to the central nervous system for processing. Sounds must possess enough energy to activate the sympthetic vibrations in the inner ear or they are not heard.

Directional capailities for sound detection are remarkable, since the ears are really not very far apart and sound energy reaches the near ear only about 1/2000th of a second sooner than the far ear. Droscher (1969) summarizes results of experiments on humans that show directional capabilities to be dependent on special nerve ganglia that convert differences in loudness to time-differences in impulses relayed to the brain. The existence of similar neurological mechanisms in wild ruminants is certainly quite possible; deer often look in the right direction when surprised by a sound, and very quickly too.

Wild ruminants continuously receive a wide range of frequencies at different levels of loudness. Hearing may be thought of as being composed of background sounds and unusual sounds. Background sounds are those which do not alter behvior even though they are received. Unusual sounds trigger a response. Wild ruminants filter out the quiet natural background sounds, but become very alert to unusual sounds. The snapping of a twig is not an alien sound, but is an unusual sound that triggers a directional response and a new level of alertness by the animal.

LITERATURE CITED

Dröscher, V. B. 1969. The Magic of the Senses. E. P. Dutton & Co., Inc., N.Y. 298 p.

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman and Co., San Francisco. 458 p.

REFERENCES, UNIT 1.2

HEARING

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
edbo	elpu	nyny	933	----	acoustic behavior of anima	busnel,rg,ed	1963

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
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965

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

CAFNA 81--1 1 22 oram obsrvtns,kootenay nt pk,bc holroyd,jc 1967

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

SWNAA 9---3 118 115 ---- biol acoust, sound spectog davis,li 1964

CHAPTER 3, Worksheet 1.2a

Auditory responses of wild ruminants

Auditory responses of wild ruminants are difficult to evaluate in the field. This WORKSHEET may help you become more aware of their visual environment by calling attention to specific field observations.

Find an animal or group of animals and record the following, using a watch and binoculars as necessary.

Time	Background sounds	Unusual sounds

Time	Background sounds	Unusual sounds

UNIT 1.3: SMELL

The sense of smell in animals is commonly associated with detection of predators, selection of food, and with reproduction (Kare 1970; 1170). These are fundamental life-support activities, and it is not suprising that wild ruminants have a well-developed sense of smell. The reaction of bison to the odor of an observer is often more marked than reaction to sight or sound (Meagher 1973), and this seems to be generally true of wild ruminants. Geist (1971) states that the sense of smell is developed well enough in sheep to scent a man 350 yards away under favorable conditions.

The scent environment of wild ruminants is difficult for humans to describe because we have no good way to relate to the olfactory capabilities of animals with much keener senses of smell than we have. We do know that the geometries of functional scent environments are very much dependent on the velocity and turbulence of the wind (Moen 1973; 20); geometries change quickly as wind characteristics change.

The total areas of scent environments depend not only on wind characteristics, but also on the concentrations of molecules detected and the sensitivities of the receiving organisms for scent-detection. The closer the source of the odor, the higher the concentration of diffusing molecules and the easier the source is detected, subject to wind effects of course.

The olfactory areas in animals with a well-developed sense of smell are larger due to elongations of the nose and by internal folds in the nose, thus increasing the surface area available for scent detection. The receptor cells used in olfaction are found in the specialized epithelium which lines parts of the nasal cavities.

The molecular basis for odor is not yet fully understood, but it appears that molecular configurations and/or molecular adsorptions are involved at the cellular level. The actions of enzymes in the biolochemical reactions within the cell result in the detection and transmission of olfactory information.

Smell and taste interact, but they are distinctly different senses. Smell is a "far sense," designed to detect stimuli at very low thresholds and without direct contact. Taste is a "near sense," designed to detect stimuli by direct contact.

Smell and taste are different senses, but the interactions between smell and taste make the design of experimental studies difficult. Further, there are interactions not only between smell and taste, but also between visual, auditory, and tactile clues. These interactions involve simultaneous detections, and it is very difficult to discern between the senses which functioned most strongly in different experimental situations, especially when the subjects in such experiments cannot communicate directly with the researcher.

A wide variety of odors are given off and detected by animals. Different species of animals give off different odors, different sexes and ages give off different odors, and individuals give off different odors. The roles of pheromones in chemical communications between individuals are discussed in UNIT 2.3.

LITERATURE CITED

Geist, V. 1971. Mountain Sheep. The University of Chicago Press. Chicago. 383 p.

Kare, M. R. 1970. Taste, smell and hearing. Chapter 51 In Swenson, J. J. (Ed.). Duke's Physiology of Domestic Animals. Cornell Univ. Press, Ithaca. 1463 p.

Meagher, M. M. 1973. The Bison of Yellowstone National Park. National Park Service, Scientific Monograph Series, Number 1. 161 p.

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman and Co., San Francisco. 458 p.

REFERENCES, UNIT 1.3

SMELL

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	ccth	spil	200	----	molecular basis of odor	amoore,je	1970
edbo	apcc	nyny	412	----	comm, chem sig: advan chem	johnston,jw,jr; /	1970
edbo	acpr	nyny	540	----	biochemistry taste, olfctn	cagan,rh; kare,mr	1980
proc	acpr	nyny	231	rata	ecochemi studies, reindeer	bertmar,g	1975

SERIALS

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ANBEA	19--1	141	152	odhe	pheromones in black-t deer	muller-schwarze,d	1971
JULRA	59--3	223	230	odhe	specialized scent hair	muller-schwarze,d	1977

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZOSA	58--2	65	68	rata	sudorifr gland, hairy skin	kallquist,l; moss	1977
JCECD	1---2	275	281	rata	volat comp, tarsl scnt gln	andersson,g; and/	1975
JCECD	3---5	591	601	rata	caudal gland, histol, chem	mueller-schwarze/	1977
KPSUA	5....	654	655	rata	chem comp, interdigi gland	sokolov,ve; brun/	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
SCIEA	183--	860	862	anam	pher, subauric scent, male	mueller-schwarze/	1974

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
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	3---2	151	162	dosh	ablatn olfctr bulbs,feedng	baldwin,ba; mcla/	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
LLOYA	38--6	532	532	many	insect & mammal pheromones	wheeler,jw	1975
LLOYA	39--1	53	59	many	insect, mammalian pheromon	wheeler,jw	1976
PSUBA	83--4	505	539	many	scent gland mrkng, soc beh	thmessen,d; rice,	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
PZSLA	1910-	840	986	rumi	specialized subcutan glnds	pocock,ri	1910

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	7---3	421	429	mamm	olfaction in mammals	moulton,dg	1967
JANSA	25--S	83	87	----	smell, exteroceptiv factor	bruce,hm	1966

UNIT 1.4: TASTE

Taste is an oral sensitivity to direct contact with chemical stimulants. This sense is used by wild ruminants when ingesting and chewing forage. There seems to be a relationship between forage selection and the nutritive quality of the forage, and this relationship is likely dependent on a combination of both olfaction and taste.

Taste receptors are located in the oral and pharyngeal cavities, with the highest concentration of receptors in the tongue (Kare 1970; 1161). Their densities, shapes, and sizes have been summarized for a variety of domestic animals by Kare, but little or no information is available for wild ruminants.

Taste capabilities and preferences are usually studied by providing test subjects with two identical lots of food except for the addition of the chemical to be tested to one of the lots. The preference of the animal is then noted, and when a sufficient number of choices have been made, statistical analyses can be made to determine probabilities of the choices by chance. Non-parametric statistical tests are particularly suited to such experiments since the results are best expressed as "either-or," or ranked in order of preference. Non-parametric tests are very useful for many behavior exeriments because behavioral responses cannot be easily described with basic units of measurement like those used in expressions of mass and energy; behavioral responses are relative expressions rather than absolute quantities.

The two-choice preference test method was used by Crawford and Church (1971) to determine responses of black-tailed deer to chemical stimuli. The deer demonstrated strong preferences for sweet solutions. Responses to different salts and acids varied. No sex differences were observed in response to sweets, salts, and acids, while males showed a marrked preference for bitter solutions which females rejected. The responses of deer were compared to those of sheep.

Some taste preferences may be characteristic of a species, with avoidance or preference responses similar for individuals, and some may be learned. The difficulties and costs of such experiments have prevented compilation of tests on large numbers of wild ruminants, and an understanding of taste in this group of mammals is dependent on a very limited number of experiments and on subjective evaluations.

LITERATURE CITED

Crawford, J. C. and D. C. Church. 1971. Responses of black-tailed deer to various chemical taste stimuli. J. Wildl. Manage. 35(2):210-215.

Kare, M. R. 1970. Taste, smell, and hearing. Chapter 51 In Swenson, J. J. (Ed.). Duke's Physiology of Domestic Animals. Cornell University Press, Ithaca. 1463 p.

REFERENCES, UNIT 1.4

TASTE

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	hill	loen	760	----	the chemical senses	moncrieff,rw	1967
edbo	acpr	nyny	540	----	biochemistry taste, olfctn	cagan,rh; kare,mr	1980

SERIALS

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	35--2	210	215	odhe	respon, chem taste stimuli	crawford,jc; chur	1971
JWMAA	40--1	114	120	odhe	pref junipr foliag,vol oil	schwartz,cc; reg/	1980

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

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

NATUA 183-2 345 346 doca thresho valu, taste, twins bell,fr; williams 1959

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

JASIA 52--1 125 128 dogo pref threshol, tast discri bell,fr 1959

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JANSA	30--5	777	783	dosh	tas resp I. sug, sacc, sal	goatcher,wd; chur	1970
JANSA	30--5	784	790	dosh	II. acids, quin, urea, sod	goatcher,wd; chur	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JANSA	31--2	364	372	many	III. sucrose, sodium chlor	goatcher,wd; chur	1970
JANSA	31--2	373	382	many	IV. acetic acid, quin hydr	goatcher,wd; chur	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
SCIEA	161--	1349	1350	----	ecol chem, palatabi spectr	brower,lp; ryers/	1968
SCIEA	164--	1183	1185	----	tast nerv fib: rand distri	frank,m; pfaffman	1969
VETRA	71...	1071	1079	----	sense of taste, domest ani	bell,fr	1959

UNIT 1.5: TOUCH

The sense of touch has not been formally described in the literature for wild ruminants. They are sensitive to the stimulation of body hairs, indicated by their attempts to clear their body surfaces of insects by flicking their ears and twitching their skin. Selective foragers, such as deer and caribou, also seem to have a highly developed sense of touch around their mouths, and use this sense in orienting forage for ingestion. Less selective foragers, such as bison, may have a less well-developed sense of touch around their mouth.

Mother-young relationships are quite dependent on touch, especially during the first few hours and days of life. The licking of the young after parturition is surely important in establishing the mother-young bond. Dams also lick the hind quarters and anal region of nursing young, stimulating urination and defecation.

Observations of mother-young interactions are rather difficult to make in the wild as some species, such as bison and white-tailed deer, are very secretive at the time of parturition. Others, such as caribou, are easier to observe. Ozoga et al. (1982) discuss changes in areas used by white-tailed deer as parturition approaches; data are given for does who ceased social habits, withdrew to use comparatively small areas, and aggressively excluded daughters from the area selected to rear young.

The roles of touch in the development of maternal behavior are not well understood. No mention of touch or other interactions was made by Ozoga et al. even though they oserved deer intensively with spotting scopes from platforms. It appears that aggressive defense of fawning areas and fawns may well include forceful touching of other animals by females of several species.

A few references to the mechanisms used by wild ruminants to repel flies may be found in CHAPTER 10, UNIT 1.1. The literature on touch as a sense is obviously limited.

LITERATURE CITED

Ozoga, J. J., L. J. Verme, and C. S. Bienz. 1982. Parturition behavior and territoriality in white-tailed deer: impact on neonatal mortality. J. Wildl. Manage. 46(1):1-11.

REFERENCES, UNIT 1.5

TOUCH

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	macm	nyny	113	----	sensory mechanisms	case,j	1966
aubo	whfr	sfca	458	----	wildlife ecology	moen,an	1973

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	46--1	1	11	odvi	parturitn behav, territori	ozoga,jj; verme,/	1982

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 3, Worksheet 1.5a

Touch responses of wild ruminants

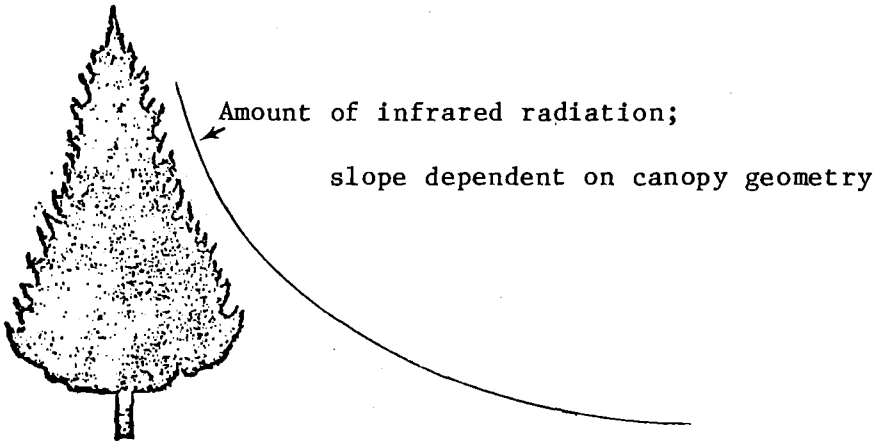
Locate an animal or a group of animals and record the times, receptors, and sources of touch responses in the columns below.

Time	Receptors	Source of touch responses

Time	Receptors	Source of touch responses

UNIT 1.6: THERMAL SENSING

It has been traditional to think of animals as having "five senses," but the list of five--sight, hearing, smell, taste, and touch--is incomplete. Animals detect heat energy with skin receptors, and are capable of detecting fairly small changes in the amounts of heat energy received. One form of energy perceived is thermal radiation. Bright sunshine is a significant source of heat energy, and wavelengths longer than the visible, called infrared energy, are also a source of heat energy. I have observed a larger-than-expected number of deer beds located next to the trunks of trees, especially in areas with few trees such as western Minnesota, and have wondered if this is a response to the larger amounts of infrared radiation present near the trunk and lesser amounts further from the trunk out to a distance about equal to the height of the tree (Moen 1968), as illustrated below.



It is important to realize that the larger amounts of radiant energy, though measurable, do not contribute significantly to the thermal balance of the deer because the amount of heat energy involved is not enough to alter the temperature profile and thermal gradient through the hair. This is discussed further in CHAPTER 16.

Thermally-sensitive bare skin, such as the nose, may be responding to the larger amounts near the tree trunks. Whitetail fawns at the Wildlife Ecology Laboratory have been observed lying in the sun with their heads in the shade on a warm summer day. This seems to indicate that their heads, probably their nose and lip surfaces, are the most thermally sensitive, and if they are in the shade, the animal "thinks" it is in a cooler environment. Thermoregulatory behavior is discussed further in CHAPTER 16.

It is well known that the warmth of the direct rays of the sun can be easily felt, and the sun's energy can add significant amounts of heat energy to the hair surface and thermal boundary region. Infrared energy, present at all times and in all places, is much less noticable because thermoreceptors at the skin surface become conditioned to this constantly-present heat energy.

Wild ruminants do adjust to changing weather and thermal conditions, and thermal senses can play a large part in determining behavioral responses under certain conditions. The literature contains essentially no information on thermal senses, however.

LITERATURE CITED

Moen, A. N. 1968. Thermal energy exchange of a birch tree and spruce tree at night. Ecology 49(1): 145-147.

REFERENCES, UNIT 1.6

THERMAL SENSING

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

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

ARPHA 15--- 357 372 ---- spec sensors: therm recept zotterman,y 1953

CHAPTER 3, Worksheet 1.6a

Thermal orientation of wild ruminants

Locate an animal of a group of animals and record your observations of their orientations in relation to the distribution of solar and infrared radiation. Further information on the radiation distribution may be found in PART V, CHAPTERS 14 and 15.

JDAY	Time	Posture	Sun	Shade	Infrared Field

JDAY	Time	Posture	Sun	Shade	Infrared Field

CHAPTER 3, Worksheet 1.6b

Bed sites in relation to solar and infrared fields

Bed sites are usually located after they have been used, especially in the winter when the beds are clearly visable in the snow. Try to determine when they were occupied, and evaluate their location with respect to solar and infrared radiation. Further information on radiation distribution may be found in PART V, CHAPTERS 14 and 15.

Time of occupancy	Solar field	Infrared field

Time of occupancy	Solar field	Infrared field

UNIT 1.7: OTHER SENSES

There are other senses in addition to those discussed in the first six UNITS. Some of the other senses are combinations of the six discussed earlier. Pain, for example, may result from too much sound (auditory), pressure (tactile), or heat (thermal).

Some senses respond to terrestrial and atmospheric stimuli. There is a gravitational sense, for example, a geometric equilibrium in relation to the earth. There may be responses to changes in barometric pressure, an atmospheric stimulus. Interesting obsevations of whitetail fawn movements in Texas are reported by Samuel and Glazener (1970). Seven fawns born and marked in lowland areas moved to upland areas prior to or during a tropical storm. The lowland areas were flooded by 1 to 20 feet of water. After the water subsided, 5 of the 7 fawns returned to their lowland areas of birth. No mortality was observed as a result of the storm, though no fawns could have survived the flooding had they not moved. Did this movement occur in response to changes in atmospheric conditions perceived by the fawns before it was too late?

Considerations of such additional senses are of potential usefulness, and an understanding of all the basic senses will help explain many ecological interactions between animal and environment.

LITERATURE CITED

Samuel, W. M. and Glazener. 1970. Movement of white-tailed deer fawns in south Texas. J. Wildl. Manage. 34(4):959-961.

REFERENCES, UNIT 1.7

OTHER SENSES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	34--4	959	961	odvi	mvt, fawns, hurricane, tex	samuel,wm; glazen	1970

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

TOPIC 2. COMMUNICATIONS

Wild ruminants communicate, though they do not speak. They communicate with visual signals, sounds, scents, and touch. Sometimes these exchanges draw the animals closer together, and sometimes they drive them farther apart. Sounds by females attract their young. Sounds by males may space the males out more.

There are seasonal differences in the forms and strengths of communications. The breeding season is characterized by communications that are different from those at other times of the year. There is a great deal of chemical communication going on; females in heat attract males. Whitetail bucks emit a deep, throaty sound during the rut. Elk "bugle," and "Elk calls reach their finest development in the bugling of the old bulls in the rutting period" (Murie 1951; 117). Bugling may be heard throughout the year, however, and both males and females "bugle."

Resource conditions also affect the meanings of different signals. Subordinate animals have different interpretations and responses to signals in times of plenty than in times of want. An abundance of forage and a low population density results in well-spaced individuals, with little need for overlaps in home ranges, and less communiction between individuals and little potential for strife. A scarcity of forage and a high population density results in crowded and overlapping home ranges, with more communication and higher potential for strife.

Some species are inherently more gregarious than others. Caribou and bison tend to gather in larger herds and for more time through the year than white-tailed or mule deer. Herds of gregarious animals have structure and organization that is a result of communications between members of the herd.

The UNITS that follow include descriptions of various forms and circumstances for communications. The effects of these communications on the use of space are discussed in the UNITS in TOPIC 3.

LITERATURE CITED

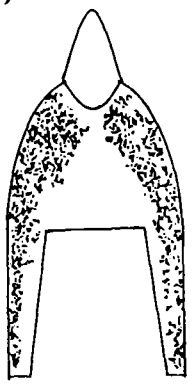
Murie, O. J. 1951. The Elk of North America. The Stackpole Company, Harrisburg, PA. 376 p.

UNIT 2.1: VISUAL COMMUNICATIONS

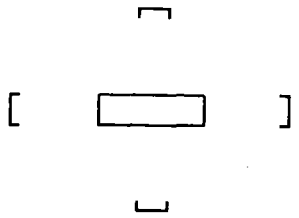
Visual communications between wild ruminants involve stance, posture, styles of movements, alertness, head and tail configurations, and other body geometries and movements. The attention posture assumed by one bighorn sheep alerts others to do the same (Geist 1971; 133). Horn displays are given by one or exchanged by two males.

The raised tail of white-tailed deer is a visual signal of danger, although deer in groups will raise the tail without triggering a general alarm. If one animal runs, others will follow, a response that is generally true of all groups of animals. An interesting use of the visual communications of white-tailed deer has been tried in Pennsylvania. Flagging behavior models have been placed along deer trails within 75 feet of roadways to redirect the movement of deer and reduce crossings in that area (Bashore 1975). Significant reductions in crossings were reported, which may be useful in reducing the number of deer-vehicle collisions.

Similar experiments have been tried at the Wildlife Ecology Laboratory, Cornell University. Silhouettes were made with tails that could be placed in the up or down position, and turned for white or brown colors.



Four silhouettes were placed around the feed trough of the captive herd in the pattern shown below. An adult female came over to feed, approached the silhouettes, stopped, stamped a front hoof, and after a short period of time dashed in to the feeder, ate briefly, and dashed out again. Within a day all of the deer were quite accustomed to the silhouettes and fed without hesitation.



Silhouettes were also placed around houses with shrubbery that was vulnerable to winter browsing in the Ithaca, N.Y. area. They also proved to be ineffective. The visual communications between deer, whether in a

captive herd or in the wild, and the silhouettes was not sufficient to overcome feeding desires. I had thought that regular reinforcement of the raised-tail signal by wild deer might be enough to make the silhouettes effective, but this was apparently not so. Further, the tails on the silhouette did not move. This may render them less effective. The stationery silhuettes provided no additional stimuli such as sounds or odors, either; only the visual senses were employed in this communication.

LITERATURE CITED

Bashore, T. C. 1975. Redirecting deer movement by use of flagging behavior models. Proc. Penn. Acad. Sci. 49(1):96.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

REFERENCES, UNIT 2.1

VISUAL COMMUNICATIONS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	dodo	nyny	1220	----	lives of game animals	seton,et	1929
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	wimi	wadc	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	stac	hapa	225	anam	hunting pronghorn antelope	popowski,b	1959

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNTA	111--	31	42	odvi	evol, alarm signals, ungul	hirth,dh; mccullo	1977
PPASA	49--1	96	96	odvi	redrct movt,flag behav mod	bashore,tl	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOBEA	12--2	219	250	ceel odhe	alal, etholog obsrvat	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observa in yellowstone prk	mcmillan,jf	1954
BEHAA	20--3	377	415	alal	behavr, n amer moose in bc	geist,v	1963

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	63	66	rata	funct anatom, tail, behavr	lewin,v; stelfax;	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3---- 1		28	anam	literature review,behavior	prenzlow,ej	1965
WLMOA	38--- 1		9	anam	social behavior & ecology	kitchen,dw	1974

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
IGWBA	2---- 1		142	oram	life history, manag, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	1---2	167	176	dosh	sight, hear, locat, discrm	arnold,gw; bound/	1975
APANE	1---4	369	377	dosh	compr visn, hearing, lambs	shillito,ee	1975
APANE	3---1	65	81	dosh	audi & visual clues, recog	alexander,g	1977
APANE	3---2	127	136	dosh	import odor, apprnce, voic	alexander,g; shil	1977
APANE	3---2	137	144	dosh	impor, vis cl matern recog	alexander,g; shil	1977
APANE	4---1	71	80	dosh	vis, hrng, ewes fndg lambs	walser,ees	1978
APANE	4---1	81	85	dosh	vis discrm of ewes by lamb	alexander,g; wals	1978
APANE	5---3	215	232	dosh	discrim color, grey shades	alexander,g; stev	1979
APANE	6---3	221	231	dosh	maternl recog, breed ident	walser,ees	1980

CHAPTER 3, Worksheet 2.1a

Visual communications

Locate a group of animals and record every visual communication possible to identify. The format below may be useful.

Time	Stimulus	Response

Time	Stimulus	Response

UNIT 2.2: AUDITORY COMMUNICATIONS

Wild ruminants are quite capable of communicating by sound. Whitetail bucks make a low, deep-throated sound when accompnying a female in estrus. Fawns bleat, though not as often as lambs of domestic sheep. It is used sparingly as a distress call. Deer and pronghorn make a snort or blow sound when alarmed. This is not a vocalization, but a forced exhalation of air. It is often accompanied by audible stomping of a front hoof, providing both a visual signal and a sound signal. Waring (1969) describes the blow sound of a pronghorn, and presents a sound spectogram and amplitude display of the blow. He suggests that the blow sound facilitates investigative behavior in the presence of suspected but unidentified danger by arousing the curiosity of the suspect which may susequently expose itself. The blow sound also aids in alerting nearby individuals.

Murie (1951) has several pages of descriptions of elk calls. Elk calves emit a loud, high-pitched squeal when temporarily separated from their dams. If the calf is siezed, it may elmit a startling medley of squeals and prolonged screams which may bring its mother on the run. Low bleats are uttered when beside the mother and undisturbed. Cows will call to their young. A traveling band of cows and calves in summer maintain more or less continuous noisy squealing. If the group is disturbed, a confusion of excited sounds are emitted.

A call emitted as a result of a "mental disturbance" is described by Murie (1951) as a ". . . hint of squeal mingled with a loud, hoarse bark." He considered this call to be a spontaneous outburst expressing emotion, and it does not always mean danger. He believes that other elk interpret the meaning of this call, responding differently to subtle differences in the tone of the call.

Bugling by elk includes several modifications of the call that is usually associated with the rutting behavior of the bulls. Cows are said to bugle also (Murie 1951; 117), and bugling may be heard throughout the year. Bugling during the rut is also called "roaring," especially in reference to the European red deer (also Cervus elaphus). The sequence of sounds produced when bugling, described by Murie (1951; 118), includes a beginning on a low note, increasing frequencies to high, clear, prolonged bugle-like notes, followed by a quick drop to a series of grunts. Variations in the pitch and character of the bugling are especially noticeable when three or four bulls are in the same area and their calls are heard in close succession. Reproductive behavior associated with bugling is described in CHAPTER 5.

LITERATURE CITED

Murie, O. J. 1951. The Elk of North America. The Stackpole Company, Harrisburg, PA. 376 p.

Waring, G. H. 1969. The blow sound of pronghorns (Antilocapra americana). J. Mammal. 50(3):647-648.

REFERENCES, UNIT 2.2

AUDITORY COMMUNICATIONS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	34--2	407	419	odvi	study, social organization	hawkins,re; klims	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	20--3	181	282	odhe	life history, california	dixon,js	1934
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JOMAA	42--4	522	526	odhe	aggressive behavio in deer	cowan,imct; geist	1961
WLSBA	6---2	169	170	odhe	respon,fawn distress calls	arthur,wj,III; h/	1978

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	69--3	145	170	ceel	roaring of red deer, hones	clutton-brock,th/	1979
EKIAA	6---1	100	102	ceel	char,biol signl field,roar	nikol'skii,aa; n/	1975
JBLPA	6....	83	95	ceel	[kinetics, stag roaring]	bubenik,a; brna,j	1967
JOMAA	13--4	331	336	ceel	elk calls	murie,a	1932

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observa in yellowstone prk	mcmillan,jf	1954
JOMAA	39--1	128	139	alal	summr obsrvtns, behv,ontar	de vos, a	1958
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
ZOBEA	12--2	219	250	alal	ethol oservatn n amer cerv	geist,v	1966
ZOOLA	41-14	105	118	alal	ecol, behav, pop dynam, wy	denniston,rh II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	10--4	481	481	rata	vocalization, behavior	ericson,ca	1970
BEHAA	40--3	295	301	rata	recognitn voice, moth, yng	espmark,y	1971
BEHAA	54--1	50	59	rata	indivi char, calls, calves	espmark,y	1975
BPURD	1----	387	397	rata	intrasp commun, mother-clf	ericson,ca	1975
BPURD	1----	398	408	rata	acoustic communicatn, revi	lent,pc	1975
BPURD	1----	423	435	rata	socializatn, calvin ground	Bmiller,fl; ander/	1975
XIWFA	54---	1	93	rata	alaska-yukon caribou	murie,a	1935
ZETIA	29--1	42	81	rata	mother-young, ontog, behav	espmark,y	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	43--2	257	354	anam	life hist,rng use,ecol,tex	buechner,hk	1950
CAFGA	30--4	221	241	anam	pronghorn antelope, calif	mclean,dd	1944
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
JOMAA	50--3	647	648	anam	the blow sound of pronghns	waring,gh	1969
WLMOA	38---	1	9	anam	social behavior & ecology	kitchen,dw	1974

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937

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
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	1---2	167	176	dosh	sight,hearng,locat,discrim	arnold,gw; bound/	1975
APANE	3---2	127	136	dosh	import odor,apprnce, voice	alexander,g; shil	1977
APANE	3---1	65	81	dosh	auditory, vis clues recogn	alexander,g	1977
APANE	4---1	71	80	dosh	vis, hrng ewes findg lambs	walser,ees	1978
APANE	6---3	221	231	dosh	maternl recog, breed ident	walser,es	1980
BEHAA	75--1	21	35	dosh	var, struc, bleats, 4 bree	walser,es; hague,	1980
JANSA	34--6	994	998	dosh	physiol respns auditr stim	ames,dr; arehart,	1972
JAURA	3----	121	132	dosh	auditory activity of sheep	wollack,ch	1963

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
STKMB	20--1	169	170	many	unusual vocl beh,antel,dee	dobroruka,lj	1972

CHAPTER 3, Worksheet 2.2a

Auditory communications

Locate a group of animals and record every auditory communication possible to identify. The format below may be useful.

Time	Stimulus	Response

Time	Stimulus	Response

UNIT 2.3: CHEMICAL COMMUNICATIONS

The role of chemicals in communications between animals is probably underestimated by humans because we cannot detect the low levels which animals are able to respond to. Rather specialized and sensitive chemical tests are needed to identify the presence of chemicals, with even more difficulties involved in identifying their physiological and behavioral roles. There are surely many unidentified chemicals that are part of the physiology and behavior of wild ruminants.

Hormones are chemical messengers within the body of a single individual that trigger responses of different tissues and organs. Some of these were discussed in CHAPTER 2, UNIT 1.7: ENDOCRINE GLANDS, and a distinction was made between those that had an effect on specific target organs (testosterone on male reproduction behavior, for example) and those that had a more diffuse effect (thyroxin on metabolism, for example).

Pheromones are chemical messengers that convey information between different members of a species (Dewsbury 1978; 184). These messengers may be signalling pheromones that have an immediate effect on the receiving animal, or primary pheromones that trigger hormone secretions that, in turn, affect overt behavior. Dewsbury briefly reviews the pheromone literature, pointing out that pheremones may be released by a variety of glands or different parts of the body, and in the feces and urine. Pheromones may convey information on a variety of individual characteristics, such as species, individual identity, and sexual identity, reproductive state, age, and others. Pheromones affect social behavior, and seem particularly important in their effects on reproductive behavior.

Pheromones of black-tailed deer are described by Muller-Schwarze (1971), who used encounter experiments in which a strange individual was introduced into a pen with an established group of deer. Metatarsal (See PART I, CHAPTER 2, UNIT 1.6) scent was discharged in fear-inducing situations. Males were attracted to female urine, and males marked their home ranges by rubbing the forehead against dry branch tips. Rub-urinating served as a distress signal in fawns, and as a threat in adults.

Scents emitted were also analyzed chemically in the above study with gas liquid chromatography techniques. Chemical analyses of scents emitted enables one to evaluate, document, and experimentally "play back" odors in experimental situations. These scents are generally highly volatile--a prerequisite for an effective pheromone--which makes isolation and identification very difficult.

There is another kind of chemical signals, allomones, that has been given little attention in wild ruminants. These are chemical messengers between species, and are very likely of importance in prey selection and avoidance. Their presence represents an unseen and largely ignored (by man) environment in the natural world that may well hold some clues to interspecies interactions. Young black-tailed deer avoided bowls of food containing vials of predator feces which would give off odors in an experiment

by Müller-Schwarze (1972). None of the captive deer tested had any experience with the predators, so the avoidance appeared to be a genetically-determined chemical communication. The coyote and mountain lion (both native predators) tests revealed complete avoidance by the deer, while African lion, snow leopard and Bengal tiger tests showed strong but not complete avoidance. The differences in avoidance of native compared to exotic predator feces may be partially due to the difference in ages of the deer when the tests were made. Exotic predator tests were made when the deer were 8 weeks and 5 months old, whereas native predator tests were made when the deer were 9 month old. While no association and therefore no learning had occurred as a result of direct experience, it may be that age is an important factor in the development of genetically-determined behavior.

Interspecies reactions also occur between closely related species, such as mule deer and whitetails, living in the same habitat. Continued reproductive separation of these species is likely based, in part at least, on chemical communications between individuals.

LITERATURE CITED

Dewsbury, D. A. 1978. Comparative Animal Behavior. McGraw-Hill Book Company, New York. 452 p.

Müller-Schwarze, D. 1971. Pheromones in black-tailed deer (Odocoileus hemionus columbianus). Anim. Behav. 19(1):141-152.

Muller-Schwarze, D. 1972. Responses of young black-tailed deer to predator odors. J. Mammal. 53(2):393-394.

REFERENCES, UNIT 2.3

CHEMICAL COMMUNICATIONS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	hill	loen	760	----	the chemical senses	moncrieff,rw	1967
aubo	ccth	spil	200	----	molecular basis of odor	amoore,je	1970
edbo	apcc	nyny	412	----	comm by chem signals: adva	johnston,jwr,jr;/	1970
edbo	acpr	nyny	344	----	olfactn,reprod, & behavior	doty,rl	1976
edbo	plpc	nyny	609	----	chemical signals, vertebra	muller-schwarze,/	1977
edbo	acpr	nyny	540	----	biochemistry taste, olfctn	cagan,rh; kare,mr	1980
proc	acpr	nyny	231	rata	ecochemi studies, reindeer	bertmar,g	1975
edbo	iucn	mosw	940	many	behav and its relat to mgt	geist,v,ed; walth	1974

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	97--2	257	266	odvi	sptl,tmprl,phys char, rubs	kile,tl; marchint	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	7---4	807	807	odhe	social odors, young mule d	muller-schwarze,d	1967
AMZOA	9---3	570	570	odhe	pheromn functn, deer urine	muller-schwarze,d	1967
ANBEA	19--1	141	152	odhe	pheromones in black-t deer	mueller-schwarze,	1971
JCECD	1---1	125	131	odhe	subsp specif rspns,soc odr	muller-schwarze,/	1975
JCECD	4---2	247	256	odhe	deer "lactone" source resp	mueller-schwarze/	1978
JOMAA	53--2	393	394	odhe	respon, youn btd pred odor	mueller-schwarze,	1972
JULRA	59--3	223	230	odhe	specialized scent hair	mueller-schwarze/	1977
NATUA	221--	284	285	odhe	isolatn,id,fnctn tarsal sc	brownlee,rg; sil/	1969
NATUA	229--	55	56	odhe	olfctry imprntng,precoc ma	muller-schwarze,/	1971
NATUA	229--	525	526	odhe	complex, rel specif, phero	muller-schwarze,d	1969
PVPCB	5----	56	63	odhe	evaluatng repellents,b-t d	campbell,dl; bull	1972
TETRA	34-10	1449	1452	odhe	synthesis of enantiomers	ravid,u; silvers/	1978

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	3---4	351	365	rata	hindleg-head contact behav	espmark,y	1977
AZOSA	58--2	65	68	rata	sudorifr glnds, hairy skin	kallquist,l; moss	1977
JCECD	1---2	275	281	rata	volat comp, tarsal scnt gl	andersson,g; and/	1975
JCECD	3---5	591	602	rata	caudal gland, histol, chem	mueller-schwarze/	1977
JCECD	4---3	325	336	rata	resp to interdig secretion	mueller-schwarze/	1978
KPSUA	5....	654	655	rata	chem comp, interdigi gland	sokolov,ve; brun/	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MAMLA	37--1	25	33	anam	scent mark, territor, wyom	gilbert,bk	1973
SCIEA	183--	860	862	anam	pher, subauric scent, male	mueller-schwarze/	1974
VDZGA	66...	146	150	anam	factrs influen scent mrkng	mueller-schwarze/	1972
ZSAEA	35...	353	356	anam	lip smacking in the prnghr	muller-schwarze,d	1971
ZOOAA	7---1	257	271	anam	social scents, hand reared	mueller-schwarze/	1972

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
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
LLOYA	38--6	532	532	many	insect & mammal pheromones	wheeler,jw	1975
LLOYA	39--1	53	59	many	insect, mammalian pheromon	wheeler,jw	1976
PSUBA	83--4	505	539	many	scent gland mrkng, soc beh	thiessen,d; rice,	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZETIA	23--5	588	592	dogo	matern imprint, role chemi	klopfer,ph; gambl	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	3---2	151	162	dosh	ablatn olfctr bulbs,feedng	baldwin,ba; mcla/	1977
APANE	4---2	153	158	dosh	odour & recog lambs by ewe	alexanderr,g	1978

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
PZSLA	1910-	840	986	rumi	specialized subcutan glnds	pocock,ri	1910

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	7---3	421	429	----	olfaction in mammals	moulton,dg	1967
JANSA	25--S	83	87	----	smell, exteroceptiv factor	bruce,hm	1966
MAMLA	36--3	315	341	----	role,vomeronasl orgn,repro	estes,rd	1972
RPHRA	19...	673	716	----	chem communi among animals	wilson,eo; bosser	1963
SCIEA	171--	443	49	----	mammlian scent marking	ralls,k	1971

UNIT 2.4: OTHER FORMS OF COMMUNICATION

No immediate and direct communications can occur unless there are stimulus-response combinations. These are dependent on the emission or display of cues or stimuli, and on the sensory capabilities of the animals in a position to detect them.

Some mother-young interactions are based on a sense of touch. The licking of the neonate by the mother just after parturition is very likely an important part of mother-young bond formation. Nursing young are often licked by their dams in their anal regions, stimulating urination and defacation. Bottle-fed fawns at Cornell's Wildlife Ecology Laboratory are routinely stroked in their hind quarters while drinking to stimulate elimination.

Genetically-determined behavior may be thought of as a form of communications or "instructions" that are passed from one generation to the next. Maternal behavior is a very important behavioral trait under genetic and hormonal control, resulting in the successful breeding of inexperienced individuals. The success rate apparently increases with experience. Ozoga et al. (1982) studied maternal behavior in white-tailed deer in a 252 ha yard (about one sq. mile) and noted an increase in neonatal losses from zero at low population density to an average of 23% at peak density. An adequate supply of nutrients was provided throughout the study. The difference in survival of fawns born to does of different ages is of particular interest. Does four years and older lost 9% of their fawns, 3-year-olds lost 22%, and 2-year-olds lost an average of 33% of their fawns. Under excessive herd density, however, 2-year-olds lost 63% of their fawns. This suggests that some learning occurred, and the importance of that learning is related to population density. The provision of ample nutrients was thought to render nutritional effects unimportant. Ozoga et al. mention aggressiveness as a characteristic of an experienced matriarch as she withdrew from the herd to raise triplets.

While it is not traditional to think of communications in genetic terms, it is important to consider the time dimension in ecological analyses, and the transmission of information by genetic means is the only way in which many ecologically important communications can occur. Reproductive behavior, for example, simply cannot be taught by mothers to their offspring for they are separated when the young become mothers. Think concepts rather than facts, and some academic traditions may be vulnerable to breakdown.

LITERATURE CITED

Ozoga, J. J., L. J. Verme, and C. S. Bienz. 1982. Parturition behavior and territoriality in white-tailed deer: impact on neonatal mortality. J. Wildl. Manage. 46(1):1-11.

REFERENCES, UNIT 2.4

OTHER FORMS OF COMMUNICATION

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	46--1	1	11	odvi	maternal behavior, w-t dee	ozoga,jj; verme,/	1982

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

TOPIC 3. THE USE OF SPACE

Wild ruminants use space resources in rather highly organized ways, which is not surprising when the functional environment, with its limitations due to physical, physiological, and neurological characteristics, is recognized and at least partially understood. The amount of space that can be used each day is ultimately limited by the energy an animal can expend for movement. This limit is usually not reached, or at least sustained for several days in succession, unless environmental conditions impose very high costs of movement on the animal. High costs do occur when snow is deep. Then the daily home range of an animal could be rather small because of the high cost of moving through snow. Further, the forage resources could be so depleted on winter range that the cost of moving through the snow exceeds the return by the forage.

There are two often-used terms that should be kept in mind when evaluating the literature and describing the use of space by wild ruminants. Home range is the area habitually traveled by an animal in the course of its normal activities. It is a descriptive, geometric term, and is not dependent on interactions between different individuals. It is simply the "home" area in which an animal spends its time. Territory is a term applied to a defended area. This was defined for birds by Noble in 1939, and has since been applied to many other species. While some species, especially birds, maintain rather strictly-respected territories, wild ruminants appear to have less well-defined territories. This may not be strictly true, however; small bird territories of less than an acre in size are much easier to identify and map than the large territories of wild ruminants.

Several terms used to describe the organization of animal societies are discussed by Dewsbury (1978; 92-97). Wild ruminants may be quite well-organized in relation to dominance, resulting in highly organized societies or animal groups. A dominant male elk, for example, is respected by other bull elk in the area, and has priority of access to an approach situation or of leaving an avoidance situation, as Van Kreveld (1970) defines dominance. Sometimes dominance is achieved by aggressiveness, sometimes by threats, and sometimes by simply having by superior physical characteristics.

Individuals of some species of wild ruminants live in herds, and of other species, in small groups. Some move over a large home range, and others live on a more restricted area, with changes in sizes of daily home ranges over the annual cycle as seasonal and animal characteristics change. There are differences in the amount of space used by different species and by members of the same species throughout the year. Males assert their dominance mostly during the breeding season, and females tend to space themselves out at parturition. These changes are discussed in UNITS 3.1 and 3.2, providing the descriptive background information needed in PART III when evaluating activity costs as part of the daily energy requirements.

LITERATURE CITED

Dewsbury, D. A. 1978. Comparative Animal Behavior. McGraw-Hill Book Company, New York. 452 p.

Noble, G. K. 1939. Dominance in the life of birds. Auk 56:263-273.

Van Kreveld, D. A. 1970. Selective review of dominance-subordination relations in animals. Genetic Psychology Monographs 81:143-173.

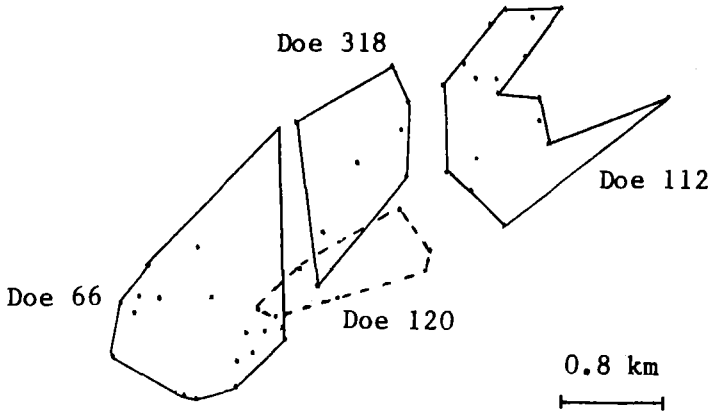
UNIT 3.1: DAILY HOME RANGES

The concept of home range is apparently quite old. Burt (1943) discusses home range and referrs to E. T. Seton's 1909 book Life-Histories of Northern Game Animals (Charles Scribner's Sons, N.Y.) in which "home regions" are discussed. Seton pointed out that wild animals do not roam at random, but each has a home region, even if it has not an actual home. Burt restricts the area of home range to that ". . . traversed by the individual in its normal activities of food gathering, mating, and caring for young."

The size of the home range may vary with sex, age, and season (Burt 1943). Burt emphasizes the point that wild animals need more than "essentials of life," [presumably food]; they need "living room." I suggest that living room is one of the essentials of life for wild, free-ranging animals, and is an important consideration when evaluating carrying capacity. In other words, space is a resource, to be considered along with food and other essentials of life. It is a geometric term, describing the size of an area in which an animal spends its time each day. It is not a defended area as the territory (UNIT 3.3) is, nor does home range imply any priviliged access to resources.

The geometry of an animal's home range is dependent on food, cover, and topographic conditions. A herd of 16 (average number, R = 2 to 27) Roosevelt elk occupied an area of beach and coastal prairie 9.6 km long and 0.1 to 0.45 km wide in California. The central area had an abundance of preferred herbaceous perennial forage, and was occupied over half of the time (Franklin et al. 1975). This strip of beach was bordered by the ocean on one side and bluffs 30 to 60 m high on the other. While the bluffs were intersected by trails into adjacent forest, this herd of elk used the long narrow coastal strip almost exclusively during the year. Home range geometry was apparently a function of both food and topography.

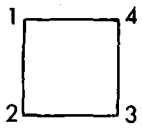
The illustration below illustrates the effect of topography on the geometry of white-tailed deer home ranges. The concave home range of Doe 112 (Nelson 1979) was due to a lake on the right-side border. Note also that the home ranges tended to fit together rather than overlap. These locations were determined in the summer, and their use of this space is discussed in UNIT 3.3, TERRITORIALITY.



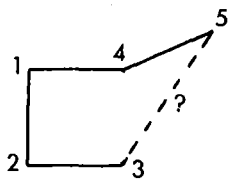
The calculation of home range may be difficult because the distance travelled each day may not be indicative of the land area covered. A resident white-tail deer, for example, may zig-zag and criss-cross considerably, traveling some distance but spending all of the time within a rather small area. A migrating caribou, however, may travel quite far in the normal course of a day's activity with little time spent in any one area. The concept of home range should be applied to animals on their seasonal range and not to animals moving from one seasonal range to another.

Calculations of home range areas are often made by determining the outer limits of each day's activities and calculating the amount of area enclosed by the polygon. This approach is satisfactory when animals remain in the same general area. The polygon is reasonably symmetrical and areas covered on different days are quite similar.

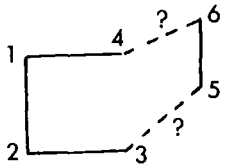
Accurate calculations of the area of the home range are more difficult to make as the home range departs from symmetry. The drawings below illustrate this point.



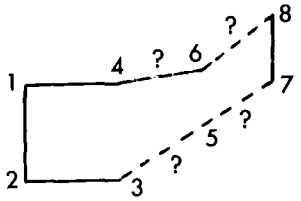
Four successive locations



Five successive locations



Six successive locations



Eight successive locations

Note that solid lines connect sequential locations and dashed lines (- - - -) not-sequential locations. Are the dashed lines legitimate biological boundaries, or are they simply lines connecting two points? As the number of locations increases, home range geometry could become easier or harder to determine, depending on the resulting geometry and the level of precision sought in the determination.

A new non-parametric technique for estimating home range size is described by Anderson (1982). This method makes no assumptions about the shape of the home range, and produces an estimate that is close to the "true" distribution. The method incorporates Fourier transformations of density fractions and is illustrated for elk data. In this approach, home range is defined in a probabilistic way, based on a bivariate probability density function that gives the probability of finding an animal at a

particular location on a plane. This "utilization distribution" is relatively recent, and is mentioned here to call attention to a new approach to home range calculations. Anderson's paper describes space use only; the "utilization distribution" with regard to space will be a function of the density distribution of food resources, and there will surely be a relationship between the two.

There are many descriptions of home range in the scientific literature (see the SERIALS list), but few of these include enough definitive data on the density of food resources to be able to relate space resources used to food. Keep in mind too that sampling within 24-hour periods is an important consideration because of the patterned distribution of the movements of wild ruminants.

There are many exciting possibilities for computer analyses of density distributions of all resources, with much potential for evaluation of interactions between animal and range.

LITERATURE CITED

Anderson, D. J. 1982. The home range: a new nonparametric estimation technique. Ecology 63(1):103-112.

Burt, W. H. 1943. Territoriality and home range concepts as applied to mammals. J. Mammal. 24(3):346-352.

Franklin, W. L.; A. S. Moseman, and M. Dole. 1975. Social organization and home range of Roosevelt elk. J. Mammal. 56(1):102-118.

Nelson, M. E. 1979. Home range location of white-tailed deer. U. S. Dep. Agric. For. Serv., Res. Pap. NC-173, 10 p. U. S. Dep. Agric. For. Serv., North Cent. For. Exp. Stn., St. Paul, MN.

REFERENCES, UNIT 3.1

DAILY HOME RANGES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NZJSA	10--3	744	751	cerv	mark captrd dee,field stud	taylor,rh; magnus	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JRMGA	25--6	480	481	od--	detection, therml scanning	parker,hd,jr; dri	1972
JWMAA	31--4	844	845	od--	device,immoblzng trpped de	white,cm	1967
JWMAA	37--3	288	300	od--	behav, dispersn, 2 sympatr	kramer,a	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	85--1	271	271	odvi	long-distance swimming by	stewart,pa	1971
BJASA	23--2	87	....	odvi	home rang,radio telem tech	groff,jm	1978
CAFNA	89--2	179	181	odvi	habitat use,home rang, ont	henry,bam	1975
CAFNA	90--2	123	136	odvi	distr,mvt,envrn fact, n br	drolet,ca	1976
CNSVA	23--4	14	17	odvi	deer trapping and tagging	hesselton,wt	1969
ECOLA	41--2	327	333	odvi	wint act, wh ced swamp, wi	habeck,jr	1960
JOMAA	5---3	201	202	odvi	range of an individual dee	bryant,hc	1924
JOMAA	51--2	392	394	odvi	new remote capture method	hawkins,re; klim/	1970
JOMAA	53--4	907	909	odvi	range extension, se washin	o'farrell,tp; hed	1972
JOMAA	56--2	535	537	odvi	marine isl, mainland movts	schemnitz,sd	1975
JOMAA	57--4	776	778	odvi	notes on dispersal of male	kammermeyer,ke; m	1976
JWMAA	2---3	151	161	odvi	trapping deer,pisgah n car	ruff,fj	1938
JWMAA	7---3	346	348	odvi	trapping & marking w-t dee	webb,wl	1943
JWMAA	21--4	397	401	odvi	movemen, deer tagged, minn	carlsen,jc; farme	1957
JWMAA	22--2	184	192	odvi	mobility of missouri deer	progulske,dr; bas	1958
JWMAA	26--1	79	85	odvi	factors affect disper, ind	hamilton,r	1962
JWMAA	26--1	114	115	odvi	expansible collar, male de	hamilton,r	1962
JWMAA	26--2	211	213	odvi	plastic, aluminum collars	fashingbauer,ba	1962
JWMAA	26--4	387	392	odvi	automatic tagging device	verme,lj	1962
JWMAA	27--3	422	427	odvi	nocturn movem, activ rhyth	montgomery,gg	1963

odvi continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JWMAA	28--1	42	45	odvi	radio-trac syst, deer movt	tester,jr; warne/	1964
JWMAA	28--1	167	170	odvi	markng tech, field recogni	knowlton,ff; mic/	1964
JWMAA	28--3	463	472	odvi	mobility, home range, texa	thomas,jw; teer,/	1964
JWMAA	29--1	44	52	odvi	movement, welder wildl ref	michael,ed	1965
JWMAA	29--3	632	634	odvi	mechan record, meas activi	ozoga,jj; gysel,l	1965
JWMAA	31--1	124	141	odvi	eval, radio-trac, triangul	heezen,kl; tester	1967
JWMAA	31--2	356	359	odvi	improved collar, wh-t deer	hawkins,re; klim/	1967
JWMAA	31--3	460	464	odvi	compar method, captur deer	hawkins,re; autr/	1967
JWMAA	31--3	464	468	odvi	diazepam bait, capture dee	montgomery,gg; ha	1967
JWMAA	32--1	191	195	odvi	dada, cannon-netting deer	hawkins,re; mart/	1968
JWMAA	32--3	618	620	odvi	movements, deer, ne texas	alexander,bg	1968
JWMAA	33--1	196	203	odvi	movem, transloc dee, telem	hawkins,re; mont/	1969
JWMAA	33--1	220	222	odvi	mobility of deer, so texas	ellisor,je	1969
JWMAA	33--2	366	379	odvi	movement, habita use, minn	rongstad,oj; test	1969
JWMAA	33--3	711	714	odvi	capturing & marking fawns	downing,rl; mcgin	1969
JWMAA	34--2	407	419	odvi	social organiz, preliminar	hawkins,re; klims	1970
JWMAA	34--2	431	439	odvi	wint feed pat, penned deer	ozoga,jj; verme,l	1970
JWMAA	34--4	959	961	odvi	movement, wt fawns, s texa	samuel,wm; glazen	1970
JWMAA	35--2	216	220	odvi	dispersal, crab orchard	hawkins,re; klim/	1971
JWMAA	36--3	996	998	odvi	salt vs brows seasnl baits	mattfeld,gf; wil/	1972
JWMAA	37--4	545	552	odvi	movements, upper michigan	verme,lj	1973
JWMAA	39--3	570	581	odvi	distrb, actv,intrstate hwy	carbaugh,b; vaug/	1975
JWMAA	40--3	429	441	odvi	migration, wolf predation	hoskinson,rl; mec	1976
JWMAA	42--1	113	117	odvi	movmt, habitat use, wiscon	larson,tj; rongs/	1978
JWMAA	43--3	610	619	odvi	habitat use by columbi w-t	suring,lh; vohs,p	1979
MRLTA	50--2	26	26	odvi	radio transmittr, tracking	howard,vw,jr	1969
NAWTA	3----	280	286	odvi	tagging, popula stud, minn	olson,hf	1938
NYCOA	11--2	4	5	odvi	live-trapping white-t deer	bromley,aw; sever	1956
OJSCA	67--6	382	384	odvi	radio-tracking a w-tl deer	balding,ta	1967
PCGFA	18---	140	152	odvi	telem, move, beha, nw flor	jeter,lk; marchin	1964
PCGFA	20---	63	69	odvi	drive-trapping white-t dee	stafford,s; lee,/	1966
PCGFA	20---	189	206	odvi	telem stud, movem-ecol, se	marchinton,rl; je	1966
PCGFA	22---	30	46	odvi	telem, h rang, behav, hunt	marshall,ad; whit	1968
PCGFA	24---	57	63	odvi	movements, fawns, telemetr	byford,jl	1971
PCGFA	29---	454	459	odvi	movt pattrns, virgina encl	downing,rl; mcgin	1975
PIAIA	81--2	76	82	odvi	movtmt at pilot knob st pk	zagata,md; haugen	1974
QJFAA	30--3	221	226	odvi	natural fctrs, affctng mvt	harlow,rf	1967
QSFRA	17...	1	49	odvi	a virginia deer in quebec	huot,j	1973
SWNAA	13--4	433	443	odvi	fixd statn radio track sys	inglis,jm; sittl/	1968

odvi continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
TISAA	62--2	117	119	odvi	day locat, bedsites, fawns	kjos,cg; montgome	1969
TJSCA	21...	417	428	odvi	activity patterns, s texas	michael,ed	1970
TNWSD	8----	1	4	odvi	trappng, swan islnd, maine	powell,se	1952
TNWSD	27---	39	81	odvi	deer trapping, tagging, ny	hesselton,wt	1970
VJSCA	26--2	61	61	odvi	behav yearl orphn as fawns	woodson,dl; mcgi/	1975
WLSBA	6---3	155	157	odvi	sika, eastern shore, mryln	feldhamer,ga; ch/	1978
WSCBA	32--4	20	21	odvi	ear-taggng whitetails, wis	kubisiak,j; hubb	1967
XFNCA	173--	1	10	odvi	home range location, w-t d	nelson,me	1979

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	40--2	175	181	odhe	deer marking devices	clover,mr	1954
CAFGA	40--4	367	373	odhe	portable trap & catch-net	clover,mr	1954
CAFGA	42--3	199	201	odhe	single-gate deer trap	clover mr	1956
CAFGA	43--3	193	199	odhe	improved device, captur de	ashcraft,g; reese	1957
CAFGA	44--2	183	189	odhe	marking deer with bells	jordan,pa	1958
CAFNA	88--4	487	489	odhe	odvi, obsrvtns,mackenz nwt	scotter,gw	1974
CGFPA	4----	1	40	odhe	lit rev, movts, captr, col	siglin,rj	1965
CGFPA	7---	1	26	odhe	literature review,behavior	dorrance,mj	1966
CWSPA	46---	1	32	odhe	distrib, movmts, colorado	carpenter,lh; gi/	1979
JOMAA	31--4	426	429	odhe	moon phases, salt lick, wa	buss,io; harbert,	1950
JOMAA	37--2	143	164	odhe	behavior, populatn ecology	dasmann,rf; taber	1956
JOMAA	38--2	247	253	odhe	observ, behav, penned mu d	browman,lg; hudso	1957
JOMAA	51--2	248	260	odhe	distrb pattrn, rel environ	miller,fl	1970
JWMAA	24--1	102	102	odhe	clover one-shot deer markr	white,kl	1960
JWMAA	27--3	414	422	odhe	movements in n east nevada	gruell,ge; papez,	1963
JWMAA	30--2	335	348	odhe	home range, dispersal, uta	robinette,w l	1966
JWMAA	30--3	631	633	odhe	automatic tagging device	siglin,rj	1966
JWMAA	33--3	704	708	odhe	photoelec, reco noctur act	harder,jd	1969
JWMAA	38--4	946	947	odhe	bait trails for trapping m	howard,vw,jr; eng	1974
MRLTA	34--1	41	46	odhe	movem, willapa hills, wash	zwickel,f; jones/	1953
NAWTA	20---	568	588	odhe	fctrs inflncing deer, ariz	hanson,wr; mccull	1955

odhe continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NOSCA	49--3	153	157	odhe	tagging fawns, washington	hedlund,jd	1975
TJSCA	1....	45	50	odhe	earl summ food, movem, tex	anderson,aw	1949
WLMOA	20---	1	79	odhe	ceel, doca, rng ecol, mont	mackie,rj	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	97--1	230	232	ceel	prehistori range extension	curren,cb,jr	1977
ECOLA	63--1	103	112	ceel	new nonparmtrc estima tech	anderson,dj	1982
FUOFA	70--5	216	231	ceel	distribut, 1900-73, sweden	lavsund,s	1975
JAPEA	14--1	55	64	ceel	selec uplnd swards on rhum	charles,wn; mcco/	1977
JOMAA	56--1	102	118	ceel	social org,home rang, roos	franklin,wl; moss	1975
JWMAA	26--1	97	100	ceel	day feed hab, roos el, cal	harper,ja	1962
JWMAA	30--3	461	466	ceel	odhe, tagging devices, elk	harper,ja; lightf	1966
JWMAA	30--4	845	846	ceel	effctivnes neckbands mrkng	knight,rr	1966
JWMAA	33--4	906	909	ceel	marking technique for elk	craighead,jj; ho/	1969
JWMAA	41--3	543	559	ceel	use, pinyn pine juni wdlnd	short,hl; evans,/	1977
MMLRA	4---3	79	91	ceel	caca, fctrs affct dispersn	staines,bw	1974
NZFSA	9---1	77	88	ceel	mvt marked dee, n islnd nz	davidson,mm	1979
PMACA	53...	29	35	ceel	movement patterns, michiga	moran,rj	1968
SZSLA	18---	211	228	ceel	observatn, dispers on rhum	lowe,vpw	1966
WLMOA	33---	1	50	ceel	hme rng, actv pat, non-mig	craighead,jj; cr/	1973
ZOLZA	46--3	448	449	ceel	[new data, dispers, russi]	mambetzhumayev,am	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	6-3/4	155	159	alal	social integration, calf	altmann,m	1958
JWMAA	24--2	162	170	alal	food hab, movem, pop, mont	knowlton,ff	1960
JWMAA	27--1	136	139	alal	tagging moose by helicoptr	simkin,dw	1963
JWMAA	37--1	87	89	alal	trap for free ranging moos	le resche,re; lyn	1973
JWMAA	37--3	266	278	alal	mvt pattrns, rng use, minn	phillips,rl; ber/	1973
JWMAA	38--4	783	788	alal	compar tech,restrain, mark	roussel,ye; piche	1974

alal continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NCANA	95--5	1153	1157	alal	[det pel gr, bed area/day]	desmeules,p	1968
NCANA	101-1	51	65	alal	distribu, habitat & status	dodds,dg	1974
NCANA	101--	379	392	alal	seasonal movements, europe	pulliainen,e	1974
NCANA	101--	393	415	alal	migratns in north america	leresche,re	1974
SYLVA	16--3	9	12	alal	moose tagging	simkin,dw; stone,	1960
XAFNB	103--	1	4	alal	odvi, collar, marking biga	phillips,rl; nich	1970
ZOOLA	41-14	105	118	alal	ecol, behav, pop dynam, wy	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATICA	25--3	193	202	rata	group cohes, man-barr	miller,fl; jonke/	1972
ATICA	28--1	54	61	rata	trail systems, ne alaska	leresche,re; lind	1975
BPURD	1----	140	154	rata	dist, movements, porc	jakimchuk,rd; mcc	1975
CJZOA	55--6	1029	1037	rata	inter-island movement	miller,fl; russe/	1977
CWPNB	46...	1	19	rata	distrib, movement, marked	dauphine,tc; and/	1975
CWPNB	77...	1	14	rata	distr, mov, 1975-75, ungav	drolet,c-a; ander	1977
CWRSB	1412	1	36	rata	distributio, movement, cal	miller,fl	1972
CWRSB	s-20	1	95	rata	biol, seasonal distributio	parker,gr	1972
CWRSB	2045	1	493	rata	obmo, movement, numbers	miller,fl; russel	1976
JEVMA	3--2	251	257	rata	assessing movement in	freeman,mmr	1975
JWMAA	31--1	150	159	rata	results, tagging caribou	miller,dr; robert	1967
NEJZA	25--3	377	378	rata	ecolog, etholog research	oostereld,p	1975
SSBLA	10--3	407	411	rata	spread, anim, pasture	baskin,lm	1975
TNWSD	28---	83	90	rata	live capture, tangle nets	miller,fl; behre/	1971
ZOLZA	51--9	1381	1386	rata	[autumn migrations of]	geller,mk; pavlov	1972

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
JWMAA	6---3	231	236	anam	live trapping texas antelo	fisher,lw	1942
JWMAA	30--1	209	211	anam	a self-collaring device	beale,dm	1966
JWMMA	31--2	347	351	anam	innovatns, trappng,handlng	spillett,jj; zobe	1967
NAWTA	33---	211	217	anam	stud, movem, fenced ranges	zobell,rs	1968
UAXBA	470--	1	79	anam	livestock fences, movemnts	spillett,jj; low/	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATICA	13--1	3	19	bibi	behavior, social organizat	fuller,wf	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZETIA	25--2	199	215	ov--	ext appear, behavio, socia	geist,v	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
JWMAA	22--4	445	446	ovca	marking technique, bighorn	aldous,mc; craigh	1958
JWMAA	30--1	208	209	ovca	modifi, dye-sprayng device	simmons,nm; phill	1966
JWMAA	34--2	446	450	ovca	movem, behav, summer, wyom	woolf,a; o'shea,/	1970
JWMAA	39--2	387	401	ovca	determ,spatl distr,rcky mt	shannon,nh; huds/	1975

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CWRSB	40---	1	56	obmo	rata, movmts, numbers, nwt	miller,fl; russe/	1977
FUNAA	22...	63	63	obmo	[wanderi ox, trans, dovre]	aune,oa	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955
JWMAA	19--4	417	429	oram	2 yr study, crazy mts, mon	lentfer,jw	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MAMLA	24--1	1	67	caca	[diel rhyth, daily activi]	bubenik,ab	1960
ZEJAA	8---3	111	123	caca	[wanderings of the red de]	szederjei,a	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	11--4	507	513	dosh	behv of indiv relatd group	hunter,rf; milner	1963
SZSLA	18--	179	210	dosh	soc grpng, home rng, feral	grubb,p; jewel,p	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BISNA	15--2	104	108	----	cmputr anal,telem movt dat	siniff,db; tester	1965
BMSIA	10...	145	152	biga	repeater type biotelem sys	cupal,jj; ward,a/	1974
JTBIA	22--2	227	237	----	measurm non-circ home rang	jennrich,ri; turn	1969
JWMAA	20--3	293	297	mamm	behavr char useful for mgt	chapman,fb	1956
JWMAA	20--4	467	467	biga	tech clsng live trap gates	sugden,lg	1956
JWMAA	21--2	251	252	biga	collar for identification	progulske,dr	1957
JWMAA	24--4	435	438	biga	color marker for big game	craighead,jj; sto	1960
JWMAA	27--2	292	296	----	new tech, use cap-chur gun	green,h	1963
JWMAA	32--3	628	629	ungl	modified markng tech,young	queal,lm; hlavach	1968
JWMAA	37--2	236	238	wldl	solar panls, radio trnsmtt	patton,dr; beaty/	1973
JWMAA	44--1	273	275	mamm	self adjst collrs,transmit	kolz,al; johnson,	1980
NFGJA	7---2	130	148	wldl	use of closed conif planta	bailey,ja; alexan	1960
SWNAA	13--4	433	443	----	fixd statn radio trckng sy	inglis,jm; sittl/	1968

OTHER PUBLICATIONS

Skinner, M. P. 1924. The American Antelope in Yellowstone National Park. Roosevelt Wildl. Forest Exp. Sta., Syracuse, N.Y. 32 p.

CHAPTER 3, WORKSHEET 3.1a

Area determinations of daily home ranges of white-tailed deer, Minnesota

The sketch of home ranges of white-tailed deer in northern Minnesota (Nelson 1979) may be used to determine the land areas used. Note in the drawing below that lengths are given for one of the home ranges sketched on page 61. Using the formula for determining the area of a triangle from the lengths of its sides, given, calculate the area of this home range. Then, determine the angles and lengths of sides for the other home ranges sketched on page 61 and calculate their areas.

$$\text{Area} = \sqrt{S(S - a)(S - b)(S - C)}$$

where $S = 1/2\ (a + b + c)$, and
a, b, c = lengths of each of the 3 sides.

This is the simplest of calculations. Superimpose an x-y grid on the drawing and write a short computing program for use with the x, y coordinates of each observation as inputs.

LITERATURE CITED

Nelson, M. E. 1979. Home range location of white-tailed deer. U. S. Dep. Agric. For. Serv., Res. Pap. NC-173, 10 p. U. S. Dep. Agric. For. Serv., North Cent. For. Exp. Stn., St. Paul, MN.

CHAPTER 3, WORKSHEET 3.1b

Area determinations of daily home ranges of white-tailed deer, Pennsylvania

A sketch of locations of sightings of two adult deer is given by Montgomery (1963), with outlines of the maximum observed limits of their ranges. The scale is also given, permitting one to calculate the areas within the limits of the ranges of these two deer. Redraw the sketches in the space below, and then use formulas for the areas of rectangles and triangles to determine the areas used by these two deer.

LITERATURE CITED

Montgomery, G. G. 1963. Nocturnal movements and activity rhythms of white-tailed deer. J. Wildl. Manage. 27(3):422-427.

UNIT 3.2: SEASONAL HOME RANGES

Daily home ranges change through the annual cycle as weather conditions, range resources, and the physiological characteristics of the animals change, resulting in recognizable differences between seasons.

Some wild ruminants move from one seasonal range to another in herds (caribou and bison, for example) while others move more as individuals (white-tailed deer, for example). Migrations, whether clearly defined or more loosely organized, are sometimes used to provide indices to populations which may be compared from year to year.

Seasonal changes may occur in relation to altitude for those species living in mountainous areas. Moose in the Gravelly Mountains in southwest Montana spent the summer and fall at elevations above 7500 feet and the winter below 7000 feet (Knowlton 1960). Elk migrated from winter range to summer range in April and May, and to winter range in late summer. Routes used were determined by topography, as elk could move from lower elevation winter range to higher elevation summer range only through passes (Picton 1960).

Some caribou may travel rather long distances between summer and winter ranges with little change in elevation. Others, such as those in Wells Gray Park, B.C. migrated between alplands above 7000 feet and lowland coniferous forest below 3500 feet several times during the year, moving down in late autumn, up in January to near treeline, down again in April, and up again in May or June. Migrations were apparently controlled by the effects of snow on availability of food and mobility of the animals (Edwards and Ritcey 1959).

Moose in Laurentides Provincial Park, Quebec showed age differences in movements; yearling and 2-year-old males moved more than adult males. Seasonal differences were observed as adult males moved more than adult females from summer to fall, apparently a function of sex and breeding behavior. Seasonal movements from summer to winter range did not show differences between sexes (Roussel et al. 1975).

White-tailed deer usually move from dispersed summer ranges to winter concentration areas. These seasonal shifts are partly due to weather and snow conditions as deep snow results in larger numbers in the winter concentration areas, and open winters in more dispersed distributions. There is indication in the literature that activity is reduced even in open winters, however, as energy conservation seems to be an adaptive physiological mechanism that occurs in response to internal changes, which are further mediated by external conditions (Moen 1976).

White-tailed deer appear to return to the same summer and winter ranges year after year. Four deer migrated 8 km between the same winter and summer ranges for the 3 years they were studied (Nelson 1979). A fifth deer made one 14 km spring migration before being killed by wolves during the return migration for the next winter. Nelson points out that the deer

migrated through habitats preferred by some to habitats avoided by others. Radio-tracking data are confirming what has been suspected from limited results on tagged deer; individual animals form habitat preferences early in life, probably as a result of the extended association with the mother, and retain these preferences for life.

Individual mule deer in Oregon also returned to the same area of the winter range each year, but dispersed throughout the summer range (Zalunardo 1965). An early study of marked elk suggested that some elk (5 animals) returned to the same winter range year after year, and possibly the same summer range also (Brazda 1953). Barren-ground caribou from two herds shared winter range, but appeared to use separate calving grounds and summer ranges (Miller and Robertson 1967). Thus it appears that there are seasonal movement patterns characteristic of individuals or groups, but the effects of different factors on the constancy of these patterns over long periods of time have not been determined yet.

LITERATURE CITED

Brazda, A. R. 1953. Elk migration patterns, and some of the factors affecting movements in the Gallatin River drainage, Montana. J. Wildl. Manage. 17(1):9-23.

Edwards, R. Y. and R. W. Ritcey. 1959. Migrations of caribou in a mountainous area in Wells Gray Park, British Columbia. The Canadian Field-Naturalist 73(1):21-25.

Knowlton, F. F. 1960. Food habits, movements and populations of moose in the Gravelly Mountains, Montana. J. Wildl. Manage. 24(2):162-170.

Miller, D. R. and J. D. Robertson. 1967. Results of tagging caribou at Little Duck Lake, Manitoba. J. Wildl. Manage. 31(1):150-159.

Moen, A. N. 1976. Energy conservation by white-tailed deer in the winter. Ecology 57(1):192-198.

Nelson, M. E. 1979. Home range location of white-tailed deer. U. S. Dep. Agric. For. Serv., Res. Pap. NC-173, 10 p. U. S. Dep. Agric. For. Serv., North Cent. For. Exp. Stn., St. Paul, MN.

Picton, H. D. 1960. Migration patterns of the Sun River elk herd. J. Wildl. Manage. 24(3):279-290.

Rousel, Y. E., E. Audy, and F. Potvin. 1975. Preliminary study of seasonal moose movements in Laurentides Provincial Park, Quebec. The Canadian Field-Naturalist 89(1):47-52.

Zalunardo, R. A. 1965. The seasonal distribution of a migratory mule deer herd. J. Wildl. Manage. 29(2):345-351.

REFERENCES, UNIT 3.2

SEASONAL HOME RANGES

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BUCDA	27--2	83	83	odvi	win, spr move, indiv, flor	bridges,rj; march	1969
CAFNA	92--3	275	282	odvi	forest clr-cts, n br, n sc	drolet,ca	1978
CGFPA	4----	1	40	odvi	odhe,lit rev, mvmnts,captr	siglin,rj	1965
ECOLA	41--2	327	333	odvi	wint actv, wh cdr swmp,wis	habeck,jr	1960
ECOLA	57--1	192	198	odvi	energy conservation, wintr	moen,an	1976
JOMAA	20--2	206	215	odvi	wint movem, food, cent wis	hamerstrom,fn,jr/	1939
JWMAA	6---4	287	291	odvi	winter habits, cent n york	cook,db; hamilton	1942
JWMAA	29--1	44	52	odvi	movemnts, welder wldlf ref	michael,ed	1965
JWMAA	32--1	130	141	odvi	rng use,fds,cndt,prd, mont	allen,eo	1968
JWMAA	34--2	420	431	odvi	seas activ patt, e sou dak	sparrowe,rd; spri	1970
JWMAA	35--3	476	487	odvi	summr habitat, n cent minn	kohn,be; mooty,jj	1971
NYCOA	7---2	6	7	odvi	fall mvts, adirondacks, ny	severinghaus,cw	1952
PIAIA	79--2	74	78	odvi	wint mvt, home range, iowa	zagata,md; haugen	1972
PNASA	29--1	13	13	odvi	seas distrib pattrn, n dak	harmoning,ak	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	54--1	27	32	odhe	winte range, herd, n calif	bauer,rd; light,/	1968
CFGGA	4----	1	139	odhe	the jawbone deer herd	leopold,as; rine/	1951
CGFPA	4----	1	40	odhe	litr rev, movmnts, capture	siglin,rj	1965
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
ECMOA	2----	1	46	odhe	seasonal migratn of mule d	russell,cp	1932
ECOLA	45--2	249	256	odhe	rel weathr to migratry mvt	mccullough,dr	1964
JOMAA	51--2	248	260	odhe	distr in relatn to environ	miller,fl	1970

odhe continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	6---2	162	164	odhe	migr cens, white r, nw col	wright,e; swift,l	1942
JWMAA	27--3	414	422	odhe	movevments in ne nevada	gruell,ge; papez	1963
JWMAA	29--2	345	351	odhe	seas distr, migratory herd	zalunardo,ra	1965
NAHIA	55--9	424	425	odhe	wintr crusing range, color	young,jm,jr	1946
WLMOA	20---	1	79	odhe	ceel,doca, rnge ecol, mont	mackie,rj	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JRMGA	16--2	74	78	ceel	chem sagebr contro, el dis	wilbert,de	1963
JWMAA	17--1	9	23	ceel	migra patt, movem, montana	brazda,ar	1953
JWMAA	24--1	103	104	ceel	determ movem, aerial count	robel,rj	1960
JWMAA	24--3	279	290	ceel	migr patt, sun r herd, mon	picton,hd	1960
JWMAA	24--3	337	338	ceel	detec, migr, hunte intervi	robel,rj	1960
JWMAA	29--2	333	338	ceel	seas movem, selway r, idah	dalke,pd; beeman/	1965
JWMAA	32--3	553	557	ceel	dif dist, wnt rang,age,sex	peek,jm; lovaas,a	1968
JZOOA	186--	544	550	ceel	sex difs,inequal win areas	watson,a; staines	1978
NAWTA	15---	597	610	ceel	re-estab, migr, transplant	allred,wj	1950
WLMOA	29---	1	48	ceel	migratns in, near yellowst	craighead,jj; at/	1972
ZOLZA	40--3	469	471	ceel	[temp, acti, fall-wi migr]	yazan,yp	1961
ZOOLA	41--8	65	71	ceel	pattrns,hrd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZOFA	5---2	220	223	alal	win foo, move, 2 moos, fin	loisa,k; pulliane	1968
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
CAFNA	83--4	339	343	alal	observ, feeding on aquatcs	ritcey,rw; verbee	1969
CAFNA	89--1	47	52	alal	seas movmt, laurentid, que	roussel,ye; audy/	1975
CAFNA	94--3	269	276	alal	radiotrk, boreal frst, ont	addison,rb; will/	1980
JOMAA	37--4	486	494	alal	migrations of a moose herd	edwards,ry; ritce	1956
JOMAA	39--1	128	139	alal	summer observatio, ontario	de vos,a	1958
JWMAA	20--3	324	325	alal	trappin, taggin, wint rang	ritcey,rw; edward	1956
JWMAA	24--2	162	170	alal	movmnts, gravelly mt, mont	knowlton,ff	1960
JWMAA	34--1	37	46	alal	wint ecol, gallatn mts,mon	stevens,dr	1970

alal continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	34--2	439	445	alal	movt,heavily hntd area,ont	goddard,j	1970
JWMAA	35--1	63	71	alal	radiotelem stud, minnesota	van ballenberghe/	1971
JWMAA	37--3	266	278	alal	movt pattrns,rang use,minn	phillips,rl; ber/	1973
MRLTA	60--1	6	11	alal	seas movement hatitat alas	mould,e	1979
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
NAWTA	21---	510	525	alal	summer studies, ontario	devos,a	1956
NCANA	101--	393	415	alal	migratns in north america	leresche,re	1974
ZOBEA	12--2	219	250	alal	ethologcl obsrvtns, n amer	geist,v	1966
ZOOLA	41-14	105	118	alal	ecol, behav, pop dynam, wy	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	18--2	256	258	rata	consequen, travel, rutting	henshaw,j	1970
ATICA	23--3	199	200	rata	abnorm migra behav, sweden	espmark,y	1970
CAFNA	73--1	21	25	rata	migrati, wells gray pk, bc	edwards,ry; ritce	1959
IJBMA	12--1	21	27	rata	activ, wint, weathe, alask	henshaw,j	1968
JOMAA	39--3	408	412	rata	land form, carib distr, bc	edwards,ry	1958
JWMAA	18--4	521	526	rata	fire, decline,mt carib hrd	edwards,ry	1954
JWMAA	31--1	150	159	rata	results of tagging, manito	miller,dr; robert	1967
NAWTA	20---	551	560	rata	barr-gr, movem, can arctic	kelsall,jp	1955
ZOLZA	41--6	927	934	rata	[wild reindeer migrations]	makridin,vp	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JWMAA	33--3	538	551	anam	wint range use, home range	bayless,s	1969
NAWTA	33---	211	216	anam	movements on fenced ranges	zobell,rs	1968

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of the mount sheep	mccann,lj	1956
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
CJZOA	55-11	1802	1810	ovca	spatl, habitat segregation	geist,v; petocz,r	1977
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	19--1	88	94	ovca	summ actv, yellowst nat pk	davis,wb	1938

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
FUOFA	67--4	176	177	obmo	migration, norway, sweden	odvik,b	1972

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955
JWMAA	19--4	417	429	oram	2 yr stud, crazy mts, mont	lentfer,jw	1955
JWMAA	19--4	429	437	oram	range use, crazy mts, mont	saunders,jk,jr	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	20--2	159	168		many snow depths,ungu abund,can	edwards,ry	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	33--3	538	551	anim	winter food hab, rang, mon	bayless,sr	1969
JWMAA	41--4	782	784	----	use, ponderos pin openings	ffolliott,pf	1977

CHAPTER 3, Worksheet 3.2a

Seasonal differences in home range areas

Using some method of determining home range areas, evaluate seasonal differences in home range sizes, preferably for the same population, from data in the literature. Compare the results by evaluating the number of winter areas that are larger or smaller than summer areas. My hypothesis is that winter areas are smaller, which can be tested by evaluating the number of results larger than and smaller than results of summer calculations and performing a chi-square or similar test. If there is no difference, the number of larger:smaller should be 1:1.

UNIT 3.3: TERRITORIALITY

Territories are defended areas which are used exclusively (or nearly so) by an animal within its home range. Thus they are a space resource with limits on their use, with these limits subjected to the effects of competition when populations are high per unit area.

Wild ruminants have generally not been considered as highly territorial as other groups of animals, such as carnivores. Results of radio-tracking studies are beginning to show that territories may be clearly defined, especially during the reproductive season. Territories are most aggressively defended by females at parturition and when nursing their young, and by males in the rut.

Aggressive interactions have been observed between whitetail does on summer range, during feeding behavior studies in northwestern Minnesota (personal communication with Lynn Rogers). Detailed accounts of white-tailed deer behavior and reproductive success in relation to herd levels with an ample supply of nutrients are given by Ozoga et al. (1982). It is of interest that does aggressively defended fawning areas, and that older, more experienced does were more successful at raising fawns to weaning. This territoriality was so strong that Ozoga suggests that complete isolation is essential for proper mother-infant bond formation, and that high-density populations limited fawn rearing space, disrupted maternal behavior, and was a factor in excessive neonate mortality among fawns of 2- and 3-year-old does.

The need for isolation observed in the captive herd in Michigan is different from the conditions observed by Michael (1964) in Texas where a wild doe was observed to give birth with 32 other does in the vicinity, some as close as 20 yards. Behavioral responses are so much more plastic than physiological responses; it is risky to expect rigid responses when there are so many variables affecting them.

The limited literature on territoriality is listed at the end of this UNIT, and that on dominance is listed in TOPIC 2 of CHAPTER 5. I suggest that more attention be given to territorial characteristics of wild ruminants. It has been easy to think of territories as characteristic of carnivores, with the explanation that some kind of competitive exclusion is desirable in view of mobile and limited prey bases. Ruminants, however, "prey" on plants, and since they do not try to escape, a much more peaceful coexistence is assumed. Nevertheless, the worst enemy of a moose may be another moose, and of a deer, another deer . . .

LITERATURE CITED

Ozoga, J. J., L. J. Verme, and C. S. Bienz. 1982. Parturition behavior and territoriality in white-tailed deer: impact on neonatal mortality. J. Wildl. Manage. 46(1):1-11.

Michael, E. D. 1964. Birth of white-tailed deer fawns. J. Wildl. Manage. 28(1):171-173.

REFERENCES, UNIT 3.3

TERRITORIALITY

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmt	einarsen,as	1948

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	28--1	171	173	odvi	birth of w-tail deer fawns	michael,ed	1964
JWMAA	46--1	1	11	odvi	parturit behav,territorial	ozoga,jj; verme,/	1982

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JOMAA	37--2	143	164	odhe	behavior, populatn ecology	dasmann,rf; taber	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	37--2	165	170	ceel	odhe, territrialsm in deer	graf,w	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BMAEA	516--	1	63	anam	rng use, food hab, montana	cole,gf	1956
CAFGA	30--4	221	241	anam	prng-hrnd antlp in califor	mclean,dd	1944
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
JOMAA	50--1	81	89	anam	territoria, bucks, montana	bromley,pt	1969
MAMLA	37--1	25	33	anam	scent mrkng, territor, wyo	gilbert,bk	1973
WLMOA	38---	1	9	anam	social behavior, ecology	kitchen,dw	1974

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
JRPFA	11--S	43	70	caca	territoriali, reprod behav	bramley,ps	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZSAEA	33--2	121	123	bibo	[territory and marking, b]	zablocki,m	1968
ZSAEA	33--2	124	125	bibo	[on territory and marking]	turcke,f	1968

CHAPTER 3, Worksheet 3.3a

Territory potentials for a given area

Territories are defended areas with some minimum size. If territories are real biological characteristics of wild ruminants, map out the number of territories possible on a particular area, putting down real and potential boundaries in relation to terrain and cover. How do the results of such an exercise compare to observed popultion densities through the year?

CLOSING COMMENTS

The behavioral characteristics of wild ruminants disussed in CHAPTER 3 have centered about the functional environment and use of space. Space should be considered more as a resource than an area, and calculations made of space resources in relation to other resources required by the individual and the population. Further insights into the use of space are discussed in CHAPTER 4, where specific behavior patterns and activity patterns through time are described. These are used in calculations of energy costs in PART III; what an animal does and for how long are two very important considerations when evaluating metabolism throughout the day and year.

Aaron N. Moen
November 9, 1981

JDAY = Julian Day

GLOSSARY OF SERIAL CODENS - CHAPTER THREE

SERIALS are identified by five-character, generally mnemonic codes called CODEN, listed in 1980 BIOSIS, LIST OF SERIALS (BioSciences Information Service, 2100 Arch Street, Philadelphia, PA 19103).

The headings for the lists of SERIALS are:

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

The volume and issue numbers (VO-NU) are given after the CODEN entry, followed by beginning page (BEPA), ending page (ENPA), species discussed (ANIM), KEY WORDS from the title, AUTHORS [truncated if necessary, slash (/) indicates additional authors], and year.

AJVRA American Journal of Veterinary Research (US)
AMNAA American Midland Naturalist (US)
AMNTA Amerrican Naturalist (US)
AMZOA American Zoologist (US)
ANBEA Animal Behaviour (England)
APANE* Applied Animal Ethology [*made up - there is no BIOSIS coden]
ARPHA Annual Review of Physiology
ATICA Arctic (Canada)
AVCSA Acta Veterinaria Scandinavica (Denmark)
AZOFA Annales Zoologici Fennici (Finland)
AZOSA Acta Zoologica (Sweden)
AZWBA Arizona Game and Fish Department Wildlife Bulletin (US)

BEHAA Behaviour (Netherlands)
BISNA BioScience
BJASA Bulletin of the New Jersey Academy of Science
BMAEA Montana Agricultural Experiment Station Bulletin
BMSIA Biomedical Sciences Instrumentation
BPURD Biological Papers of the University of Alaska Special Report
BUCDA Bulletin of the Georgia Academy of Sciences

CAFGA California Fish and Game (US)
CAFNA Canadian Field Naturalist (Canada)
CFGGA California Department of Fish and Game, Game Bulletin
CGFPA Colorado Division of Game, Fish, and Parks Special Report (US)
CJZOA Canadian Journal of Zoology (Canada)
CNSVA Conservationist
CWPNB Canadian Wildlife Service Progress Notes
CWRSB Canadian Wildlife Service Report and Management Bulletin Series
CWSPA Colorado Division of Wildlife Special Report

ECMOA Ecological Monographs (US)
ECOLA Ecology
EKIAA Ekologiya (USSR)

FUNAA Fauna (Oslo)
FUOFA Fauna och Flora (Stockholm)

IGWBA Idaho Department of Fish and Game Wildlife Bulletin
IJBMA International Journal of Biometeorology

JANSA Journal of Animal Science (US)
JAPEA Journal of Applied Ecology (England)
JASIA Journal of Agricultural Science (England)
JAURA Journal of Auditory Research
JBLPA Jelen
JCECD Journal of Chemical Ecology
JEVMA Journal of Environmental Management (England)
JOMAA Journal of Mammalogy (US)
JRMGA Journal of Range Management (US)
JRPFA Journal of Reproduction and Fertility (England)
JTBIA Journal of Theoretical Biology
JULRA Journal of Ultrastructure Research
JWMAA Journal of Wildlife Management (US)
JZOOA Journal of Zoology (London)

KPSUA Khimiya Prirodnykh Soedinii (Tashkent) (USSR)

LLOYA Lloydia

MAMLA Mammalia (France)
MDCBA Minnesota Department of Conservation Technical Bulletin
MDCRA Michigan Department of Conservation Game Division Report (US)
MMLRA Mammal Review (England)
MRLTA Murrelet, The
MUZPA Miscellaneous Publications, Museum of Zoology, University of Michigan

NAHIA Natural History (US)
NATUA Nature (England)
NAWTA North American Wildlife and Natural Resources Conference, Transactions of the, (US)
NCANA Naturaliste Canadien, Le
NEJZA Netherlands Journal of Zoology
NFGJA New York Fish and Game Journal (US)
NOSCA Northwest Science (US)
NPSMD United States National Park Service Scientific Monograph Series

NTCNB Nature Canada (Canada)
NYCOA New York State Conservationist
NZFSA New Zealand Journal of Forest Science
NZJSA New Zealand Journal of Science

OJSCA Ohio Journal of Science (US)

PCGFA Proceedings of the Southeastern Association of Game and Fish Commissioners (US)
PIAIA Proceedings of the Iowa Academy of Science (US)
PMACA Papers of the Michigan Academy of Sciences, Arts and Letters
PNASA Proceedings of the National Academy of Sciences of the United States
PPASA Proceedings of the Pennsylvania Academy of Science
PVPCB Proceedings of the Vertebrate Pest Conference
PZSLA Proceedings of the Zoological Society of London

QJFAA Quarterly Journal of the Floridal Academy of Science
QRBIA Quarterly Review of Biology
QSFRA Quebec Service de la Faune Rapport (Quebec Wildlifel Service Report)

RPHRA Recent Progress in Hormone Research
RWLBA Roosevelt Wildlife Bulletin

SCBUB Sierra Club Bulletin
SCIEA Science
SCZFA Schweizerische Zeitschrift fuer Forstwesen
SSBLA Sel'skokhozyaistvennaya Biologiya
STKMB Saeugetierkundliche Mitteilungen
SWNAA Southwestern Naturalist (US)
SYLVA Sylva
SZSLA Symposia of the Zoological Society of London (England)

TETRA Tetrahedron
TISAA Transactions of the Illinois State Academy of Science (US)
TJSCA Texas Journal of Science
TNWSD Transactions of the Northeast Section, The Wildlife Society

UABPA Biological Papers of the University of Alaska
UAXBA Utah Agricultural Experiment Station Bulletin
UCPZA University of California Publications in Zoology

VDZGA Verhandlungen der Deutschen Zoologischen Gesellschaft
VETRA Veterinary Record
VJSCA Virginia Journal of Science
VLUBB Vestnik Leningradskogo Universiteta Biologiya

WCDBA Wisconson Conservation Department Technical Bulletin
WGFBA Wyoming Game and Fish Commission Bulletin
WLMOA Wildlife Monographs
WLSBA Wildlife Society Bulletin
WMBAA Wildlife Management Bulletin (Ottawa) Series 1
WSCBA Wisconsin Conservation Bulletin

XAFNB U S Forest Service Research Note NC (US)
XFNCA U S Forest Service Research Paper NC (US)
XIWFA U S D A, Biological Survey, North American Fauna
XNFSA U S National Park Service Fauna of the National Parks of the United States, Fauna Series

ZEJAA Zeitschrift fuer Jagdwissenschaft
ZETIA Zeitschrift fuer Tierpsychologie
ZOBEA Zoologisch Beitraege
ZOGAA Zoologische Garten
ZOLZA Zoologicheskii Zhurnal (USSR)
ZOOAA Zoologica Africana
ZOOLA Zoologica (New York)
ZSAEA Zeitschrift fuer Saeugetierkunde

LIST OF PUBLISHERS - CHAPTER THREE

The headings for the lists of BOOKS are:

TYPE PUBL CITY PAGE ANIM KEY WORDS---------- AUTHORS/EDITORS-- YEAR

All essential information for finding each book in the library is given on just one line. The TYPE of book could have either AUTHORS (aubo) or EDITORS (edbo). Publishers (PUBL) and CITY of publication are given with four-letter mnemonic symbols defined below. The PAGE column gives the number of pages in the book; ANIM refers to the species discussed in the book (given as a four-letter abbreviation of genus and species), and KEY WORDS listed are from the title. The AUTHORS/EDITORS and YEAR of publication are given in the last two columns.

acpr	Academic Press	New York, NY	nyny
anth	Antheneum	New York, NY	nyny
apcc	Appleton-Century-Crofts	New York, NY	nyny
blai	Blaisdell	New York, NY	nyny
ccth	Charles C. Thomas	Springfield, IL	spil
cite	Cambridge Institute of Terrestrial Ecology	Oxford, England	oxen
cnha	Chapman & Hall	London, England	loen
dodo	Doubleday Doran	New York, NY	nyny
dohr	Dowden, Hutchinson, & Ross	Stroudsburg, PA	stpa
elpu	Elsevier Press	New York, NY	nyny
epdu	E. P. Dutton	New York, NY	nyny
fost	Forest and Stream Publishing Co.	New York, NY	nyny
hill	Hill	London, England	loen
iucn	International Union for the Conservation of Nature and Natural Resources	Morges, Switzerrland	mosw
jwis	John Wiley and Sons, Inc.	New York, NY	nyny

macm	MacMillan Co.	New York, NY	nyny
meth	Methuen & Co., Ltd.	London, England	loen
mhbc	McGraw-Hill Book Company, Inc.	New York, NY	nyny
olbo	Oliver & Boyd	Edinburgh, Scotland	edsc
oxup	Oxford University Press	London, England	loen
phli	Philosophical Library	New York, NY	nyny
plpc	Plenum Publishing Corporation	New York, NY	nyny
plpr	Plenum Press	New York, NY	
prha	Prentice-Hall, Inc.	Englewood Cliffs, NJ	ecnj
qupr	Queen's Printer	Ottawa, Ontario	oton
saco	Saunders Publishing Co.	Philadelphia, PA	phpa
stac	Stackpole Company, The	Harrisburg, PA	hapa
tapl	Taplinger	New York, NY	nyny
thcr	Thomas Crowell Co.	New York, NY	nyny
ucap	University of California Press	Berkely, CA	beca
uchp	University of Chicago Press	Chicago, IL	chil
unbp	University of Nebraska Press	Lincoln, NE	line
uopr	University of Oklahoma Press	Norman, OK	nook
uwyp	University of Wyoming Press	Laramie, WY	lawy
whfr	W. H. Freeman Company	San Francisco, CA	sfca
wimi	Wildlife Management Institute	Washington, DC	wadc
wiso	Wildlife Society, The	Washington, DC	wadc
wiwi	Williams and Wilkins	Baltimore, MD	bama

GLOSSARY OF ANIMAL CODE NAMES

Wild ruminants are referred to in this CHAPTER by a 4-character abbreviation from the family, genus and genus-species. These are listed below under Abbreviation.

Scientific names of North American wild ruminants are those used in BIG GAME OF NORTH AMERICA, edited by J.C. Schmidt and D. L. Gilbert (1979: Stackpole Books, Harrisburg, PA 17105, 494 p.), and may be different from the scientific names given in the original literature.

The abbreviations used for North American wild ruminants are listed below.

CLASS: MAMMALIA

ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: Odocoileus (deer)	od--
SPECIES: O. virginianus (white-tailed deer)	odvi
O. hemionus (mule deer)	odhe
GENUS: Cervus (Wapiti, elk)	ce--
SPECIES: C. elaphus	ceel
GENUS: Alces (moose)	
SPECIES: A. alces	alal
GENUS: Rangifer (caribou)	
SPECIES: R. tarandus	rata
FAMILY: ANTILOCAPRIDAE	
GENUS: Antilocapra	
SPECIES: A. americana (pronghorn)	anam
FAMILY: BOVIDAE	bovi
GENUS: Bison (bison)	bi--
SPECIES: B. bison	bibi
GENUS: Ovis (sheep)	ov--
SPECIES: O. canadensis (bighorn sheep)	ovca
O. dalli (Dall's sheep)	ovda
GENUS: Ovibos	
SPECIES: O. moschatus (muskox)	obmo
GENUS: Oreamnos	
SPECIES: O. americanus (mountain goat)	oram

The abbreviations used for European wild ruminants are listed below.

CLASS: MAMMALIA	
ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: Capreolus (roe deer)	ca--
SPECIES: C. capreolus	caca
GENUS: Dama (fallow deer)	da--
SPECIES: D. dama	dada
GENUS: Cervus (Wapiti, elk)	ce--
SPECIES: C. elaphus (red deer)	ceel
GENUS: Alces (moose)	
SPECIES: A. alces	alal
GENUS: Rangifer (caribou)	
SPECIES: R. tarandus	rata
FAMILY: BOVIDAE	
GENUS: Bison (bison)	
SPECIES: B. bonasus	bibo
GENUS: Capra (ibex, wild goat)	cp--
SPECIES: C. aegargrus(Persian ibex)	cpae
C. siberica (Siberian ibex)	cpsi

OTHERS

Abbreviations for a few other species and groups of species may appear in the reference lists. These are listed below.

Axis axis (axis deer)	axax
Elaphurus davidianus (Pere David's deer)	elda
Cervus nippon (Sika deer)	ceni
Hydropotes inermis (Chinese water deer)	hyin
Muntiacus reevesi (Chinese muntjac)	mure
Moschus moschifer (Chinese musk deer)	momo
Ammotragus lervia (Barbary sheep)	amle
Ovis nivicola (snow sheep)	ovni
Ovis musimon (moufflon)	ovmu
Ovis linnaeus (Iranian sheep)	ovli
Rupicapra rupicapra (chamois)	ruru
big game	biga
domestic sheep	dosh
domestic cattle	doca
domestic goat	dogo
domestic ruminant	doru
mammals	mamm
three or more species of wild ruminants	many
ruminants	rumi
ungulates	ungu
vertebrates	vert
wildlife	wldl
wild ruminant	wiru

JULIAN DAY: MONTH AND DAY EQUIVALENTS*

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	1
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	3
4	004	035	063	094	124	155	185	216	247	277	308	338	4
5	005	036	064	095	125	156	186	217	248	278	309	339	5
6	006	037	065	096	126	157	187	218	249	279	310	340	6
7	007	038	066	097	127	158	188	219	250	280	311	341	7
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	11
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029	[060]	088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

* For leap year, February 29 = JDAY 60. Add 1 to all subsequent JDAYs.

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THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS

CHAPTER FOUR

ACTIVITIES AND ACTIVITY PATTERNS

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CHAPTER 4. ACTIVITIES AND ACTIVITY PATTERNS

Wild ruminant activities may be divided into several categories. One category includes the basic postures of bedding and standing; an animal is either "up or down." Another category includes activities involving locomotion, such as walking, running, jumping, and climbing. Foraging and rumination are a third and very important category as free-ranging wild ruminants are responsible for their own feeding regime. Maintenance activities include such things as grooming, urinating and defecation. Social activities such as playing, fighting, and other activities may be considered as a fifth category.

Since animals are not gear-driven machines, there are gradients and combinations of the activities in these categories. Foraging, for example, involves both standing and walking. Standing often includes grooming, and at intervals during the day, urination and defecation. Playing and fighting involve locomotion, etc.

Routine participation in basic postures and locomotion are a major part of activity-time budgets. Activity patterns may be divided into two main groups--daily and seasonal. Predictable activity patterns over both 24-hour and 365-day periods are related to the light regime, including differences between light intensities through the day and changes in the length of daylight over seasons. Animals that are active during daylight hours are said to be diurnal, those active at night nocturnal, and those active at twilight crepuscular. Wild ruminants are often active at all these times, with differences between species and seasons of the year. It is important to recognize that length of daylight affects behavioral rhythms by causing changes in endocrine glands and hormone balances, linking the overall biochronology of a species to changes in environmental characteristics and range conditions through the year.

Activity-time budgets of wild ruminants often tend to be rather predictable, partly due to an historical environment that is genetically controlled, partly due to learned responses, and partly due to the physical environment, especially the light regime. Visual capabilities discussed in CHAPTER 3, UNIT 1.1, are genetically inherited, and are partial determinants of activity patterns as animals with large numbers of light-sensitive rods tend to be more nocturnal those with fewer rods and more cone cells. Learned responses also occur, however; groups that are disturbed more frequently during the day tend to become more active at night than groups living in more peaceful environs.

Time budgets over the annual cycle are important considerations, not only because of their interesting characteristics, but also because of their importance when evaluating seasonal rhythms in energy metabolism. Females, for example, charged with the responsibility of providing nutrients during the lactation period, spend more time foraging in the summer to meet the high cost of lactation than in the winter when metabolism is depressed.

Descriptions of activities and temporal activity patterns follow in TOPICS 1 and 2 respectively. WORKSHEETS for compiling activity budgets are included, and are used in PART III when estimating the metabolic costs of various activities.

REFERENCES, CHAPTER 4

ACTIVITIES AND ACTIVITY PATTERNS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	dodo	nyny	1220	----	v 3, lives of game animals	seton,et	1929
aubo	prha	ecnj	171	----	behavio aspects of ecology	klopfer,ph	1962
aubo	olbo	edsc	653	----	animal dispersion, soc beh	wynne-edwards,vc	1962
edbo	jwis	nyny	349	----	maternal behavr in mammals	rheingold,hl	1963
edbo	acpr	nyny	159	----	natural hist of aggression	carthy,jd; ebling	1964
edbo	uchp	chil	307	----	soc behav, organiza, verte	etkin,w	1964
aubo	meth	loen	150	----	soci behav, animals, verte	tinbergen,n	1965
aubo	macm	nyny	118	----	integral animal behavior	davis,d	1966
aubo	jwis	nyny	432	----	patterns animl communities	elton,cs	1966
aubo	mhbc	nyny	534	----	anim behav: ethol, com psy	hinde,ra	1966
aubo	jwis	nyny	771	----	mechanisms of animal behav	marler,p; hamilto	1966
aubo	prha	ecnj	297	----	introdu to animal behavior	klopfer,ph; hailm	1967
aubo	hill	loen	760	----	the chemical senses	moncrieff,rw	1967
edbo	saco	phpa	563	----	abnormal behavr in animals	fox,mw	1968
edbo	botc	loen	647	----	the behav of domestic anim	hafez,ese	1969
edbo	apcc	nyny	412	----	comm, chem sig: advan chem	johnston,jw,jr; /	1970
aubo	uchp	chil	349	----	animal behavior	scott,jp	1972
aubo	whfr	sfca	458	----	wildlife ecology	moen,an	1973
edbo	acpr	nyny	344	----	mamm olfact, reprod, behav	doty,rl	1976
edbo	wiwi	bama	532	----	behavior of domestic anima	hafez,ese	1976
edbo	plpc	nyny	609	----	chemical signals, vertebra	muller-schwarze,/	1977
edbo	jwis	nyny	364	----	quantitative ethology	colgon,pw	1978
aubo	mhbc	nyny	452	----	comparative anim behavior	devisbury,da	1978
edbo	dohr	stpa	369	----	evolution of play behavior	muller-schwarze,d	1978
edbo	wiso	wadc	206	----	animal behavior	teague,rd,ed; moe	1979
aubo	oxup	loen	688	----	animal play behavior	fagen,rm	1981
aubo	fost	nyny	426	cerv	antelope, deer, north amer	caton,jd	1877
edbo	stac	hapa	668	od--	deer of north america	taylor,wp	1956
edbo	nhfg	conh	256	odvi	the white-tailed deer, n h	siegler,hr	1968
edbo	sfes	nate	130	odvi	w-t,southern forest habita	halls,lk	1969
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
edbo	unbp	line	605	odhe	mule, black-tailed, no ame	wallmo,oc	1981
aubo	oxup	loen	215	ceel	herd, red dee, stud, behav	darling,ff	1937
aubo	ucap	beca	209	ceel	tule elk, hist, behav, eco	mccullough,dr	1971
aubo	cite	caen	74	ceel	ecology of red deer	mitchell,b; stai/	1977
edbo	wimi	wadc	....	ceel	ecology, mngmnt,n amer elk	thomas,jw; towei in pr	
aubo	uwyp	lawy	294	ceel	n amer elk: ecol,behav,mgt	boyce,ms; hayden-	1979
aubo	utop	toon	280	alal	north american moose	peterson,rl	1955

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	stac	hapa	225	anam	hunting pronghorn antelope	popowski,b	1959
aubo	aakn	nyny	339	bibi	the time of the buffalo	mchugh,t	1972
aubo	uchp	chil	383	ovca	mount sheep: behavi, evolu	geist,v	1971
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965
edbo	iucn	mosw	940	many	behav & its relatn to mgmt	geist,v; walther,	1974
edbo	stac	hapa	494	many	big game, n amer, ecol,mgt	schmidt,jl; gilbe	1978
aubo	acpr	nyny	202	ungu	reproductive behavior, ung	fraser,af	1968

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOBEA	12--2	219	250	cerv	ethologi obsrvatns, n amer	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MDCBA	5----	1	64	odvi	w-tailed deer of minnesota	erickson,ab; gunv	1961
MDCRA	14---	1	80	odvi	michigan white-tailed deer	jenkins,dh; bartl	1959
RWLBA	6---2	153	325	odvi	w-t deer of the adirondcks	townsend,mt; smit	933
RWLBA	6---2	327	385	odvi	wntr, spr obsrv, adirndcks	spiker,cj	1933
WCDBA	14---	1	282	odvi	white-tailed deer, wiscons	dahlberg,bl; guet	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZWBA	3----	1	109	odhe	in arizona chaparral	swank,wg	1958
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CFGGA	8----	1	163	odhe	life hist, managemt, calif	taber,rd; dasmann	1958
CGFPA	4----	1	39	odhe	lit review, movmnts,captur	siglin,rj	1965
CGFPA	7----	1	26	odhe	literature review on behav	dorrance,mj	1967
JOMAA	37--2	143	164	odhe	behavior, populatn ecology	dasmann,rf; taber	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
UCPZA	88---	1	209	ceel	tule elk: hist, behav, eco	mccullough,dr	1969
WLMOA	16---	1	49	ceel	status, ecol, roosevel elk	harper,ja; harn/	1967
WLMOA	24---	1	66	ceel	the sun river elk herd	knight,rr	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observ in yellowstone park	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavi in british columbia	geist,v	1963
FUNAA	8....	40	43	alal	moose habits and habitat	rush,wm	1946
JOMAA	39--1	128	139	alal	summr obsrvtns, behv,ontar	de vos,a	1958
MUZPA	25---	1	44	alal	the moose of isle royale	murie,a	1934
NCANA	101--	1	436	alal	ecol, proc inter sym, pt 1	bedard,j	1974
NCANA	101--	437	735	alal	ecol, proc inter sym, pt 2	bedard,j	1974
VLUBB	22-15	74	82	alal	[elk behav, leningr, russ]	timofeeva,ek	1967
ZOOLA	41-14	105	118	alal	ecol behav popula dynamics	denniston,rh	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BPURD	2----	1	215	rata	ecol, caribou, prudhoe bay	white,rg; thomso/	1975
CWRSB	38---	1	71	rata	biology, kaminuriak popula	dauphine,tc,jr	1976
UABPA	3----	1	44	rata	behav of barren-ground car	pruitt,wo	1960
UABPA	8----	1	82	rata	ecology, managment, sweden	skunke,f	1969
WMBAA	10A--	1	79	rata	prelim investigation, pt 1	banfield,awf	1954
WMBAA	10B--	1	112	rata	prelim investigation, pt 2	banfield,awf	1954
WMBAA	12---	1	148	rata	caribou, continued studies	kelsall,jp	1957
WMBAA	15---	1	145	rata	barrn gr carib, coop study	kelsall,jp	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	43--2	257	354	anam	life hist,ecol,rng use,tex	buechner,hk	1947
CAFGA	30--4	221	241	anam	prong-hornd antlp in calif	mclean,dd	1944

anam continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3---- 1		28	anam	litera revi on prong behav	prenzlow,ej	1965
CGFPA	17--- 1		16	anam	some behav patterns of the	prenzlow,ej; gil/	1968
JOMAA	3---- 82		105	anam	the prong-horn	skinner,mp	1922

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NPSMD	161-- 1		161	bibi	bison, yellowston nat park	meagher,mm	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	24--3	505	580	ov--	distribut, variat, no amer	cowan,imct	1940
AZWBA	1---- 1		153	ov--	desert bighorn	russo,jp	1956
WLMOA	4---- 1		174	ov--	united sta, past to future	buechner,hk	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of mountain sheep	mccann,lj	1956
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
CJZOA	46--5	899	904	ovca	ovda,delay soc, phys matur	geist,v	1968
IGWBA	1---- 1		154	ovca	stat, life hist, mgt, idah	smith,dr	1954
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	20--4	440	455	ovca	bighorn sheep of texas	davis,wb; taylor,	1939
JOMAA	24--1	1	11	ovca	notes on life histor, colo	spencer,cc	1943
SCBUB	35--6	29	76	ovca	survey, sierra nevada bigh	jones,fl	1950
WGFBA	1---- 1		127	ovca	wyoming bighorn study	honess,rf; frost,	1942
WLMOA	4---- 1		174	ovca	bighorn sheep in the u s	buechner,hk	1960
XNFSA	6---- 1		242	ovca	bighorn of death valley	welles,re; welles	1961

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5---- 1		238	ovda	the wolves of mt mckinley	murie,a	1944

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
WMBAA	9----	1	34	obmo	prelim stud,ellesmr is,nwt	tener,js	1954

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, mgtmt, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
SCZFA	113--	660	668	caca	[obs behav roe dee; germa]	eiberle,k	1962
ZEJAA	8---2	61	81	caca	behavior of roe bucks	hennig,r	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MRLTA	41--3	34	40	dogo	feral goats, british colum	geist,v	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
PZSLA	142-1	129	163	dosh	study, feral pop, st kilda	boyd,m; doney,jm/	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOGAA	33...	65	78	momo	behav of moschus moschifer	fradich,h	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JTBIA	2---1	63	68	----	environments of anim, plan	browning,to	1962
QRBIA	22---	283	314	----	life tabls, natrl pop anim	deevey,es	1947

OTHER PUBLICATIONS

Proceedings of the White-tailed Deer in the Southern Forest Habitat Symposium (First meeting in 1962)

Transactions of the Annual Meeting of the Northeast Deer Study Group (Annual meeting beginning 1964)

Proceedings of the North American Moose Conference (Fifth conference in 1968)

Proceedings of the International Reindeer/Caribou Symposium (First meeting in 1977, second in 1980)

Proceedings of the Biennial Antelope States Workshop

Transactions of the Interstate Antelope Conference

Transactions of the North American Wild Sheep Conference (Second meeting in 1976)

Transactions of the Desert Bighorn Council (Annual meeting beginning 1957)

Proceedings of the International Mountain Goat Symposium

Proceedings of the Annual Conference of Western Association of State Game & Fish Commissioners (Annual conference beginning 1921)

TOPIC 1. CATEGORIES OF ACTIVITIES

Bedding and standing are two basic postures assumed by wild ruminants. There are a large number of references to bedding habits but few that describe standing habits. Walking and running are activities which involve locomotion. There are various gaits and speeds which may be employed. Foraging is a special category by itself because of its importance as a life-support activity.

All individuals participate in most if not all of the activities in these three categories each day. They bed down and rest for part of each day, maintaining various levels of alertness while bedded. They stand for part of each day, sometimes loitering and sometimes alert. They often ruminate while bedding and standing. When they are not bedded or standing, they are moving about. Locomotion may be slow and intermittent as in foraging, slow and steady as in walking, or fast as in trotting, running or bounding.

Sometimes they play, especially the young, with considerable running and jumping. All of these behaviors require the expenditure of energy for muscle tone and for the movement of mass through distance, and descriptions of them are useful when quantifying energy expenditures.

Grooming, urination, and defecation may be considered as maintenance activities. They are necessary activities each day and are usually completed while the animal is standing. Social and other activities are introduced here and discussed further in CHAPTER 5. They involve interactions between individuals in a population or group within a population, such as an age group, herd, or harem. Social activities may involve activities as subtle as head posture or as obvious as playing and frolicking with total abandon.

The physical facts--what few there are--about these activities are discussed in the UNITS which follow. Basic postures--bedding and standing--are discussed in UNIT 1.1. Locomotion--walking and running--is discussed in UNIT 1.2. Foraging--which involves both standing and walking--is discussed in UNIT 1.3, maintenance activities in UNIT 1.4, and social and other activities in UNIT 1.5.

UNIT 1.1: BASIC POSTURES

Wild ruminants bed down and stand in place, without locomotion, at various levels of alertness. Bedding is an easily-recognized activity, and is relatively easy to quantify in terms of energy costs. Standing is not so easily quantified because it may be intermittent with foraging, walking, or running.

Bedded wild ruminants place their legs in different positions, with apparent thermoregulatory effects in some cases. In warm weather, the legs may be extended with the forelegs out in front, much like a dog. They may lie on their side with all four legs extended. Geist (1963) illustrates these postures for moose. In cold weather, the legs are usually tucked under the body, often very tightly. Slight differences in the spacing of the legs result in different amounts of contact by the underside of the body with the ground. The legs can function like "runners," adjustable for distance apart. Raising the body off the ground results in maximum reduction of heat loss to the snow. Further, vasoconstriction in the legs (very difficult to measure) may be employed, reducing temperature gradients between animal and substrate as uncompressed hair is a better insulator than compressed hair.

Bedding apparently involves physical comforts too. Deer sometimes paw the ground before lying down. Bighorn sheep usually scratch in the bed first (Geist 1971). McLean (1940) describes how a very large mule deer buck that was lying down under a juniper got up and pawed some small rocks out of the bed, repeating that three times before being satisfied to remain bedded. I have observed whitetails bedded down for hours, rise to stretch and turn, and bed down in the same bed again.

Bedding may be accompanied by various levels of alertness, and by rumination (see UNIT 1.3). Bedded animals may be quite alert, with head up, ears erect, and eyes wide open, or very unalert and appearing to sleep. Differences in levels of alertness also appear to exist among days; deer seem to be hyperalert on some days for reasons I cannot yet explain. This was discussed briefly in CHAPTER 3, TOPIC 1. There are seasonal differences in levels of alertness that seem to accompany the metabolic rhythms. Winter is a time of depressed metabolism (see PART III, CHAPTER 7) and the general level of alertness appears to be less at times than in the summer. Similar changes are evident in black bears, which do not hibernate, but become lethargic and conserve considerable energy by remaining inactive, depressing metabolism, and depressing rectal temperatures.

Deer often urinate and defecate in the bed when they get up. Sheep and goats do too, and since their beds are used repeatedly, nutrients are concentrated there and earlier and more lush plant growth occurs the following spring. The effect on plant growth is so obvious that bedding sites can be identified as green spots on the mountains for a couple of weeks in early spring (Geist 1971).

Wild ruminants sometimes stand in place, doing little or nothing while simply "loitering" (Townsend and Smith 1933). Loitering has little or no social significance, other than that the animals are relaxed and unaware of danger. Townsend and Smith observed that loitering usually occurred in a sunny area.

Bedding patterns are used in analyses of energy metabolism in PART III, CHAPTER 7 and thermal exchange in PART V, CHAPTER 16. The proportion of time spent in bedding is discussed in TOPIC 2 and used when calculating activity costs and thermal exchange in CHAPTER 7. Standing activities are used in analyses of energy metabolism in PART III, CHAPTER 7 and thermal exchange in PART V, CHAPTER 16. The proportion of time spent in standing is discussed in TOPIC 2 and used when calculating activity costs and thermal exchange in CHAPTER 7.

LITERATURE CITED

Geist, V. 1963. On the behaviour of the North American Moose (Alces alces andersoni Peterson 1950) in British Columbia. Behaviour 20(3/4):377-415.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

McLean, D. D. 1940. The deer of California, with particular reference to the Rocky Mountain mule deer. Calif. Fish Game 26(2):139-166.

Moen, A. N. 1963. A study of the winter bedding cover of the white-tailed deer in deciduous forest areas. M.S. Thesis, St. Cloud State College, Minnesota. 114 p.

Severinghaus, C. W. and E. L. Cheatum. 1956 . Life and times of the white-tailed deer. Pages 57-186 In W. P. Taylor, Ed., The Deer of North America. The Stackpole Company, Harrisburg, PA. 668 p.

Townsend, M. T., and M. W. Smith. 1933. The white-tailed deer of the Adirondacks. Roosevelt Wild Life Bulletin 6(12):153-325.

REFERENCES, UNIT 1.1

BASIC POSTURES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ECOLA	53--2	262	270	odvi	activ patt, fawns, s texas	jackson,rm; whit/	1972
JWMAA	27--3	422	427	odvi	nocturnl move, activ rhyth	montgomery,gg	1963
PCGFA	18---	140	152	odvi	telem, movem, behav, flori	jeter,lk; marchin	1964
RWLBA	6---2	153	325	odvi	w-t deer of the adirondcks	townsend,mt; smit	1933
TISAA	62--2	117	119	odvi	day location, beds, fawns	kjos,cg; montgome	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZWBA	3---	1	109	odhe	mule de, arizona chaparral	swank,wg	1958
CAFGA	20--3	181	282	odhe	life hist, food hab, calif	dixon,js	1934
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mcclean,dd	1940
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JWMAA	41--1	150	151	odhe	birth, first day behavior	truett,jc	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	9---4	295	319	ceel	roosvlt elk, olympic penin	schwartz,je,II; m	1945
JWMAA	15--4	396	410	ceel	biology of the elk calf	johnson,de	1951

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observ in yellowstone park	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
CAFNA	92--2	189	192	alal	late wintr bedding practic	mcnicol,jg; gilbe	1978
JWMAA	35--1	63	71	alal	telemetry, neast minnesota	vanballenberghe,/	1971
MSFFA	35---	95	100	alal	diurnal activity of moose	geist,v	1959
NCANA	95--5	1153	1157	alal	[number beds per day,wntr]	desmeules,p	1968
TLPBA	14--1	76	104	alal	time-energ budget of a moo	belovsky,ge; jord	1978

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
UABPA	3----	1	44	rata	behavior, barrn-gr caribou	pruitt,wo,jr	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	19--1	88	94	ovca	summer activity yellowston	davis,wb	1938
JWMAA	34--2	446	450	ovca	mvmnt,behav,smmr rang, wyo	woolf,a; oshea,t/	1970

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
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966

OTHER PUBLICATIONS

Skinner, M. P. 1924. The American Antelope in Yellowstone National Park. Roosevelt Wildl. Forest Expt. Sta., Syracuse, N.Y. 32 p.

CHAPTER 4, Worksheet 1.1a

Activity-times in the two basic postures

Descriptions of activity-times in the literature are often short on detail. The minimum detail necessary to begin analyses of activity patterns is the determination of times "up and down." Evaluate references describing activities of wild ruminants by recording data in the columns below. If information is given for different levels of activity or locomotion, use WORKSHEET 1.2a rather than this one.

GESP	JDAY	Time up	Time down	Reference

GESP	JDAY	Time up	Time down	Reference

UNIT 1.2: LOCOMOTION

Locomotion includes walking, running, jumping, and climbing. These whole-body movements occur at different rates of speeds, with changes in speed affecting the gait used. Gaits and ways in which they are used are also characteristic of the species.

Walking is an activity of wild ruminants that is part of daily maintenance. Walking is defined as movement occurring when at least two of the feet are on the ground at the same time, whereas running results when one, two or three feet are on the ground at the same time, except when bounding. Running occurs in several different ways. A "trotting" gait may be used when an animal is moving away but not at top speed. Caribou, elk, and moose move very gracefully in this way. It is a fluid gait, similar to that of trotting horses. High speeds are attained by various methods. White-tailed deer bound for several meters, with their feet touching the ground in sequence rather than simultaneously. Mule deer also bound for several meters too, but their feet land simultaneously and the next bound is made as all four legs spring together, like domestic sheep do. The differences between bounding white-tails and mule deer are striking when observed in the field.

Wild ruminants have structural characteristics and skills for movement suitable for the places in which they live. Wild sheep and mountain goats, which live in rugged topographies, have particularly good agility and senses of balance that enable them to move well over steep gradients, and hooves that are well-designed for gripping rugged rocky topography. Geist (1971) calls mountain goats "methodical climbers" who rarely jump or run.

Caribou have large hooves (see Thing 1977 and additional references listed in PART I, CHAPTER 1, UNIT 2.1) compared to those of other ruminants of similar body size, providing some advantages in moving through snow and less tendency to sink on wind-packed snow.

Walking and running speeds are not well-known for wild ruminants, even though measurements of speeds are very simple in the field. Those of us that spend considerable time in the field should take advantage of opportunities to measure speeds when we see animals walking or running between identifiable points in the field. A stopwatch is all that's needed to measure the time spent moving between points, followed by measurement of distances between points. Speed may be calculated by:

$$\text{speed} = \text{distance}/\text{time}$$

Boertje (1981) used 3.22 km per hr as the average walking speed of caribou based on data for reindeer in Norway. The speed of walking is an important parameter because energy expenditure was a direct linear function of the speed of elk (Robbins et al. 1979).

Loose snow presents a barrier to walking. Increasing depths cause the animals to lift their legs higher (see PART I, CHAPTER 1, UNIT 2.2). In

deep snow, white-tailed deer bound, as do bighorn sheep, but mountain goats plow through it at a walk (Geist 1971). All species will struggle and bound when mired in deep snow, but this very costly activity can continue for a limited time only.

I observed an interesting pattern of white-tailed deer movement through snow in northern Minnesota after fresh snow had accumulated to about 45 cm. A doe and fawn had crossed a plowed road, leaving easily-identified hoof prints. As they entered the woods, the doe continued to walk, dragging her hooves, but the fawn was forced to bound as the 45 cm snow depth was too great to walk through. Thus two deer moved through the same snow but at greatly different activity costs. The social tie was costly to the smaller deer.

Running by wild ruminants is usually thought of as escape behavior. Gaits vary, from a steady trot to long leaps and bounds. Leaps, bounds, and jumps of some wild ruminants can be rather impressive. Leaps of 16 feet (4.9 m) or more are reported for black-tailed deer by Cowan (1956). I have measured leaps of 24 feet (7.4 m) for white-tailed deer. Severinghaus and Cheatum (1956) report running broad jumbs by whitetails of 29 feet (8.9 m) over a 7.5 foot high (2.3 m) windfall, and vertical jumps of 8.5 feet (2.6 m). A bighorn ram in captivity cleared 7.5 feet (2.3 m) (Geist 1971).

How fast can wild ruminants run? Actual measurements are few under natural conditions. Boertje (1981) used Thomson's average trotting/galloping speed of 12 km/hr (7.5 mph) for reindeer in Norway. Wild bison in Wood Buffalo National Park attained a top speed of 56 km/hr (35 mph) (Fuller 1960). Black-tailed deer have been clocked at 14.9 km/hr (24 mph) (Cowan 1956). Murie (1951) cites Cowan (1947) as stating that elk were clocked at speeds up to 45-46 km/hr (28-29 mph).

I observed an interesting chase across a field in western Minnesota some years ago. Two deer, appearing to be a doe and fawn , came over a hill very close to me at high speed. When they came to a 3-strand barbed wire fence bordering a field and adjacent wildlife management area, the doe easily leaped over but the fawn scooted under the lowest strand without breaking stride. A few hairs were found on the wire, and the wire was only 20 inches (51 cm) off the ground! A dog followed in futile pursuit, for the snow barely covered the ground and escape was easy.

LITERATURE CITED

Boertje, R. D. 1981. Nutritional ecology of the Denali caribou herd. M.S. Thesis, University of Alaska, Fairbanks. 194 p.

Cowan, I. M. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Canadian J. Research, D 25:139-174. National Research Council of Canada.

Cowan, I. M. 1956. The black-tailed Deer. Pages 521-617 In W. P. Taylor, Ed., The Deer of North America. The Stackpole Company, Harrisburg, PA. 668 p.

Fuller, W. A. 1960. Behavior and social organization of the wild bison of Wood Buffalo National Park, Canada. Arctic. 13(3-19).

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

Murie, O. J. 1951. The Elk of North America. The Stackpole Company, Harrisburg, Pa. 376 p.

Robbins, C. T., Y. Cohen, and B. B. Davitt. 1979. Energy expenditure by elk calves. J. Wildl. Manage. 43(2):445-453.

Severinghaus, C. W. and E. L. Cheatum. 1956. Life and times of the white-tailed deer. Pages 57-186 In W. P. Taylor, Ed., The Deer of North America. The Stackpole Company, Harrisburg, PA. 668 p.

Thing, H. 1977. Behavior, mechanics, and energetics associated with winter cratering by caribou in northwestern Alaska. Biological Papers of the University of Alaska No. 18. 41 p.

REFERENCES, UNIT 1.3

LOCOMOTION

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	stac	hapa	225	anam	hunting pronghorn antelope	popowski,b	1959

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ECOLA	53--2	262	270	odvi	activ patt, fawns, s texas	jackson,rm; whit/	1972
FEPRA	33--2	250	250	odvi	thyroxin lev, seasn, matur	byrne,jj; reinek/	1974
JWMAA	27--3	422	427	odvi	nocturnl mvmnt,activ rhyth	montgomery,gg	1963
PCGFA	18---	140	152	odvi	telem, movem, behav, flori	jeter,lk; marchin	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	15--4	396	410	ceel	biology of the elk calf	johnson,de	1951
JWMAA	43--2	445	453	ceel	energy expenditure, calves	robbins,ct; cohe/	1960
ZOOLA	41--8	65	71	ceel	pattrns,hrd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	393	399	alal	observ in yellowstone park	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavior, north america	geist,v	1963
JWMAA	35--1	63	71	alal	radiotelemetry, ne minneso	van ballenberghe/	1971
TLPBA	14--1	76	104	alal	time-energ budget of a moo	belovsky,ge; jord	1978
ZOOLA	41-14	105	118	alal	ecol,behav,pop dynam,wyomi	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
UABPA	3----	1	44	rata	behavior, barre gr caribou	pruitt,wo,jr	1960
UABPA	18---	1	41	rata	behv, mechn, ener, cratrng	thing,h	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JWMAA	31--2	347	351	anam	innovatns, trappng, hndlng	spillett,jj; zobe	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATICA	13--1	3	19	bibi	behav, socl organiz, canad	fuller,wa	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	34--2	446	450	ovca	mvmnt, behav,smmr rang,wyo	woolf,a; oshea,t/	1970

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
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JRMGA	19--4	200	204	doca	use of mountain slope	cook,cw	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	41--1	112	112	mamm	locmtr speeds large nrthrn	pruitt,wo	1960

CHAPTER 4, Worksheet 1.2a

Locomotor activities of wild ruminants

Tabulate the following information as activity-times from references in the literature.

GESP	JDAY	Time bedded	Time active	Activity	Reference

GESP	JDAY	Time bedded	Time active	Activity	Reference

UNIT 1.3: FORAGING AND RUMINATION

Wild ruminants spend much of their active time foraging for food. They are usually very selective as they forage, choosing not only the kinds of plants but also the parts of plants to ingest. This is different from domestic ruminants which graze much less selectively, especially early in the grazing season. Later in the season, cattle avoid coarse stems and unpalatable forbs.

Bedded animals ruminate, or "chew their cud." This may occur during a large proportion of the time spent bedded. A deer observed by McLean chewed its cud an average of 33 chews to a cud (R = 29-37). Rumination patterns are discussed in PART III, CHAPTER 6, UNIT 1.1.

Wild ruminants alter their foraging behavior in response to range conditions. In early spring when small areas of new plant growth appear between snow patches, the animals actively seek the green succulent forage. This preferred forage is present in small quantities early in the growing season. Later, when there is an abundance of new growth, foraging periods are interrupted with periods of loitering and other non-foraging behavior.

Wild ruminants are usually quite alert when foraging, looking about frequently. When there are several in a group, they collectively provide almost continuous coverage of the surrounding area. Their alertness varies between days, conditions, age, sex, reproductive status, and other factors. The learned experiences of individuals are also important. If snowmobiles have been associated with a supply of artificial feed, then deer will be attracted to their noise. Chain saws used in felling trees have a similar effect as the tops of the trees become good sources of forage.

Bison in South Dakota learned to associate the sounding of a truck horn with their daily supply of hay in the winter, and I have observed them running from the surrounding hills to mill around the hay truck as the bales were dropped to the ground. Such artificial feeding was used as a management practice, keeping the bison in selected areas when there was snow on the ground. If they were not fed, they would tend to range more widely in search of snowless areas to forage in. Bison were quite migratory before settlers began using the land for farming and ranching, moving seasonally in relation to range conditions. Meagher (1973) indicates that in mild to average winters in Yellowstone, snow depths did not limit forage availability. They cleared snow up to 2.5 feet deep by swinging their heads in a sideways motion.

Foraging speeds are quite variable, depending on forage density, the time spent searching in relation to the time spent standing and eating. Boertje (1981) estimated the grazing speed of caribou to be 0.13 ± 0.08 km per hour.

Caribou are well-known for "cratering," or digging through the snow to feed on lichens. Removal of snow from an area about 0.50 meters in diameter to depths of 0.20 meters requires some effort. The energy cost of cratering

has been etimated by Thing (1977) who concluded that energy expenditure of free grazing during the early winter seems to be about the same as in the summer (229 kcal per hour of foraging). It does not seem right that the cost of grazing with snow present, resulting in 90 craters per day, should be no more than the cost of grazing in the summer. Since summer, early winter, and late winter costs were all estimated by calculations, it may be that the summer estimate was high, or that the early winter estimates were low. In late winter, when snow density was 0.32 gm cm^{-3}, cratering was estimated to cost 287 kcal per hour of foraging.

Wild ruminants on browse diets rise up on their hind legs to reach browse that is much higher (see CHAPTER 1, UNIT 2.2) than can be reached when standing on all four. This brings up an important point when defining the environment of an animal. The animal determines its environment by its abilities to relate to habitat components. If an animal stands on its hind legs to reach forage, its forage supply is enlarged accordingly.

Standing up on the hind legs is a learned behavior that can be used to advantage. It is an example of a behavioral act that is ultimately limited by physical capabilities and genetic characteristics in relation to current conditions. If the forage is so depleted that animals must reach for it, however, the range is overbrowsed.

A thick crust of snow and ice elevates the animals to a new height level. Crust conditions cannot be counted on, however, and the forage that is out of reach when standing at ground level should not be considered part of the forage supply. It is better to be conservative when evaluating the importance of these temporary advantages. Spiker (1933; 368) recognized the danger of a snow crust for white-tailed deer, pointing out that "The snow crust, however, is seldom thick enough to be generally dependable, and a deer in hasty flight may break through with possible injury to its legs."

LITERATURE CITED

Boertje, R. D. 1981. Nutritional ecology of the Denali caribou herd. M.S. Thesis, University of Alaska, Fairbanks. 194 p.

Meagher, M. M. 1973. The Bison of Yellowstone National Park. National Park Service, Scientific Monograph Series, Number 1. 161 p.

McLean, D. D. 1940. The deer of California, with particular referrence to the Rocky Mountain mule deer. Calif. Fish Game 26(2):139-166.

Spiker, C. J. 1933. Some late winter and early spring observations on the white-tailed deer of the Adirondacks. Roosevelt Wildl. Bull. 6(2): 327-385.

Thing, H. 1977. Behavior, mechanics, and energetics associated with winter cratering by caribou in northwestern Alaska. Biol. Pap. Univ. Alaska No. 18. 41 p.

REFERENCES, UNIT 1.3

FORAGING

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	27--3	422	427	odvi	nocturnl mvmnt, actv rhyth	montgomery,gg	1963
JWMAA	34--2	431	439	odvi	wint feeding pattr, penned	ozoga,jj; verme,l	1970
PCGFA	18---	140	152	odvi	telem, movem, behav, flori	jeter,lk; marchin	1964
RWLBA	6---2	327	385	odvi	wntr, sprng obsrv, adirndk	spiker,cj	1933
TISAA	62--2	117	119	odvi	day location, beds, fawns	kjos,cg; montgome	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZWBA	3---	1	109	odhe	mule de, arizona chaparral	swank,wg	1958
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
ECMOA	15--2	109	139	odhe	ecol relns food, coast, bc	cowan,imt	1945
JOMAA	38--2	247	253	odhe	observatns, behavr, penned	browman,lg; hudso	1957
JWMAA	34--4	852	862	odhe	response kaibab deer,manag	hungerford,cr	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	74--3	294	309	ceel	social rank & food access	appleby,mc	1980
JWMAA	9---4	295	319	ceel	roosvlt elk, olympic penin	schwartz,je,II; m	1945
JWMAA	15--4	396	410	ceel	biology of the elk calf	johnson,de	1951
ZOOLA	41--8	65	71	ceel	pattrns,brd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observv in yellowstone prk	mcmillan,jf	1954
AMNAA	96--1	229	232	alal	clf learn eat by fllw mthr	edwards,j	1976
BEHAA	20--3	377	416	alal	behavior, north america	geist,v	1963
CAFNA	83--4	339	343	alal	observ, feeding on aquatic	ritcey,rw; verbee	1969
CAFNA	90--4	475	476	alal	behavior, calf, ontario	croskery,p	1976
CAFNA	92--3	252	258	alal	summer movements, feeding	joyal,r; scherrer	1978
ECOLA	34--1	102	110	alal	feeding habits, yellowston	mcmillan,jf	1953
IUNRA	24...	690	....	alal	social organization	geist,v,ed; houst	1974
JWMAA	35--1	63	71	alal	radiotelemet, ne minnesota	vanballenberghe,/	1971
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
TLPBA	14--1	76	104	alal	time-energ budget of a moo	belovsky,ge; jord	1978
VLUBB	22-15	74	82	alal	[elk behav, leningr, russ]	timofeeva,ek	1967
ZOOLA	41-14	105	118	alal	ecol,behav,pop dynam,wyomi	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NPOAA	1974-	129	138	rata	mnth patt, feed intk, rein	nyholm,es	1976
UABPA	3----	1	44	rata	behavior, barren gr caribo	pruitt,wo,jr	1960
UABPA	18---	1	41	rata	behv,mechan, enrg, cratrng	thing,h	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JAPEA	12--2	411	420	anam	doca, compar foragng behav	ellis,je; travis,	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NPSMD	1----	1	161	bibi	bison, yellowstone nat prk	meagher,mm	1973
PIAIA	76---	245	262	bibi	bull behavior traits	herrig,dm; hauge	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	19--1	88	94	ovca	summer activity, yellowstn	davis,wb	1938
JWMAA	34--2	446	450	ovca	mvmnt, beha, smmr rang,wyo	woolf,a; oshea,t/	1970

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	40--1	151	162	obmo	rata, sum rang reltns, nwt	wilkinson,pf; sh/	1976
PASCC	21---	122	122	obmo	rata, snow cover, foraging	lent,pc; knutson,	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	37--3	353	362	oram	forage, habit pref, alaska	hjeljord,o	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JRMGA	19--4	200	204	doca	use of mountain slope	cook,cw	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CJZOA	53--4	378	384	ungl	activ pat at mineral licks	carbyn,ln	1975

CHAPTER 4, Worksheet 1.3a

Foraging times of wild ruminants

References containing information on the five major activities--bedding, standing, walking, foraging, and running--may be tabulated here.

GESP	JDAY	BDNG	STNG	WKNG	FGNG	RNNG	References

GESP	JDAY	BDNG	STNG	WKNG	FGNG	RNNG	References

CHAPTER 4, Worksheet 1.3b

Equations representing activity patterns through the year

The tabular data in the previous WORKSHEET should be evaluated for possible representation with equations as discussed in Moen (1978). Derive the equations and complete the numerical statements below for the fraction of each day spent in the five different activities.

FTBD =

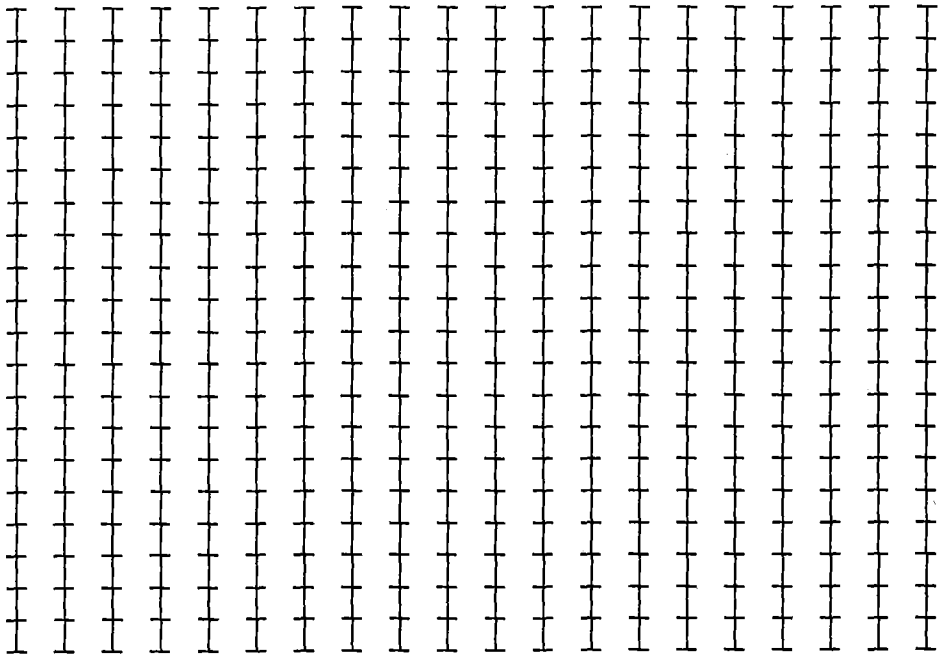
FTSD =

FTWD =

FTFD =

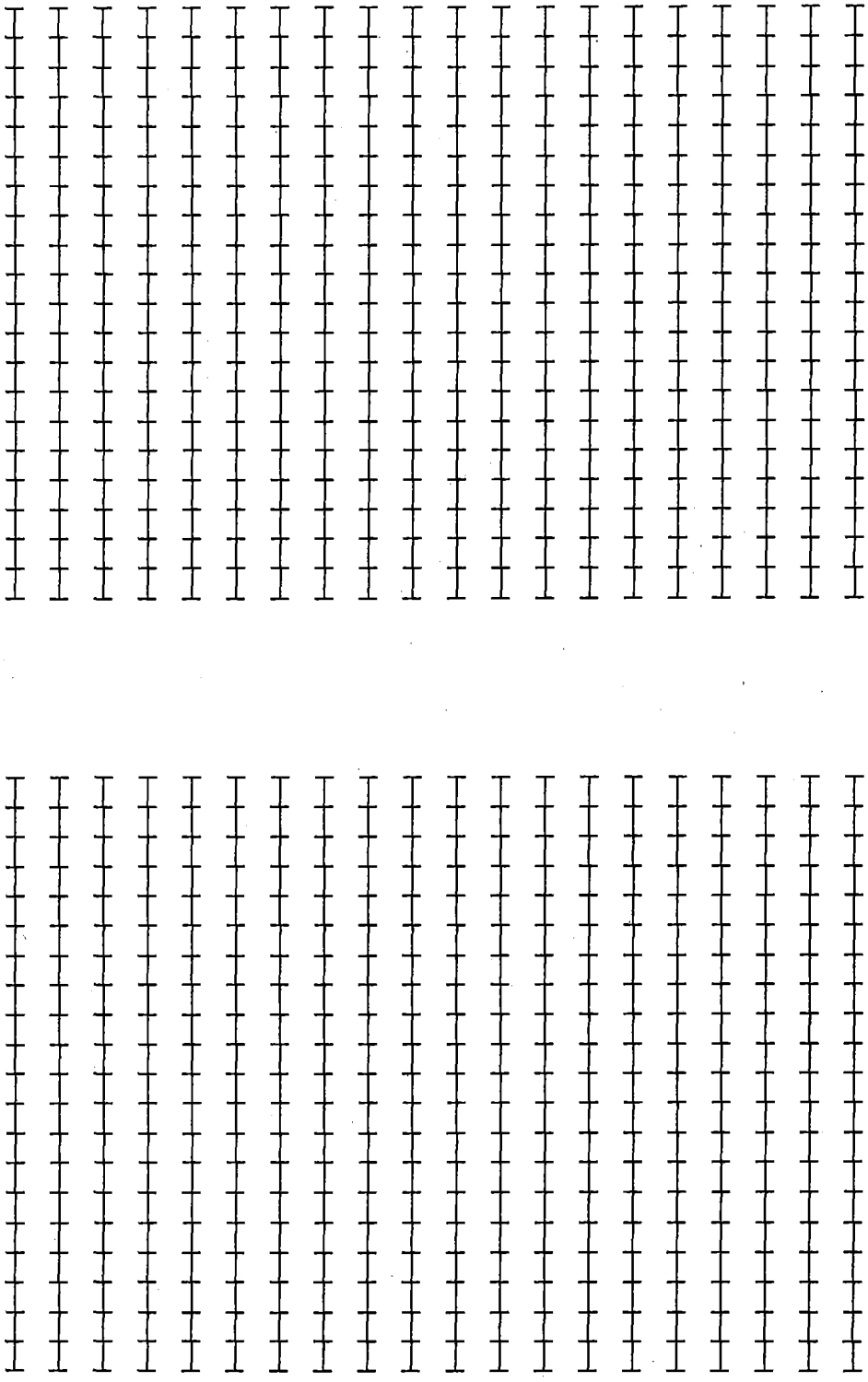
FTRD =

Plot the patterns below. Additional grids are on the next page.



Literature Cited

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 42(4):715-738.



UNIT 1.4: MAINTENANCE ACTIVITIES

Grooming, urinating, and defecating are part of daily body maintenance. Grooming often occurs when animals rise leisurely fter a bedding period. Various parts of the body may be licked. Sometimes posts or trees are used for rubbing, which may be part of grooming. Other "comfort movements" may also be considered a part of grooming and maintenance behavior. An animal may arise from its bed, stretch, yawn, shake, urinate, defecate, lick parts of its body, and scratch or rub itself or on another object.

Geist (1963) noted that rubbing of the velvet-covered antlers was the most commonly seen comfort movement among bulls in spring and summer. They usually rubbed the antler tips on a raised hind leg rather than on a hard object such as a dead branch. One can logically surmise that the growing antlers "itch" because the use of a hind leg as a rubbing post stops after the velvet has been shed. The use of a hind leg as a rubbing post allows the moose to have more control over the pressure exerted than if it were rubbing on a foreign object such as a branch. This is important in order to avoid damage to the antlers.

Urinating and defecating are maintenance activities that may occur at any time, but usually occur at the beginning or end of an activity period in moose (Geist 1963) and in other wild ruminants too.

Urination and defecation postures in moose are described by Geist (1963). He noted that the urination posture is very rigid, and is dominant over feeding and walking. Defecation may occur while feeding or walking, an observation on moose that also applies to white-tailed deer from my observations. Geist observed that moose may urinate on their hind legs when alarmed, but did not observe rub-urinating as reported by Müller-Schwarze (1971) for black-tailed deer and my observations of white-tailed deer.

Urinations also occur in scrapes, wallows, and rutting pits. Geist (1963) reports this for moose and Severinghaus and Cheatum (1956) for white-tailed deer. This is discussed further in UNIT 1.5.

LITERATURE CITED

Geist, V. 1963. On the behaviour of the North American Moose (Alces alces andersoni Peterson 1950) in British Columbia. Behaviour 20(3/4):377-415.

Müller-Schwarze, D. 1971. Pheromones in black-tailed deer (Odocoileus hemionus columbianus). Animal Behaviour 19(1):141-152.

Severinghaus, C. W. and E. L. Cheatum. 1956. The white-tailed deer. Pages 57-186 In The Deer of North America, W. P. Taylor, Ed. The Stackpole Co., Harrisburg, PA. 668 p.

REFERENCES, UNIT 1.4

MAINTENANCE ACTIVITIES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953

SERIALS

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	19--1	141	152	odhe	pheromones in black-t deer	muller-schwarze,d	1971
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
ECMOA	15...	109	139	odhe	ecol relns food, coast, bc	cowan,imt	1945
JOMAA	38--2	247	253	odhe	observatns, behavr, penned	browman,lg; hudso	1957

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--3	392	399	alal	some obsrvatns, yellowston	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
ZOBEA	12--2	219	250	alal	ethologcl obsrvtns, n amer	geist,v	1966

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	43--2	257	354	anam	lif hstry,ecol,rng use,tex	buechner,hk	1950
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow;ej gil/	1968

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	19--1	88	94	ovca	summer activity yellowston	davis,wb	1938

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
ZETIA	43--2	188	213	mure	socl behav captiv muntjacs	barrette,c	1977

UNIT 1.5: SOCIAL AND OTHER ACTIVITIES

Social activities of wild ruminants include playing, which is age and time-of-year dependent, fighting, reproductive activities, which are sex, age and time-of-year dependent (discussed in CHAPTER 5, TOPIC 1), and various levels of gregariousness that are species and time-of-year dependent.

Play, or "ludic behavior" (Berlyne 1960), is interesting behavior to observe because it seems to be so enjoyed by the participants. Play is not a matter of immediate life or death, but is a voluntary activity that seems to have "enjoyment" as its main purpose. It is more common for the young of a species to play than for the adults, but play behavior may occur in all ages.

What is the significance of play? Since play behavior incorporates actions used in later life when developing social rankings and escape from predators, it is important for developing action and reaction programs (Geist 1971) to be stored in their memories. Another potentially significant importance of play is given by Geist concerning the need to put stress on bones for proper growth. Thus animals which exercise frequently should have a more optimally functioning skeleton. He noted a surprisingly high frequency of broken legs among Banff bighorns, and ". . . a low quality population with somewhat listless lambs . . ." Muller-Schwarze (1978) concluded that play is related to a general readiness to be active. Individuals with less than adequate energy intakes would be expected to play less then, an hypothesis that seems to be borne out by field observations.

Play behavior of white-tailed deer includes running, jumping, chasing, playful fighting, and other interactions that appear to be done for the sheer joy of doing them. Fawns will play until panting for breath, and sometimes stimulate adults to play too. I have observed adult deer playing in the shallow water of a lake on a hot summer day, running and splashing in the water like children. Similar accounts of playing both on land and water are given by Severinghaus and Cheatum (1956).

Geist (1971) notes such activities as running, frolicking, bounding into the air, turning about, etc. as part of the play behavior of wild sheep. Lambs begin playing within a few hours after birth. Adult sheep rarely play, and ewes play less than rams. Play was more common on cool than hot summer days, and rare in winter.

There is a near elimination of play behavior in the winter by white-tailed deer (Moen 1978). Such a response appears to be part of the energy conservation adaptation employed in the winter. Snow conditions can markedly increase energy expenditures; a reduction in activity and avoidance of high-cost behavior acts is logical. Play seems to be the first activity to go, and running is done only when necessary to escape predators or other harrassments.

Play, then, appears to be common among juveniles, less common among adults, and very rare in the winter.

LITERATURE CITED

Berlyne, D. E. 1960. Conflict, Arousal and Curiosity. McGraw Hill Book Co., New York. 350 p.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 683 p.

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 42(4):715-738.

Muller-Schwarze, D. 1978. Play deprivation in deer. Pages 287-305 In Evolution of Play Behavior. D. Muller-Schwarze, Ed. Dowden, Hutchinson, and Row, Inc., Stroudsberg, PA. 396 p.

Severinghaus, C. W. and E. L. Cheatum. 1956. Life and times of the white-tailed deer. Pages 57-186 In W. P. Taylor, ed. The Deer of North America. The Stackpole Company, Harrisburgh, Pa. 668 p.

REFERENCES, UNIT 1.5

SOCIAL AND OTHER ACTIVITIES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
edbo	dohr	stpa	369	----	evolution of play behavior	muller-schwarze,d	1978
aubo	oxup	oxen	688	----	animal play behavior	fagen,rm	1981

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	31--2	144	162	cerv	play deprivation in deer	muller-schwarze,d	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	31--2	144	162	od--	play deprivation in deer	muller-shwarze,d	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	80--5	534	537	odvi	playing by w-t deer, s tex	michael,ed	1968
ECOLA	53--2	262	270	odvi	activ patt, fawns, s texas	jackson,rm; whit/	1972
JWMAA	27--3	422	427	odvi	nocturnl mvmnt, actv rhyth	montgomery,gg	1963
JWMAA	42--4	715	738	odvi	seas chang,hrt rt,actv,mtb	moen,an	1978
PCGFA	18---	140	152	odvi	telem, movem, behav, flori	jeter,lk; marchin	1964
SCIEA	215--	85	87	odvi	play beh,food shortg,fawns	muller-schwarze,/	1982
TISAA	62--2	117	119	odvi	day location, beds, fawns	kjos,cg; montgome	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BZOBA	20--1	282	289	odhe	[play behav, gen activity]	muller-schwarze,/	1969
CAFNA	89--2	149	156	odhe	play activities, nw oregon	miller,fl	1975
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JOMAA	37--2	143	164	odhe	behav,w/ ref to popul ecol	dasmann,rf; taber	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNTA	111--	395	414	ceel	age-depend sched, play beh	fagen,r	1977
ANBEA	28--4	1290	1290	ceel	ontog play beh, bimodl age	fagen,rm	1980
JWMAA	15--4	396	410	ceel	biology of the elk calf	johnson,de	1951
ZOOLA	41--8	65	71	ceel	pattrns,hrd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observ in yellowstone park	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
CAFNA	87--3	321	321	alal	associatn of calf and bull	lynch,gm; labonte	1973
CAFNA	90--4	475	476	alal	behavior, calf, ontario	croskery,p	1976
JWMAA	35--1	63	71	alal	radiotelemet, ne minnesota	van ballenberghe/	1971
NCANA	101--	325	369	alal	mother infant relations in	stringham,sf	1974
NCANA	101--	371	377	alal	behv chng, age, domesticat	knorre,ep	1974
TLPBA	14--1	76	104	alal	time-energ budget of a moo	belovsky,ge; jord	1978
ZOOLA	41-14	105	118	alal	ecol,behav, pop dynam wyom	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	31--1	150	159	rata	results, tagging, manitoba	miller,dr; robert	1967
UABPA	3----	1	44	rata	behavior, bar grou caribou	pruitt,wo,jr	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
PIAIA	76---	245	262	bibi	bull behavior traits	herrng,dm; hauge	1969
ZETIA	30--4	416	419	bibi	rel, dominance, play behav	lumia,ar	1972

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	34--2	446	450	ovca	mvmnt,beh,summer rang,wyom	woolf,a; oshea,t/	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

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
ZSAEA	33--2	116	121	bibo	[wisent, willingn to play]	mohr,e	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BVJOA	110..	46	68	doca	play, analysis, britain	brownlee,a	1954
JRMGA	19--4	200	204	doca	use of mountain slope	cook,cw	1966

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

ANBEA 26--3 678 684 dosh sex diff,dev chng, juv act sachs,bd; harris, 1978

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

AMNTA 79--- 523 541 ---- currnt concepts, anim play beach,fa 1945

TOPIC 2. ACTIVITY LOCATIONS AND TIMES

Locations and times of activities of free-ranging animals are rather predictable on both a daily and seasonal basis. Locations are dependent on food, cover, and weather. Activity times are related to current weather conditions and to the light regime. Seasonal patterns of activity times are related to the physiological condition of the animals, which is dependent on hormone balances and range conditions. References to hormones may be found in PART I, CHAPTER 2, UNIT 1.7, and to range conditions, including such things as the distribution and abundance of food resources, weather conditions that affect the ease of movement and forage availability, and energy exchange in different cover types in PARTS IV and V.

Activity occurs only as a result of physiological processes; metabolism must occur before an animal can do anything. This being true, it must be recognized that all activities have associated metabolic costs, and the total cost of living, or ecological metabolism, is related to the amounts and kinds of activities considered in this CHAPTER 4, and to the maintenance and production costs considered in CHAPTER 7.

Activity patterns, both daily and seasonal, may be detected when animals are studied through their daily and seasonal cycles. The use of radio telemetry in the past 20 years has made regular and sometimes continuous locations possible, contributing to our knowledge of the behavior of elusive, secretive, and often nocturnal animals.

Activity levels are often but not always related to vital signs which may also be telemetered from free-ranging animals. When an animal is in a rest period during the daily cycle, heart and respiration rates are reduced. They are also reduced in the winter, a long-term "rest-period." Data on vital signs may be used to interpret activity levels, but heart rate measurements at the Wildlife Ecology Laboratory have also shown marked variations due to transient stimuli. Heart rates alone are not always good indicators of the level of physical activity.

Daily and seasonal activity patterns are discussed and quantified in the next two UNITS. It is difficult to determine activity-time patterns with a high level of precision because different activities are not always easy to quantify. Walking, for example, is an activity, and so is foraging. Animals walk intermittently while foraging, however, and judgement is necessary when determining the amount of time actually spent walking and the amount spent foraging. Guidelines for recording activity times are necessary, such as stating that walking between "bites" is a part of foraging, but directed walking from one spot to another, with no attempt to forage along the way, is defined as walking. Deviations from the expected patterns occur in response to transient stimuli. Anyone who has tried to quantify time budgets of free-ranging animals is aware of these difficulties.

Changes in daily activity patterns result in changes in seasonal activity patterns. It is helpful to set up a series of possible daily and seasonal time allotments for different activities when evaluating potential

energy benefits due to different behavioral regimes. An example of this kind of analysis may be found in Moen (1976) where the importance of reductions in activity levels as part of the energy conservation adaptation was illustrated. Since there are some absolute mathematical limits and some reasonable biological limits in analyses of activity-time budgets, first approximations using reasonable combinations of time allotments may be quite realistic. For example, the sum of the time spent each day in all activities must equal 24 hours. Bedding usually does not continue all day. Foraging periods usually occur several times a day. Running cannot continue for hours because animals do not have the stamina to do so. In fact, wild ruminants are quite capable of short bursts of speed, but generally do not run for periods of time longer than a few minutes at the very most.

Literature data and common sense enable one to put together reasonable first approximations of activity-time budgets, and variability analyses allow one to test the effects of different time allotments to different activities.

Details of daily activity patterns are discussed in UNIT 2.1 and seasonal activity patterns in UNIT 2.2

LITERATURE CITED

Moen, A. N. 1976. Energy conservation by white-tailed deer in the winter. Ecology. 57(1):192-198.

UNIT 2.1: DAILY PATTERNS

Free-ranging animals exhibit different daily locations and patterns of activity at different times of the year. These patterns are based on external factors, such as cover, light and weather conditions, and internal conditions, such as hormone balance and nutrient needs.

Locations of daily activities are fairly predictable in terms of the kind of habitat chosen, but not necessarily the location in that kind of habitat when there are several options. Foraging, for example, occurs where there is forage available. One hardly expects to find deer in a plowed field or under a dense canopy during the period of time after sunrise when they are expected to be foraging.

The location of beds in relation to the surrounding topography seems to be important. White-tailed deer in west-central Minnesota tended to bed more frequently near the tops of hills than near the bottoms, with the majority of beds located on the upper one-third of the hill (Moen 1963). Small mounds and slight rises were also used; visibility seemed to be an important factor in choosing bed sites. Such sites are also likely to be drier than sites further downslope.

Geist (1959) observed that nearly all moose beds were in open, elevated locations in British Columbia. Good visibility in all directions seemed to be most important.

There are discussions in the early literature about whether animals use the same bed more than once. Moose do not use the same bed over and over, but bighorn sheep and mountain goats do (Geist 1971). Deer may, but this does not seem to be the usual occurrence, at least during spring, summer, and fall. Individuals have been observed to use the same bed site repeatedly (Severinghaus and Cheatum 1956) but this is not necessarily the custom of most deer. A deer wintering area may have hundreds of beds in the snow if new snow does not cover them, and many of them may be used more than once. Sibling (presumably) fawns appear to bed close together often. Two smaller beds very close to each other and a larger bed a short distance away suggests that a doe and her fawns bedded there.

It is necessary, for practical reasons, to limit field observations to definable, consistent categories of behavioral activities. Several activities may be recognized in the daily regime of an animal. Five activities--bedding, standing, walking, foraging, and running--are considered essential for evaluating daily activity-time patterns of wild ruminants. These can be further divided, of course--standing activity may or may not include grooming activity, and bedding activity may or may not include rumination, for example, but field observations are often lacking in such fine details. Also, night-time activities are very difficult to observe, even for major activities.

The time of sunrise and sunset seems to regulate the timing of the activities of many different animals, and this is not surprising. Ruminants generally show peaks in activity at sunrise and sunset, with additional activity periods during the day and night. There are shifts in the timing of activity periods from one season to the next. The general trend in the winter is toward more activity during daylight hours, and later in the day too when air temperatures are warmer.

Animals of different ages and sexes have different activity patterns. Ruminant neonates are, as a group, remarkably well-developed at birth. Some, such as white-tailed deer, are quite inactive for a day or two after birth, increasing their activities as they grow larger and stronger. Others, such as caribou and sheep, are quite active just hours after birth. Lighter-than-average young are less well-developed physiologically than heavier-than-average ones. The much lighter-than-average ones can be considered "premies," exhibiting a lag in their stage of development in relation to age.

Activity characteristics, and other characteristics too, appear to be more closely related to weight than age. By the end of the suckling period, the young are very similar to the adults in their activity patterns because they associate with them, either their dam or a group of adults, assuming the adult behavior patterns.

The fractions of time spent in various activities by fawns has been measured at the Wildlife Ecology Laboratory, and can be predicted from the age of the fawn. Neonatal behavior includes a large proportion of time bedded, with a rapid decline during the first month of life. The foraging or feeding fraction per day increases rapidly during the first month, the pattern being almost a mirror image of the bedded activity pattern. The remaining three activities--standing, walking, and running--combined occupy from 7 to 11% of the fawn's time from birth to 105 days of age. The fractions of the day spent standing, walking, and running are less predictable than the fractions of the day spent bedding and feeding (foraging), but since 7 to 11% of the day is a small amount of time, the errors contribute little to the 24-hour total that is dominated by the more predictable bedding and feeding fractions. The equations listed below for determining fractions of time in each activity merge at 105 days of age into the adult equations for fractions of time spent in different activities, given in Moen (1978).

Bedded:	FTBD	=	0.98 - 0.07306 ln AGDA
Standing:	FTSD	=	0.05 + 0.00285 ln AGDA
Walking:	FTWD	=	0.02 + 0.00280 ln AGDA
Foraging:	FTFD	=	0.08173 ln AGDA - 0.14
Running:	FTRD	=	0.00255 ln AGDA

After AGDA 105, the equations for adults give in Moen (1978) should be used as the fractions of time spent in an activity varies seasonally, independent of the age of the deer. These are given in UNIT 2.2.

The sum of the costs of each activity during a 24-hour period is one component of the total cost of living for that period, and the equations for predicting time spent daily in different activities in this UNIT will be used in estimating ecological metabolism in CHAPTER 7, UNIT 6.1.

The daily sum of hours spent in all of the activities must equal 24, of course, and the sum of the fractions of time spent in each per 24-hour period must equal 1.0. Reasonable estimates may be made if complete field data are not available, and evaluations of changes in metabolism due to changes in daily activity patterns made. Such variability analyses provide much insight into ecological relationships and compensations. An illustration based on field observations may be found in Moen (1976).

A mathematical format expressing a general pattern for a day should also allow for changes in the amounts of time spent in different activities due to transient changes in the environment. A very cold winter day, for example, may cause an animal to remain bedded longer than usual. Animals may remain bedded during a snowstorm, and the accumulation of large amounts of snow alters their activity patterns after the storm. Electronic computing systems may be programmed so general patterns are calculated first, followed by overrides of calculated values with observed values or variations for error analyses.

Complete the WORKSHEETS using observed data of your own or in the literature, and then vary the categories to test the effects of variations.

LITERATURE CITED

Geist, V. 1959. Diurnal activity of moose. Memoranda Societas pro Fauna et Flora Fennica 35:95-101.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

Moen, A. N. 1963. A study of the winter bedding cover of the white-tailed deer in deciduous forest areas. M.S. Thesis, St. Cloud State College, Minnesota. 114 p.

Moen, A. N. 1976. Energy conservation by white-tailed deer in the winter. Ecology 57(1):192-198.

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. Journal of Wildl. Manage. 42(4): 715-738.

Severinghaus, C. W. and E. L. Cheatum. 1956. Life and times of the white-tailed deer. Pages 57-186 In W. P. Taylor, Ed., The Deer of North America. The Stackpole Company, Harrisburg, PA. 668 p.

REFERENCES, UNIT 2.1

DAILY PATTERNS

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOBEA	12--2	219	250	cerv	etholog observatns, n amer	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ECOLA	53--2	262	270	odvi	activ patt, young deer,tex	jackson,rm; whit/	1972
ECOLA	57--1	192	198	odvi	energy conservatn in wintr	moen,an	1976
JWMAA	27--3	422	427	odvi	nocturnl mvts, activ rhyth	montgomery,gc	1963
JWMAA	29--3	632	634	odvi	mechan recordr, meas activ	ozoga,jj; gysel,l	1965
JWMAA	33--1	196	203	odvi	mvmnts translocated, telem	hawkins,re; montg	1969
JWMAA	39--4	679	683	odvi	activ pattrn, durng estrus	ozoga,jj; verme,l	1975
JWMAA	41--2	315	317	odvi	seas chang,circadian activ	kammermeyer,ke; m	1977
JWMAA	42--4	715	738	odvi	seas chang, heart rate, ac	moen,an	1978
JWMAA	44--4	927	929	odvi	diurnal behavior, neonate	lagory,ke	1980
PCGFA	21---	51	57	odvi	drinking habits, sou texas	michael,ed	1967
TJSCA	21--4	417	428	odvi	activity patterns, s texas	michael,bd	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZWBA	3----	1	109	odhe	mule de, arizona chaparral	swank,wg	1958
BZOBA	20---	282	289	odhe	play behav, general activi	muller-schwarze,/	1969
JWMAA	33--3	704	708	odhe	photo-elec syst,noct activ	harder,jd	1969
JWMAA	39--3	605	616	odhe	doca,rnge rel, prairie hab	dusek,gl	1975
WLMOA	20---	1	79	odhe	ceel,doca, rnge ecol, mont	mackie,rj	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
CAFNA	83--4	339	343	alal	observ, feeding on aquatic	ritcey,rw; verbee	1969
JOMAA	39--1	128	139	alal	summr obsrvtns, behv,ontar	de vos,a	1958
MSFFA	35---	95	100	alal	diurnal activity of moose	geist,v	1959
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	40--1	151	162	rata	obmo, summer range relatns	wilkinson,pf; sh/	1976
NPOAA	1974-	129	138	rata	mnth patt, feed intk, rein	nyholm,es	1976
OECOB	48---	64	70	rata	seas dev, circad act, capt	erriksson,l-o; k/	1981

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JAPEA	12--2	411	420	anam	doca, comprtv grazng behav	ellis,je; travis,	1975

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
CAFNA	77--2	77	94	ovca	bahavior of a bighorn herd	blood,dal	1963

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
FRKZA	12--4	125	130	obmo	biol, polar musk ox,norway	pleticha,p	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	71--3	246	290	caca	time-budgeting, agric area	turner,dc	1979
IZYBA	4----	297	300	caca	artif rearing, behav obser	pinter,h	1962
VILTA	11--8	315	353	caca	daily, seasnl activ pattrn	cederlund,g	1981

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JASIA	44--1	5	66	doca	inf win nut depres grow,re	voubert,dm	1954

OTHER PUBLICATIONS

Skinner, M. P. 1924. The American Antelope in Yellowstone National Park. Roosevelt Wildl. Forest Expt. Sta., Syracuse, N.Y. 32 p.

CHAPTER 4, WORKSHEET 2.1a

Five major daily activities of wild ruminants

Daily activity patterns may be divided into two main components: resting and active. Resting includes the time spent lying down, and may be further divided into postures, considering head position and leg positions. Active time may be divided into 4 major categories: standing, walking, foraging, and running. These may be subdivided into two or more categories each.

This WORKSHEET presents a format for recording the five major activity groups given above for use in calculating energy costs in PART III, CHAPTER 7, TOPIC 4. Complete the time budgets below based on your field observations or data in the literature. Data for different behavioral regimes of white-tailed deer may be used as examples if you do not have your own data.

Activity	JDAY and time fractions of different activities						
JDAY =	_____	_____	_____	_____	_____	_____	_____
Bedding	_____	_____	_____	_____	_____	_____	_____
Standing	_____	_____	_____	_____	_____	_____	_____
Walking	_____	_____	_____	_____	_____	_____	_____
Foraging	_____	_____	_____	_____	_____	_____	_____
Running	_____	_____	_____	_____	_____	_____	_____
SUMS	1.00	1.00	1.00	1.00	1.00	1.00	1.00

LITERATURE CITED

Moen, A. N. 1976. Energy conservation of white-tailed deer in the winter. Ecology 57(1):192-198.

Activity	JDAY and time fractions of different activities						
JDAY =							
Bedding							
Standing							
Walking							
Foraging							
Running							
SUMS	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Activity	JDAY and time fractions of different activities						
JDAY =							
Bedding							
Standing							
Walking							
Foraging							
Running							
SUMS	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Activity	JDAY and time fractions of different activities						
JDAY =							
Bedding							
Standing							
Walking							
Foraging							
Running							
SUMS	1.00	1.00	1.00	1.00	1.00	1.00	1.00

CHAPTER 4, WORKSHEET 2.1b

Time spent in different postures and activity intensities

This WORKSHEET is an expansion of the previous one, incorporating posture and intensity into the five major activities of WORKSHEET 2.1a. Complete the blanks as before for later use in calculating activity costs as described in PART III, CHAPTER 7, TOPIC 4.

		Time fraction	Time fraction	Time fraction	Time fraction
Bedding:	Head up	_____	_____	_____	_____
	Head down	_____	_____	_____	_____
Standing:	Loitering	_____	_____	_____	_____
	Alert	_____	_____	_____	_____
Walking:	*Speed	_____	_____	_____	_____
	*Vertical ascent	_____	_____	_____	_____
Foraging:	Speed	_____	_____	_____	_____
	Vertical ascent	_____	_____	_____	_____
Running:	Speed	_____	_____	_____	_____
	Vertical ascent	_____	_____	_____	_____

*Speed and vertical ascent are used when calculating the costs of walking, foraging and running. Recording these along with time spent in these activities makes it convenient to complete energy cost calculations in CHAPTER 7, TOPIC 4.

		Time fraction	Time fraction	Time fraction	Time fraction
Bedding:	Head up				
	Head down				
Standing:	Loitering				
	Alert				
Walking:	*Speed				
	*Vertical ascent				
Foraging:	Speed				
	Vertical ascent				
Running:	Speed				
	Vertical ascent				

		Time fraction	Time fraction	Time fraction	Time fraction
Bedding:	Head up				
	Head down				
Standing:	Loitering				
	Alert				
Walking:	*Speed				
	*Vertical ascent				
Foraging:	Speed				
	Vertical ascent				
Running:	Speed				
	Vertical ascent				

CHAPTER 4, WORKSHEET 2.1c

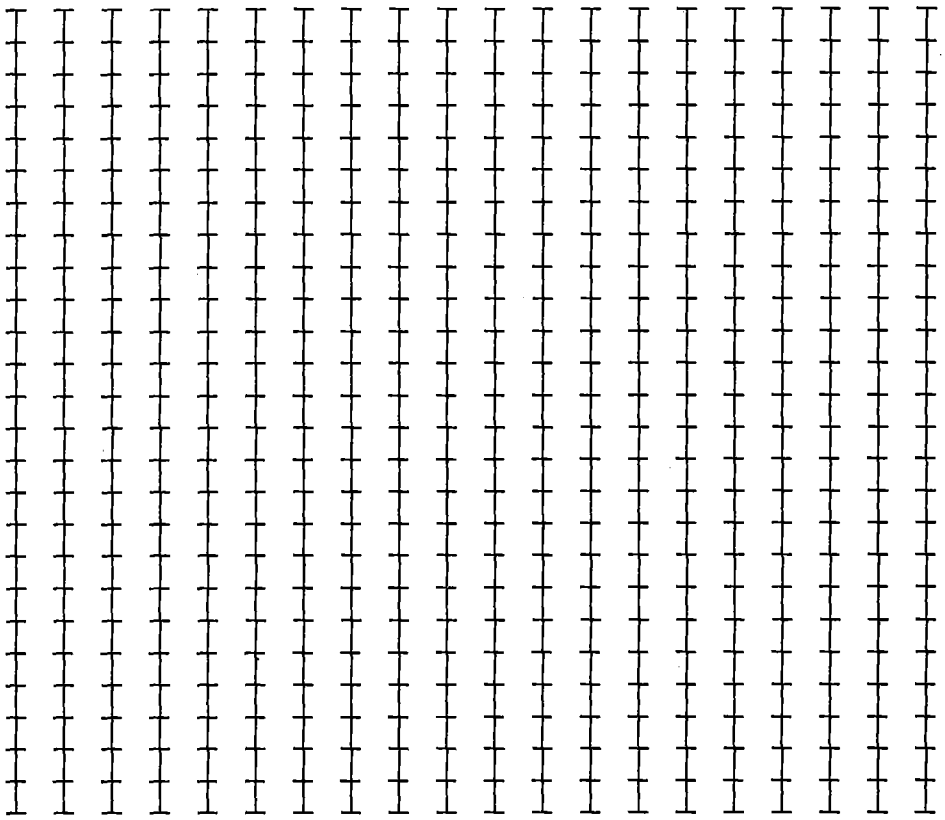
Estimates of activity-time fractions from birth to weaning

The equations given in UNIT 2.1 for calculating fractions of time in different activities included logarithmic changes in the fractions over time. They also merged with adult equations in Moen (1978) at AGDA = 105.

If fractions of time at birth and fractions of time at weaning are known or estimated, first approximations may be made by using a logarithmic fit between these points. Four of the five may be determined in this way, and the fifth by subtraction.

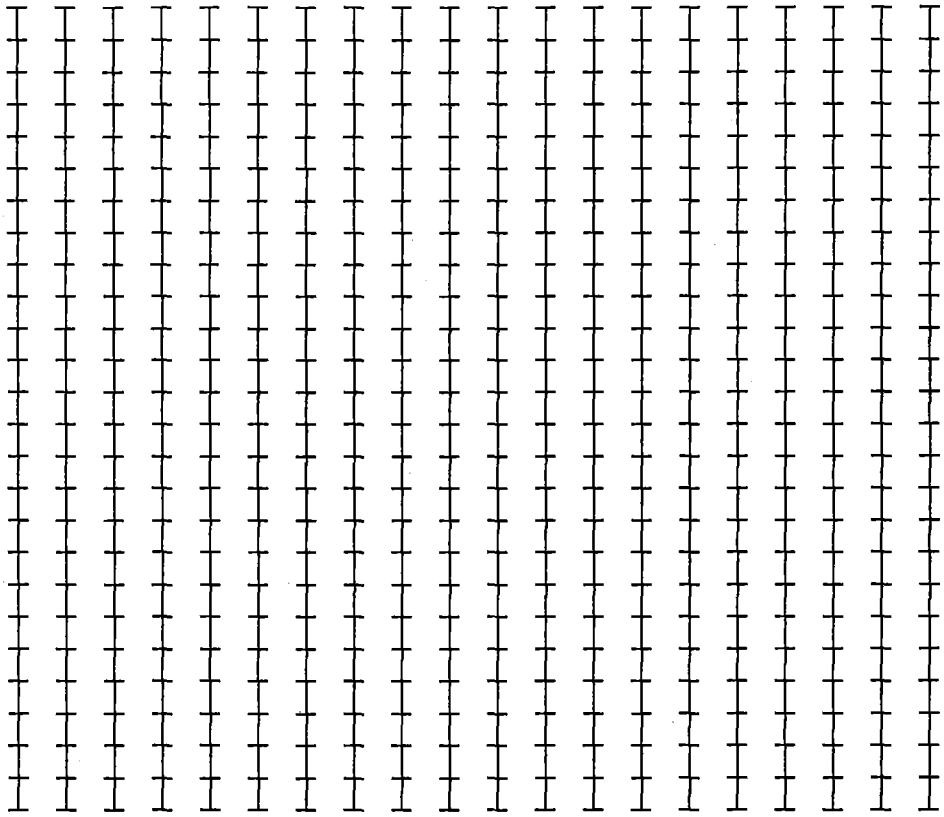
This procedure illustrates how estimates may be made because they must be made when evaluating the total ecology of animals from birth to death. If you have a better way to make such estimates, do so. You must not say "I don't know" and leave it out, for that is a certain mistake.

Make your estimates and plot the results below.



LITERATURE CITED

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 42(4):715-738.



UNIT 2.2: SEASONAL PATTERNS

Locations of wild ruminants and their activity times vary from one season to the next because they are closely related to seasonal changes in range resources and conditions, and to the productivity cycle of the animals. Thus when the cost of living is high because of lactogenesis, the amount of foraging activity is also high. In the winter when the cost of living is low because of the metabolic depression, the amount of activity is also low, a reasonable adaptive response to a range with limited forage resources. Seasonal changes in the use of space were discussed in CHAPTER 3, UNIT 3.2. The discussion here in this UNIT 2.2 will be directed toward activity times and how they change through the year.

Verbal descriptions of activity cannot be communicated directly to programmed electronic computing systems. Codes and time intervals must be entered, determining the fractions of time spent in different activities such as bedding, standing, walking, foraging, and running. The time spent per day in each of these activities may change gradually through the year, and may be expressed as continuous mathematical functions based on the time of year (JDAY).

Sine wave equations that were determined for the time spent in different activities by captive white-tailed deer (Moen 1978) illustrate an approach that is very useful when evaluating seasonal changes in activity patterns and in energy costs. Observed times spent by wild ruminants in different activities in different areas may be fit to equations in a similar way, providing a mathematical format for expressing time functions in different activities through the year.

The format is similar to that for expressing weights as described in PART I, CHAPTER 1, UNIT 1.4. The equations are given below.

$$FTBD = \{0.0885 \sin[(JDAY)(0.9863) - 103] + 0.0005\} + 0.597$$

$$FTSD = \{0.0934 \sin[(JDAY)(0.9863) + 77] - 0.0004\} + 0.100$$

$$FTWD = \{0.0208 \sin[(JDAY)(0.9863) + 77] - 0.0000\} + 0.066$$

$$FTFD = \{0.0232 \sin[(JDAY)(0.9863) - 103] + 0.0002\} + 0.231$$

$$FTRD = \{-0.0006 \sin[(JDAY)(0.9863) - 103] - 0.0004\} + 0.006$$

where FTBD = fraction of time bedded,
FTSD = fraction of time standing,
FTWD = fraction of time walking,
FTFD = fraction of time foraging, and
FTRD = fraction of time running.

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It is difficult to get enough data to derive equations for activity patterns of free-ranging animals over the annual cycle. Thus data on year-long activity patterns are virtually lacking for wild ruminants. Measurements of activity patterns over several annual cycles on penned animals may be compared with accounts of scattered field observations reported in the literature. Franzmann and Hebert (1971), for example, briefly mention "the docility of bighorns in late winter may be a behavioral mechanism to conserve energy and enhance survival . . ." This indicates a metabolic depression and reduced activity, which is useful information when making first approximations of seasonal activity patterns.

A useful first step in determining whether sine waves are appropriate expressions of the fractions of time in each activity over the annual cycle is the plotting of the data. If the patterns show seasonal differences with sine-wave patterns, annual averages for the five activities may be determined and deviations from the annual averages fit as described for the weight analyses in the CHAPTER 1, UNIT 1.4. Primary and secondary phase corrections may also be made as described in CHAPTER 1. One important point to remember is that the sum of the fractions of time in each activity must equal 1.0. If five activities are considered, four may be fit to curves and the fifth expressed as the difference between the sum of the other four and 1.0.

Transient changes occur between seasons in the annual cycle, depending primarily on range conditions. An open winter with little snow and ample range resources allows greater mobility, more movement, and higher activity levels than a cold, deep-snow winter. Such changes in the amounts of different activities are changes in the amplitudes of sine waves, and may be easily accomodated mathematically. The important point to remember is that increases in some activities must result in decreases in others since the total amount of time spent in any day throughout the year cannot exceed 24 hours.

The two WORKSHEETS at the end of this UNIT provide opportunities for evaluating seasonal changes in time spent daily in different activities.

LITERATURE CITED

Franzmann, A. W. and D. M. Hebert. 1971. Variation of rectal temperature in bighorn sheep. J. Wildl. Manage. 35(3):488-494.

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 42(4):715-738.

REFERENCES, UNIT 2.2

SEASONAL PATTERNS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
AMNAA	77--3	390	417	cerv	socai behav, repro period	devos,a; broky,p/	1967
JOMAA	37--2	165	170	cerv	territorialism in deer	graf,w	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
BUCDA	27--2	83	83	odvi	wint sprng movt, indiv, fl	bridges,rj; march	1969
CJZOA	44--1	59	62	odvi	breeding seasons	ransom,ab	1966
ECOLA	41--2	327	333	odvi	wint act, wh ced swamp, wi	habeck,jr	1960
ECOLA	57--1	192	196	odvi	energy conservat in winter	moen,an	1976
JFUSA	63--7	523	529	odvi	swamp conifer deer yards	verme,lj	1965
JWMAA	10--3	249	263	odvi	breeding season, new york	cheatum,el; morto	1946
JWMAA	24--4	364	371	odvi	test shelt req, penned dee	robinson,wl	1960
JWMAA	32--3	615	618	odvi	summer flight behav, adiro	behrend,df; lubec	1968
JWMAA	34--2	420	431	odvi	season activ patt, sou dak	sparrowe,rd; spri	1970
JWMAA	34--2	431	439	odvi	winte feeding patt, penned	ozoga,jj; verme,l	1970
JWMAA	34--3	553	559	odvi	winter habitat selection	telfer,es	1970
JWMAA	39--4	679	683	odvi	actv pattrns during estrus	ozoga,jj; verme,l	1975
JWMAA	41--2	315	317	odvi	seasonl chang circad activ	kammermayer,ka; m	1977
JWMAA	42--4	715	738	odvi	seasonal heart rates, meta	moen,an	1978
PIAIA	79--2	74	78	odvi	wint movt, home rang, iowa	zagata,md; haugen	1972
WSCBA	17--4	20	21	odvi	deer scattered throu winte	wisc conserv dept	1952
WCDBA	7----	1	32	odvi	wint habits, censu methods	kabat,c; collias/	1953

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	36--4	343	365	odhe	calif mule d,chaparral for	cronemiller,fp; b	1950
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
ECMOA	2---1	1	46	odhe	seasonal migration, mule d	russell,cp	1932
ECOLA	45--2	249	256	odhe	relat weather, migra movem	mccullough,dr	1964
JOMAA	31--4	426	429	odhe	rel moon phas,occr salt lk	buss,il; harbert,	1950
JOMAA	37--2	143	164	odhe	behavr, ref to pop ecolgy	dasmann,rf; taber,	1956
JOMAA	51--2	248	260	odhe	distr patt in rela to envi	miller,fl	1970
JWMAA	39--3	605	616	odhe	range relatn, doca, prarie	dusek,gl	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	9---4	295	319	ceel	roosvlt elk, olympic penin	schwartz,je,II; m	1945
JWMAA	32--3	553	557	ceel	diff distr, sex, age, mont	peek,jm; lovaas,a	1968
WLMOA	33---	1	50	ceel	home range, activ pattern	craighead,jj; cr/	1973
VEZOA	4---5	15	19	ceel	ecolo, c. elaphus brauneri	kormylytsyn,aa	1970
ZETIA	24--1	80	114	ceel	behavior, during the rut	struhsaker,tt	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	6---2	155	159	alal	social integration of calf	altmann,m	1958
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
BYMOA	82--1	29	40	alal	winter distr, ussr, migrat	sobanski,gg	1977
CAFNA	89--1	47	52	alal	season movement, laurenti	roussel,ye; audy/	1975
JOMAA	39--1	128	139	alal	summr obsrvtns behv, ontar	de vos,a	1958
JOMAA	53--1	129	138	alal	north limits, west canada	kelsall,jp	1972
JWMAA	24--2	162	170	alal	mvmnts, food hab, pop,mont	knowlton,ff	1960
JWMAA	34--2	439	445	alal	mvmnts, hunted area, ontar	goddard,j	1970
JWMAA	34--3	553	559	alal	winter habitat selection	telfer,es	1970
JWMAA	35--1	63	71	alal	radiotelemet, ne minnesota	val vallenberghe,	1971
JWMAA	37--3	266	278	alal	moveme patterns, range use	phillips,rl; ber/	1973

alal continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
LYNXA	12...	5	24	alal	migrations, central europe	briedmann,l	1971
NAWTA	21---	510	525	alal	summer studies in ontario	de vos,a	1956
NCANA	101--	51	65	alal	distributn,habitat, status	dodds,dg	1974
NCANA	101--	143	178	alal	distribu, habitats, alaska	leresche,re; bis/	1974
NCANA	101--	379	392	alal	seasonal movements, europe	pulliainen,e	1974
NCANA	101--	393	415	alal	migrations in north americ	lefesche,re	1974
QSFRA	3----	51	73	alal	influence snow on behavior	des meules,p	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	13--2	259	264	rata	rutting behavio, bar gr ca	lent,pc	1965
ANBEA	18--2	256	258	rata	consequ of travel, rutting	henshaw,j	1970
ATICA	23--3	199	200	rata	abnormal migratory behavio	espmark,y	1970
JWMAA	24--3	250	258	rata	behav, bar gr car, calving	devos,a	1960
JWMAA	38--1	54	66	rata	synchronous matng, bar gro	dauphine,tc; mccl	1974
NPOAA	1974-	129	138	rata	mnth patt, feed intk, rein	nyholm,ex	1976
OECOB	48---	64	70	rata	seas dev, circad,act, capt	erriksson,l-o; k/	1981
TNWSD	1961-	1	31	rata	reprod season, newfoun car	bergerud,at	1961
ZETIA	23--6	701	756	rata	calving, relat soc behavio	lent,pc	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	43--2	257	354	anam	lif his, eco, ran use, tex	bueshner,hk	1950
CAFGA	30--4	221	241	anam	prng-hrnd antlp,california	mclean,dd	1944
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JOMAA	10--2	135	141	anam	pronghorn antelope	grinnell,gb	1929
JOMAA	50--1	129	138	anam	territorial, bucks, montan	bromley,pt	1969

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	19--1	88	94	ovca	summer activity, yllstn pk	davis,wb	1938
JWMAA	35--3	488	494	ovca	variatn of rectal temperat	franzmann,aw; heb	1971

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
BMSIA	11---	139	144	oram	radio tracking, w montana	rideout,cb	1974
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966

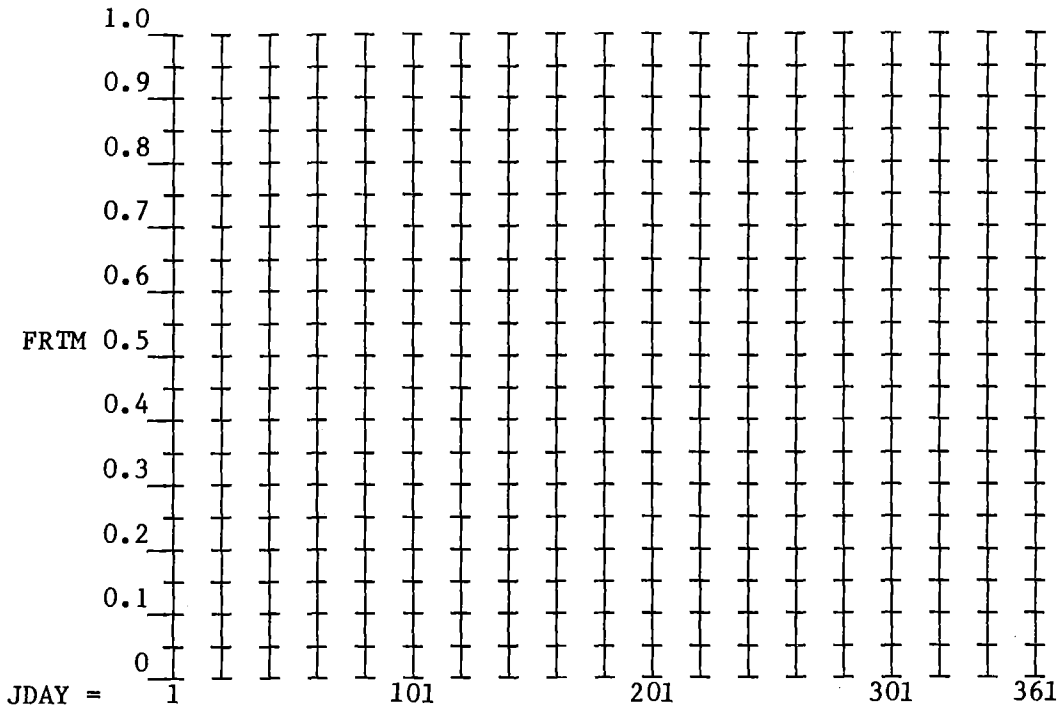
OTHER PUBLICATIONS

Skinner, M. P. 1924. The Americn Antelope in Yellowstone National Park. Roosevelt Wildl. Forest Expt. Sta., Syracuse, N.Y. 32p.

CHAPTER 4, WORKSHEET 2.2a

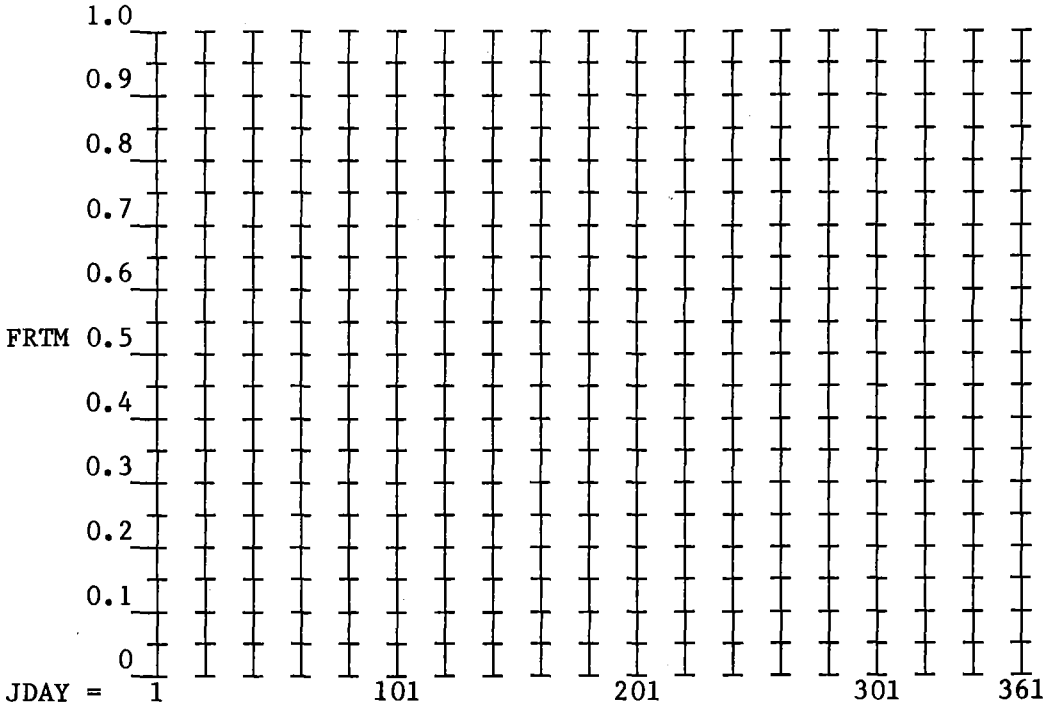
Seasonal activity patterns

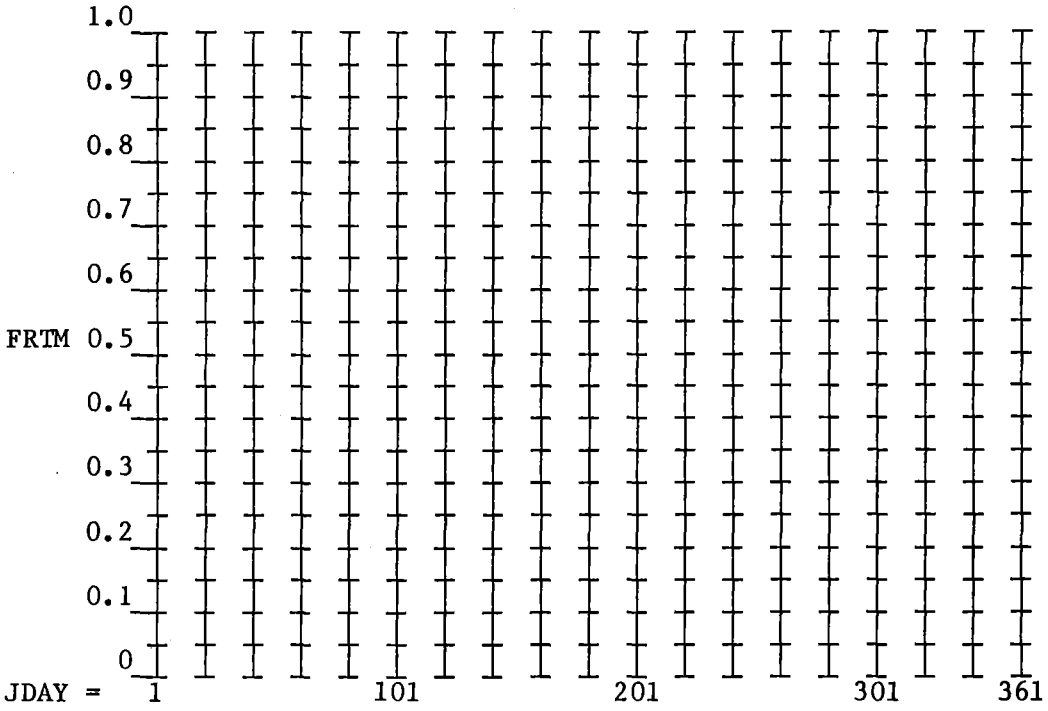
Seasonal activity patterns are made from a collection of daily activity patterns through the annual cycle. Refer back to WORKSHEET 2.1a for a listing of fractions of time in five major activities on different JDAYs. Plot the fractions of time (FRTM) you derived in the grid below. If you do not have data for enough JDAYs to complete patterns through the year, complete more days of activity patterns in WORKSHEET 2.1a and then complete this WORKSHEET.



Use the space below to write or derive equations for the data plotted.

Additional plots may be made on the two grids on the next page.


1.0
0.9
0.8
0.7
0.6
FRTM 0.5
0.4
0.3
0.2
0.1
0
JDAY = 1
101
201
301
361


1.0
0.9
0.8
0.7
0.6
FRTM 0.5
0.4
0.3
0.2
0.1
0
JDAY = 1
101
201
301
361

CHAPTER 4, WORKSHEET 2.2b

Variability in seasonal activity patterns

Patterns over the annual cycle are emphasized in all seven PARTS of The Biology and Management of Wild Ruminants. This WORKSHEET provides an opportunity for adjusting fractions of time through the year. The variations presented here will be useful when calculating the energy costs of activities in PART III, CHAPTER 7, TOPIC 4.

Use Figure 5 in my paper on seasonal rhythms (Moen 1978) as a starting point. Note that peaks in the sine waves occur on about JDAYs 16 and 196. Considering running to be 1.0% (FTRD = 0.01) throughout the year in this illustration, the following estimates may be made.

	JDAY 16	JDAY 196
FTBD =	0.50	0.68
FTSD =	0.19	0.01
FTWD =	0.09	0.06
FTFD =	0.21	0.24
FTRD =	0.01	0.01
SUMS =	1.00	1.00

Each of these may be expressed as symmetric sine waves as described in PART I, CHAPTER 1, UNIT 1.4. In the above example, FTBD = 0.59 $\pm$ 0.09, and the phase correction is -103. Thus:

$$FTBD = 0.09 \sin [(JDAY)(0.9863) - 103] + 0.59$$

Equations for each of the others may be written in the same way. Be sure to determine proper phase corrections; some are 180° out of phase.

FTSD =

FTWD =

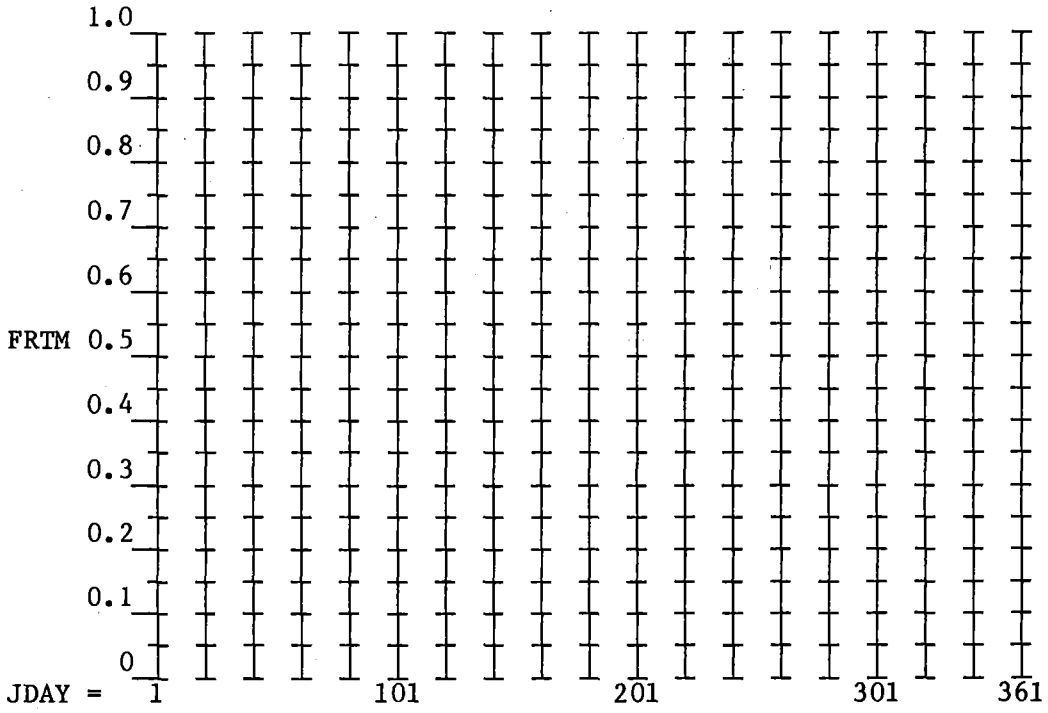
FTFD =

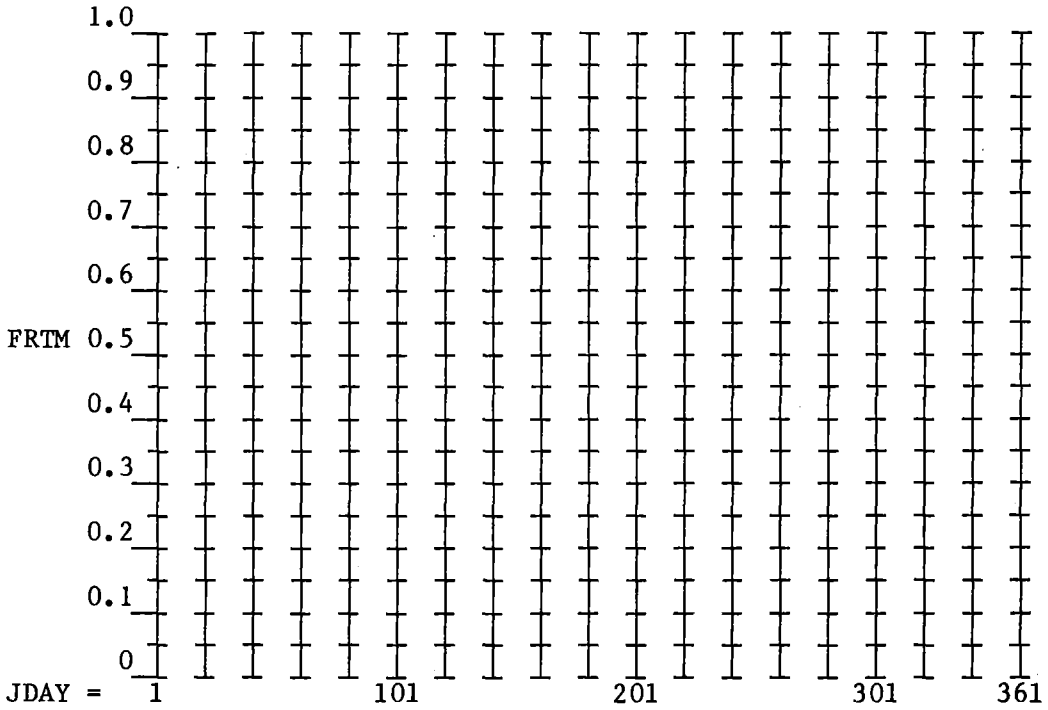
FTRD = 0.01

After writing the equations suggested above, alter the maximum and minimum fractions of time in each activity, and the timing, or phase of each of the patterns. Write the equations and plot the results in the grid on the next page. Be sure that the total FRTM for any JDAY calculated = 1.00.

LITERATURE CITED

Moen, A. N. 1978. Seasonal changes in heart rates, activity, metabolism, and forage intake of white-tailed deer. J. Wildl. Manage. 41(4):715-738.


1.0
0.9
0.8
0.7
0.6
FRTM 0.5
0.4
0.3
0.2
0.1
0
JDAY = 1
101
201
301
361


1.0
0.9
0.8
0.7
0.6
FRTM 0.5
0.4
0.3
0.2
0.1
0
JDAY = 1
101
201
301
361

CLOSING COMMENTS

This CHAPTER 4 included descriptions of different activities and of two very important temporal--daily and seasonal--behavior patterns. There are limited data on these two patterns, but the mathematical frameworks described provide ways to estimate the effects of different behavior patterns and activity levels on energy expenditures over time periods of 24 hours and 365 days in PART III. The results will be used to determine ecological metabolism in PART III, and in all of the remaining PARTS as calculations are made for individuals and populations, and of carrying capacity.

Aaron N. Moen
November 12, 1981

GLOSSARY OF SYMBOLS - CHAPTER FOUR

BDNG = Bedding

FGNG = Foraging
FRTM = Fraction of time
FTBD = Fraction of time bedded
FTFD = Fraction of time foraging
FTRD = Fraction of time running
FTSD = Fraction of time standing
FTWD = Fraction of time walking

GESP = Genus and species

JDAY = Julian day

RNNG = Running

STNG = Standing
SUMS = Sums

WKNG = Walking

GLOSSARY OF SERIAL CODENS - CHAPTER FOUR

Serials are identified by five-character, generally mnemonic codes called CODEN, listed in 1980 BIOSIS, LIST OF SERIALS (BioSciences Information Service, 2100 Arch Street, Philadelphia, PA 19103).

The headings for the lists of SERIALS are:

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

The volume and issue numbers (VO-NU) are given after the CODEN entry, followed by beginning page (BEPA), ending page (ENPA), species discussed (ANIM)1, KEY WORDS from the title, AUTHORS [truncated if necessary, slash (/) indicates additional authors], and YEAR.

AMNAA American Midland Naturalist (US)
AMNTA American Naturalist (US)
ANBEA Animal Behaviour (England)
ATICA Arctic (Canada)
AZWBA Arizona Game and Fish Department Wildlife Bulletin (US)

BEHAA Behaviour (Netherlands)
BMSIA Biomedical Sciences Instrumentation
BPURD Biological Papers of the University of Alaska Special Report
BUCDA Bulletin of the Georgia Academy of Sciences
BVJOA British Veterinary Journal
BYMOA Byulletin Moskovskago Obshchestva Ispyrtatalei Prirody Otdel Biologicheskii (USSR)
BZOBA Bonner Zoologische Beitraege

CAFGA California Fish and Game (US)
CAFNA Canadian Field Naturalist (Canada)
CFGGA California Department of Fish and Game, Game Bulletin
CGFPA Colorado Division of Game, Fish, and Parks Special Report (US)
CJZOA Canadian Journal of Zoology (Canada)
CWRSB Canadian Wildlife Service Report and Management Bulletin Series

ECMOA Ecological Monographs (US)
ECOLA Ecology

FEPRA Federation Proceedings (US)
FRKZA Freunde de Koelner Zoo
FUNAA Fauna (Oslo)

IGWBA Idaho Department of Fish and Game Wildlife Bulletin
IUNRA International Union for Conservation of Nature and Natural Resources Annual Report (Switzerland)
IZYBA International Zoo Year Book

JAPEA Journal of Applied Ecology (England)
JASIA Journal of Agricultural Science (England)
JFUSA Journal of Forestry (US)
JOMAA Journal of Mammalogy (US)
JRMGA Journal of Range Management (US)
JTBIA Journal of Theoretical Biology
JWMAA Journal of Wildlife Management (US)

LYNXA Lynx (Czechoslovakia)

MDCBA Minnesota Department of Conservation Technical Bulletin
MDCRA Michigan Department of Conservatioon Game Division Report
MRLTA Murrelet, The
MSFFA Memoranda Societatis pro Fauna et Flora Fennica
MUZPA Miscellaneous Publications, Museum of Zoology, University of Michigan

NAWTA North American Wildlife and Natural Resources Conference, Transactions of the (US)
NCANA Naturaliste Canadien, Le
NPOAA Norsk Polarinstitutt Arbok (Norway)
NPSMD United States National Park Service Scientific Monograph Series

OECOB Oecologia (Berlin)

PASCC Proceedings of the Alaskan Scientific Conference (US)
PCGFA Proceedings of the Southeastern Association of Game and Fish Commissioners
PIAIA Proceedings of the Iowa Academy of Science
PZSLA Proceedings of the Zoological Society of London

QRBIA Quarterly Review of Biology
QSFRA Quebec Service de la Faune Rapport (Quebec Wildlife Service Report)

RWLBA Roosevelt Wild Life Bulletin

SCBUB Sierra Club Bulletin
SCIEA Science
SCZFA Schweizerische Zeitschrift fuer Forstwesen

TISAA Transactions of the Illinois State Academy of Science (US)
TJSCA Texas Journal of Science
TLPBA Theoretical Population Biology
TNWSD Transactions of the Northeast Section, The Wildlife Society (US)

UABPA Biological Papers of the University of Alaska
UCPZA University of California Publications in Zoology

VEZOA Vestnik Zoologii
VILTA Viltrevy (Sweden)
VLUBB Vestnik Leningradskogo Universiteta Biologiya

WCDBA Wisconsin Conservation Department Technical Bulletin
WGFBA Wyoming Game and Fish Commission Bulletin
WLMOA Wildlife Monographs (US)
WMBAA Wildlife Management Bulletin (Ottawa) Series 1 (Canada)
WSCBA Wisconsin Conservation Bulletin

XNFSA U S National Park Service Fauna of the National Parks of the United States, Fauna Series

ZEJAA Zeitschrift fuer Jagdwissenschaftl
ZETIA Zeitschrift fuer Tierpsychologie
ZOBEA Zoologisch Beitraege
ZOGAA Zoologische Garten
ZOOLA Zoologica (New York)
ZSAEA Zeitschrift fuer Saeugetierkunde

LIST OF PUBLISHERS - CHAPTER FOUR

The headings for the lists of BOOKS are:

TYPE PUBL CITY PAGE ANIM KEY WORDS---------- AUTHORS/EDITORS-- YEAR

All essential information for finding each book in the library is given on just one line. The TYPE of book could have either AUTHORS (aubo) or EDITORS (edbo). Publishers (PUBL) and CITY of publication are given with four-letter mnemonic symbols defined below. The PAGE column gives the number of pages in the book; ANIM refers to the species discussed in the book (given as a four-letter abbreviation of genus and species), and KEY WORDS listed are from the title. The AUTHORS/EDITORS and YEAR of publication are given in the last two columns.

aakn	Alfred A. Knopf	New York, NY	nyny
acpr	Academic Press	New York, NY	nyny
apcc	Appleton-Century-Crofts	New York, NY	nyny
botc	Bouilliere, Tindall & Cassell	London, England	loen
cite	Cambridge Institute of Terrestrial Ecology	Cambridge, England	caen
dodo	Doubleday Doran	New York, NY	nyny
dohr	Dowden, Hutchinson, & Ross	Stroudsburg, PA	stpa
fost	Forest and Stream Publishing Co.	New York, NY	nyny
hill	Hill	London, England	loen
iucn	International Union for the Conserrvation of Nature and Natural Resources	Morges, Switzerland	mosw
jwis	John Wiley and Sons, Inc.	New York, NY	nyny
macm	MacMillan Co.	New York, NY	nyny
meth	Methuen & Co.	London, England	loen
mhbc	McGray-Hill Book Company, Inc.	New York, NY	nyny

olbo	Oliver & Boyd	Edingurgh, Scotland	edsc
oxup	Oxford University Press	London, England	loen
plpc	Plenum Publishing Corporation	New York, NY	nyny
prha	Prentice-Hall, Inc.	Englewood Cliffs, NJ	ecnj
qupr	Queen's Printer	Ottawa, Ontario	oton
saco	Saunders Publishing Co.	Philadephia, PA	phpa
sfes	USDA Forest Servide, Southern Forest Experiment Station	Nacagdoches, TX	nate
stac	Stackpole Company, The	Harrisburg, PA	hapa
ucap	University of California Press	Berkely, CA	beca
uchp	University of Chicago Press	Chicago, IL	chil
unbp	University of Nebraska Press	Lincoln, NE	line
utop	University of Toronto Press	Toronto, Ontario	toon
uwyp	University of Wyoming Press	Laramie, WY	lawy
whfr	W. H. Freeman Co.	San Francisco, CA	sfca
wimi	Wildlife Management Institute	Washington, DC	wadc
wiso	Wildlife Society, The	Washington, DC	wadc
wiwi	Williams and Wilkins	Baltimore, MD	bama

GLOSSARY OF ANIMAL CODE NAMES

Wild ruminants are referred to in this CHAPTER by a 4-character abbreviation from the family, genus and genus-species. These are listed below under Abbreviation.

Scientific names of North American wild ruminants are those used in BIG GAME OF NORTH AMERICA, edited by J.C. Schmidt and D. L. Gilbert (1979: Stackpole Books, Harrisburg, PA 17105, 494 p.), and may be different from the scientific names given in the original literature.

The abbreviations used for North American wild ruminants are listed below.

CLASS: MAMMALIA

ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: Odocoileus (deer)	od--
SPECIES: O. virginianus (white-tailed deer)	odvi
O. hemionus (mule deer)	odhe
GENUS: Cervus (Wapiti, elk)	ce--
SPECIES: C. elaphus	ceel
GENUS: Alces (moose)	
SPECIES: A. alces	alal
GENUS: Rangifer (caribou)	
SPECIES: R. tarandus	rata
FAMILY: ANTILOCAPRIDAE	
GENUS: Antilocapra	
SPECIES: A. americana (pronghorn)	anam
FAMILY: BOVIDAE	bovi
GENUS: Bison (bison)	bi--
SPECIES: B. bison	bibi
GENUS: Ovis (sheep)	ov--
SPECIES: O. canadensis (bighorn sheep)	ovca
O. dalli (Dall's sheep)	ovda
GENUS: Ovibos	
SPECIES: O. moschatus (muskox)	obmo
GENUS: Oreamnos	
SPECIES: O. americanus (mountain goat)	oram

The abbreviations used for European wild ruminants are listed below.

CLASS: MAMMALIA	
ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: *Capreolus* (roe deer)	ca--
SPECIES: *C. capreolus*	caca
GENUS: *Dama* (fallow deer)	da--
SPECIES: *D. dama*	dada
GENUS: *Cervus* (Wapiti, elk)	ce--
SPECIES: *C. elaphus* (red deer)	ceel
GENUS: *Alces* (moose)	
SPECIES: *A. alces*	alal
GENUS: *Rangifer* (caribou)	
SPECIES: *R. tarandus*	rata
FAMILY: BOVIDAE	
GENUS: *Bison* (bison)	
SPECIES: *B. bonasus*	bibo
GENUS: *Capra* (ibex, wild goat)	cp--
SPECIES: *C. aegargrus*(Persian ibex)	cpae
C. siberica (Siberian ibex)	cpsi

OTHERS

Abbreviations for a few other species and groups of species may appear in the reference lists. These are listed below.

Axis axis (axis deer)	axax
Elaphurus davidianus (Pere David's deer)	elda
Cervus nippon (Sika deer)	ceni
Hydropotes inermis (Chinese water deer)	hyin
Muntiacus reevesi (Chinese muntjac)	mure
Moschus moschifer (Chinese musk deer)	momo
Ovis nivicola (snow sheep)	ovni
Ovis musimon (moufflon)	ovmu
Ovis linnaeus (Iranian sheep)	ovli
Rupicapra rupicapra (chamois)	ruru
big game	biga
domestic sheep	dosh
domestic cattle	doca
domestic goat	dogo
domestic ruminant	doru
herbivore	hrbv
mammals	mamm
three or more species of wild ruminants	many
ruminants	rumi
ungulates	ungu
vertebrates	vert
wildlife	wldl
wild ruminant	wiru

JULIAN DAY: MONTH AND DAY EQUIVALENTS*

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	1
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	3
4	004	035	063	094	124	155	185	216	247	277	308	338	4
5	005	036	064	095	125	156	186	217	248	278	309	339	5
6	006	037	065	096	126	157	187	218	249	279	310	340	6
7	007	038	066	097	127	158	188	219	250	280	311	341	7
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	11
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029	[060]	088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

* For leap year, February 29 = JDAY 60. Add 1 to all subsequent JDAYs.

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1.1a Activity-times in the two basic postures 16a

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THE BIOLOGY AND MANAGEMENT OF WILD RUMINANTS

CHAPTER FIVE

INTERACTIONS WITHIN AND BETWEEN SPECIES

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CHAPTER 5. INTERACTIONS WITHIN AND BETWEEN SPECIES

Interactions within and between species occur constantly, except when an individual animal is alone. Interactions may be divided into two main categories: those occurring within a species, or intraspecies interactions, and those occurring between species, or interspecies interactions. Intraspecies interactions may be "positive" or "negative." For example, the social ties between a female and her offspring are strong and beneficial (positive) in the summer and fall, yet in a competitive winter situation when food is scarce, the female may be agonistic (negative) in relation to her own offspring. Interspecies interactions may be "positive", "neutral" or "negative." For example, members of some of the different species do not develop social ties or associate together in ways that enhance survival and productivity (neutral), while members of some species have a direct effect, such as predators which kill their prey (negative).

Predation is one of the most easily-recognized negative interspecies interactions because it is dramatic and direct. Competition between herbivores is not as easily recognized but potentially important negative interspecies interaction on some ranges. Competition may be reduced by predation, however; an apparently negative interaction between species, such as predator and prey, may be positive with respect to their populations by reducing competition. Predation is, ecologically, good for a population and its range, but "bad" for the individual.

The relationships of pathogens and parasites to their hosts are two more kinds of intespecies relationships; they may have little effect (neutral) or pronounced effects (negative) on the hosts, depending on the action of the pathogen and parasite and on the condition of their hosts.

Social interactions are very difficult to quantify because there are no standard units with which to express the amounts of interactions. Social hierarchies result in high levels of organization within groups, but they are difficult to detect by casual observation. Continued study over a period of time is necessary.

This CHAPTER 5 is directed toward behavioral interactions within and between species. The first two TOPICS are directed toward interactions within a species, and the third TOPIC toward interactions between species. The material in TOPIC 3 is discussed further in PARTS VI and VII where the effects on populations and management are discussed.

REFERENCES, CHAPTER 5

INTERACTIONS WITHIN AND BETWEEN SPECIES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	dodo	nyny	1220	----	v 3, lives of game animals	seton,et	1929
aubo	meth	loen	150	----	social behavior in animals	tinbergen,n	1953
aubo	uchp	chil	281	----	animal behavior	scott,jp	1958
aubo	prha	ecnj	171	----	behavio aspects of ecology	klopfer,ph	1962
aubo	olbo	edsc	653	----	animal dispersion, soc beh	wynne-edwards,vc	1962
edbo	jwis	nyny	349	----	maternal care in mammals	rheingold,lh,ed	1963
edbo	acpr	nyny	159	----	natural hist of aggression	carthy,jd; ebling	1964
edbo	uchp	chil	307	----	soc behav, organiza, verte	etkin,w	1964
aubo	meth	loen	150	----	soci behav, animals, verte	tinbergen,n	1965
aubo	macm	nyny	118	----	integral animal behavior	davis,d	1966
aubo	wile	nyny	432	----	pattern, animal communitie	elton,cs	1966
aubo	mhbc	nyny	534	----	anim behav: ethol, com psy	hinde,ra	1966
aubo	jwis	nyny	771	----	mechanisms of animal behav	marler,p; hamilto	1966
aubo	isup	amia	277	----	of predation and life	errington,pl	1967
aubo	prha	ecnj	297	----	introdu to animal behavior	klopfer,ph; hailm	1967
edbo	saco	phpa	563	----	abnormal behavior in amina	fox,mw	1968
aubo	dove	nyny	166	----	pschol, behav, zoos,circus	hediger,h	1968
edbo	nags	wadc	422	----	marvels of animal behavior	allen,tb	1972
aubo	uchp	chil	349	----	animal behavior	scott,jp	1972
aubo	whfr	sfca	458	----	wildlife ecology	moen,an	1973
edbo	dohr	stpa	362	----	hormones and sexual behavr	carter,cs	1974
edbo	dohr	stpa	401	----	social hierarch, dominance	schein,mw	1975
aubo	bhup	cama	697	----	sociobiol, the new synthes	wilson,eo	1975
edbo	acpr	nyny	344	----	mamm olfact, reprod, behav	doty,rl	1976
edbo	wiwi	bama	532	----	behavr of domestic animals	hafez,ese	1976
edbo	dohr	stpa	411	----	vertebrt social organizatn	banks,em	1977
edbo	plpc	nyny	609	----	chemical signals, vertebra	muller-schwarze,/	1977
edbo	jwis	nyny	364	----	quantitative ethology	colgon,pw	1978
aubo	mhbc	nyny	452	----	comparative anim behavior	devisbury,da	1978
edbo	plpr	nyny	183	----	aggress, domnce,indv spcng	krames,l/	1978
edbo	wiso	wadc	206	----	animal behavior	teague,rd,ed; moe	1979
aubo	fost	nyny	426	cerv	antelope, deer, north amer	caton,jd	1877
edbo	stac	hapa	668	od--	deer of north america	taylor,wp	1956
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
edbo	unbp	line	605	odhe	mule, black-tailed, no ame	wallmo,oc	1981
aubo	oxup	loen	215	ceel	herd, red dee, stud, behav	darling,ff	1937
aubo	cite	oxen	74	ceel	ecology of red deer	mitchell,b; stai/	1977
edbo	wimi	wadc	....	ceel	ecology,mngmnt, n amer elk	thomas,jw; towei	in pr
aubo	uwyp	lawy	294	ceel	n amer elk: ecol,behav,mgt	boyce,ms; hayden-	1979
aubo	utop	toon	280	alal	north american moose	peterson,rl	1955

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS EDITORS--	YEAR
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	aakn	nyny	339	bibi	the time of the buffalo	mchugh,t	1972
aubo	uopr	nook	247	ov--	the great ark of the wild	clark,jl	1964
aubo	uchp	chil	383	ovca	mount sheep: behavr, evolu	geist,v	1971
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965
edbo	iucn	mosw	940	many	behav, its relatn to mgmnt	geist,v; walther,	1974
edbo	stac	hapa	494	many	big game, n amer, ecol,mgt	schmidt,jl; gilbe	1978
aubo	acpr	nyny	202	ungu	reproductive behav, ungula	fraser,af	1968
edbo	blsp	oxen	652	ungl	p 413-424,man comm for con	duffey,e; watt,as	1971

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
ZOBEA	12--2	219	250	cerv	ethologi obsrvatns, n amer	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
MDCBA	5----	1	64	odvi	w-tailed deer of minnesota	erickson,ab; gunv	1961
MDCRA	14---	1	80	odvi	michigan white-tailed deer	jenkins,dh; bartl	1959
RWLBA	6---2	153	325	odvi	w-t deer of the adirondcks	townsend,mt; smit	933
RWLBA	6---2	327	385	odvi	wntr, spr obsrv, adirndcks	spiker,cj	1933
WCDBA	14---	1	282	odvi	white-tailed deer, wiscons	dahlberg,bl; guet	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
AZWBA	3----	1	109	odhe	in arizona chaparral	swank,wg	1958
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CFGGA	8----	1	163	odhe	life hist, managemt, calif	taber,rd; dasmann	1958
CGFPA	4----	1	39	odhe	lit review, movmnts,captur	siglin,rj	1965
CGFPA	7----	1	26	odhe	literature review on behav	dorrance,mj	1967
JOMAA	37--2	143	164	odhe	behavior, populatn ecology	dasmann,rf; taber	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
UCPZA	88---	1	209	ceel	tule elk: hist, behav, eco	mccullough,dr	1969
WLMOA	16---	1	49	ceel	status, ecol, roosevel elk	harper,ja; harn/	1967
WLMOA	24---	1	66	ceel	the sun river elk herd	knight,rr	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observ in yellowstone park	mcmillan,jf	1954
BEHAA	20--3	377	416	alal	behavi in british columbia	geist,v	1963
FUNAA	8....	40	43	alal	moose habits and habitat	rush,wm	1946
JOMAA	39--1	128	139	alal	summr obsrvtns, behv,ontar	de vos,a	1958
MUZBA	25---	1	44	alal	the moose of isle royale	murie,a	1934
NCANA	101--	1	436	alal	ecol, proc inter sym, pt 1	bedard,j	1974
NCANA	101--	437	735	alal	ecol, proc inter sym, pt 2	bedard,j	1974
VLUBB	22-15	74	82	alal	[elk behav, leningr, russ]	timofeeva,ek	1967
ZOOLA	41-14	105	118	alal	ecol behav popula dynamics	denniston,rh	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BPURD	2----	1	215	rata	ecol, caribou, prudhoe bay	white,rg; thomso/	1975
CWRSB	38---	1	71	rata	biology, kaminuriak popula	dauphine,tc,jr	1976
UABPA	3----	1	44	rata	behav of barren-ground car	pruitt,wo	1960
UABPA	8----	1	82	rata	ecology, managment, sweden	skunke,f	1969
WMBAA	10A--	1	79	rata	prelim investigation, pt 1	banfield,awf	1954
WMBAA	10B--	1	112	rata	prelim investigation, pt 2	banfield,awf	1954
WMBAA	12---	1	148	rata	caribou, continued studies	kelsall,jp	1957
WMBAA	15---	1	145	rata	barrn gr carib, coop study	kelsall,jp	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	43--2	257	354	anam	life hist,ecol,rng use,tex	buechner,hk	1947
CAFGA	30--4	221	241	anam	prong-hornd antlp in calif	mclean,dd	1944
CGFPA	3----	1	28	anam	litera revi on prong behav	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behav patterns of the	prenzlow,ej; gil/	1968
JOMAA	3----	82	105	anam	the prong-horn	skinner,mp	1922

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NPSMD	161--	1	161	bibi	bison, yellowston nat park	meagher,mm	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	24--3	505	580	ov--	distribut, variat, no amer	cowan,imct	1940
AZWBA	1----	1	153	ov--	desert bighorn	russo,jp	1956
WLMOA	4----	1	174	ov--	united sta, past to future	buechner,hk	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of mountain sheep	mccann,lj	1956
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
CJZOA	46--5	899	904	ovca	ovda,delay soc, phys matur	geist,v	1968
IGWBA	1----	1	154	ovca	stat, life hist, mgt, idah	smith,dr	1954
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	20--4	440	455	ovca	bighorn sheep of texas	davis,wb; taylor,	1939
JOMAA	24--1	1	11	ovca	notes on life histor, colo	spencer,cc	1943
SCBUB	35--6	29	76	ovca	survey, sierra nevada bigh	jones,fl	1950
WGFBA	1----	1	127	ovca	wyoming bighorn study	honess,rf; frost,	1942
WLMOA	4----	1	174	ovca	bighorn sheep in the u s	buechner,hk	1960
XNFSA	6----	1	242	ovca	bighorn of death valley	welles,re; welles	1961

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
WMBAA	9----	1	34	obmo	prelim stud,ellesmr is,nwt	tener,js	1954

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, mgtmt, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
SCZFA	113--	660	668	caca	[obs behav roe dee; germa]	eiberle,k	1962
ZEJAA	8---2	61	81	caca	behavior of roe bucks	hennig,r	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MRLTA	41--3	34	40	dogo	feral goats, british colum	geist,v	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
PZSLA	142-1	129	163	dosh	study, feral pop, st kilda	boyd,m; doney,jm/	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZOGAA	33...	65	78	momo	behav of moschus moschifer	fradich,h	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JTBIA	2---1	63	68	----	environments of anim, plan	browning,to	1962
QRBIA	22---	283	314	----	life tabls, natrl pop anim	deevey,es	1947

OTHER PUBLICATIONS

Proceedings of the White-tailed Deer in the Southern Forest Habitat Symposium (First meeting in 1962)

Transactions of the Annual Meeting of the Northeast Deer Study Group (Annual meeting beginning 1964)

Proceedings of the North American Moose Conference (Fifth conference in 1968)

Proceedings of the International Reindeer/Caribou Symposium (First meeting in 1977, second in 1980)

Proceedings of the Biennial Antelope States Workshop

Transactions of the Interstate Antelope Conference

Transactions of the North American Wild Sheep Conference (Second meeting in 1976)

Transactions of the Desert Bighorn Council (Annual meeting beginning 1957)

Proceedings of the International Mountain Goat Symposium

Proceedings of the Annual Conference of Western Association of State Game & Fish Commissioners (Annual conference beginning 1921)

TOPIC 1. INTRASPECIES INTERACTIONS

Intraspecies interactions occur between different individuals, sexes, and age groups in a population. Some of the interactions are sex-specific, such as male reproductive behavior in relation to the female. Some are age-specific interactions, such as female reproductive behavior in relation to the offspring. Some interactions occur primarily between individuals within an age group, such as play among juveniles.

Social hierarchies are the result of intraspecies interactions among sex and age groups. Such hierarchies may have easily-identified individuals at both extremes. The most dominant animal, such as a large male, is at one extreme, and the most subordinate one, such as a late-born juvenile that cannot compete even with other juveniles, at the other extreme. Between these two extremes, the rank-order may often be recognized, although it may change as it is not absolute, of course.

In general, the larger and stronger animals are dominant and the smaller and weaker ones subordinate. The position of dominance is usually not attained by physical fighting however, but by non-contact assertions. Seasonal changes occur in social hierarchies as a result of changes in hormone balances, reproductive status, weather, and resource availability.

Descriptions of male and female reproductive behavior follow in UNITS 1.1 and 1.2, respectively. Such descriptions are more descriptive than quantitative. It is easier to quantify the metabolic requirements for lactation than it is to quantify behavior during lactation. One important approach to quantifying such behavior is the determining of the amount of time spent in different aspects of reproductive behavior. Thus activity-time budgets show up again with changes through time as animals grow, mature, and reproduce.

Social hierarchies are discussed in UNIT 1.3. The roles of aggressive and non-contact assertions are discussed, along with seasonal changes in social hierarchies as a result of changes in both the internal and external environment.

UNIT 1.1: MALE REPRODUCTIVE BEHAVIOR

The seasonal activity patterns of male wild ruminants are related to the reproductive cycle, with a general increase in activity levels during the rut. Males of some species breed females that are defended as a group (elk, for example), and in other species, males make no attempts to collect or defend a group; females are bred on an individual basis (whitetail and mule deer, for example).

Reproductive behavior of males during the breeding season is usually very stereotyped. The animals are, at that time, under rather marked chemical control as both hormones and pheromones are released that affect physiology and behavior. Food intake is reduced, even when ample feed is available. The fat reserve is often depleted during the breeding season as a result of increased activity levels and decreased forage intake. This results in a negative energy balance and a rapid and significant weight loss. This negative energy balance is apparently under hormonal control as a male black-tailed deer on a low plane of nutrition did not increase intake when fed ad libitum during the rutting season, but maintained a level of intake that was characteristic of the rut (Nordan et al. 1968).

Wild ruminant males are separated socially by their status in a group. Some species, such as caribou, have quite well-defined groups. Others, such as moose, have more poorly-defined groups. The males exhibit rutting behavior in late summer and fall after growth of the antlers has been completed and the velvet is shed. Then, the males become aggressive, prone to spar with objects in their habitat and combat with other males of their own species. Saplings and shrubs become targets for the relief of aggressive tendencies as male deer rub their antlers. Some people believe that such "buck rubs" are made by males rubbing the velvet off the antlers. The velvet comes off very quickly, often in a few hours, and may be accompanied by little or no rubbing (Moen 1973: 211). Dixon (1934) observed that the shedding of velvet was rapid in mule deer. Velvet-covered antles were bare within 13 hours, with some velvet that had not been rubbed off on saplings hanging in shreds from the base of the antlers. These shreds were removed by using the sharp rear hooves to dislodge them. Antler-rubbing, or "horning," then continued for as long as the antlers were retained. Bucks rub objects, especially straight saplings, that offer appropriate resistance as part of their territorial displays; saplings up to a few cm in diamter are usually chosen.

Actual breeding by the male white-tailed deer involves spending time with a female in heat, breeding the female as often as she will stand, and then going on to another receptive female. The larger, dominant males have more opportunities for breeding as they can replace a sub-dominant running with a female. In the captive herd at the Wildlife Ecology Laboratory, Cornell University, the dominant male would breed a receptive female first. After several successive breedings, a sub-dominant male may have a chance to breed a receptive female because the dominant male was exhausted. This may be partly due to confinement conditions; a six-acre yard does not allow the overall freedom of movement characteristic of free-ranging deer.

Evidence of physical combat is sometimes found in the field as antlers have become locked together, resulting in the eventual deaths of both deer. Hostile fights were observed between males only during the mating season in Texas (Michael 1968). At other times of the year, antlers were used in aggressive behavior but not maliciously; pushing contests were the common form of aggressive interaction. Geist (1963) observed more spirited sparring among yearling and two-year old bull moose than among older bulls; the older ones did more pushing with the antlers in contact.

Males are rather quiescent after the breeding season is over. Male white-tailed deer may form loosely-defined groups then with no particular social structure. They may still have antlers (Zagata and Moen 1974), but serious aggressive tendencies have waned. Their fat reserves are quite depleted, and the metabolic depression of winter sets in. Bull moose also formed loosely-organized groups in the winter, with no obvious leadership or dominance hierarchy observed (Geist 1963).

Specific behavioral acts have been described for some species. Geist (1971) describes several male reproductive behavior acts for bighorn sheep. Some of these are listed and defined below.

Spontaneous ejaculation	Non-contact ejaculation with stiff-legged striding or short forward steps.
Sniffing rear	Sniffing and nuzzling of the rear of a ewe after approaching in low-stretch. Rams also sniff subordinate males.
Tongue-flicking	Flicking of the tongue preperatory to licking the body.
Lipcurl (Flehmen)	Raised head and upward curling of upper lip by rams after nuzzling and licking urine of ewes.
Mount	Copulation-type posture by male on either female or male sheep, with pelvic thrusts.

The lipcurl, or Flehmen (a German word introduced into the literature in 1930; Altieri and Müller-Schwarze 1980) is a rather stereotyped response of ungulates to urine (Henderson et al. 1980). Geist (1963) cites early speculations of Walther concerning the role of lipcurl in relation to testing the urine of females. An interesting pattern of responses in black-tailed deer is given in Henderson et al. (1963: 539); the annual cycle of general responses and Flehmen by male black-tailed deer to female and male urination is a rather characteristic sine wave. Peak responses occurred in November, during the breeding season.

Sniffing the rear of a female is a common male response during the rut. Geist (1963) observed it, mainly during the rut, in moose. Licking of the cow's genitalia was much less common. Cervids and pronghorn males paw the ground during the rutting season. The scrapes of deer and rutting pits of moose are similar male acts in their beginning, but deer do not appear to wallow in the scrape as moose do in the pit. Moose rutting pits were made by pawing the ground with the front hooves, urinating in the wallow, and then wallowing in it (Geist 1963). Bull elk 2 1/2 years and older also dig; their penial region palpitated while digging, and they would stop to ejaculate in the dirt, and on the forelegs and throat (Struhsaker 1967).

The culmination of rutting behavior is breeding of the female, or of several females through the rutting period. After that, the males are passing time, growing antlers, and gaining weight in spring and summer in preparation for another breeding season.

LITERATURE CITED

Altieri, R. and D. Müller-Schwarze. 1980. Seasonal changes in Flehmen to constant urine stimuli. J. Chem. Ecol. 6(5):905-909.

Dixon, J. S. 1934. A study of the life history and food habits of mule deer in California. Cal. Fish Game 20(3):181-282.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 683 p.

Henderson, J., R. Altieri, and D. Muller-Schwarze. 1980. The annual cycle of Flehmen in black-tailed deer (Odocoileus hemionus columbianus). J. Chem Ecol. 6(3):537-547.

Michael, E. D. 1968. Aggressive behavior of white-tailed deer. The Southwestern Naturalist 13(4):411-420.

Moen, A. N. 1973. Wildlife Ecology. W. H. Freeman and Co., San Francisco. 458 p.

Nordan, H. C., I. McT. Cowan, and A. J. Wood. 1968. Nutritional requirements and growth of black-tailed deer (Odocoileus hemionus columbianus) in captivity. In Comparative Nutrition of Wild Animals, ed. M. A. Crawford. Symp. Zool. Soc. London, No. 21. pp. 89-96.

Struhsaker, T. T. 1967. Behavior of elk (Cervus canadensis) during the rut. Zt. Tierpsychcol. 24(1):80-114.

Zagata, M. D. and A. N. Moen. 1974. Antler shedding by white-tailed deer in the midwest. J. Mammal. 55(3):656-659.

REFERENCES, UNIT 1.1

MALE REPRODUCTIVE BEHAVIOR

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
AMNAA	77--2	390	417	cerv	soc behav, repro per, n am	de vos,a; brokx,/	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
AMNAA	97--2	257	266	odvi	char rubs, scrapes, social	kile,tl; marchint	1977
ANBEA	26--1	179	183	odvi	reprod behav captive w-t d	warren,rj; vogel/	1978
JOMAA	35--1	129	130	odvi	rutting behavior of the wh	pruitt,wo,jr	1954
JOMAA	46--2	314	327	odvi	soc be, herd, hypogon male	thomas,jw; robin/	1965
JOMAA	48--1	146	147	odvi	rubbi, conif, successi yrs	de vos,a	1967
JOMAA	52--3	616	620	odvi	auto-erotic behavior, male	marchinton,rl; mo	1971
JOMAA	55--3	656	659	odvi	antler shedding in midwest	zagata,md; moen,a	1974
NAWTA	7----	334	342	odvi	tech det rut period in ny	cheatum,el; morton	1942
NFGJA	2---2	239	241	odvi	observa, breeding behavior	severinghaus,cw	1955
PCGFA	18---	140	152	odvi	telem, movem, behav, flori	jeter,lk; marchin	1964
SWNAA	13--4	411	420	odvi	aggressive behavior, w-t d	michael,ed	1968
VJSCA	24--3	112	112	odvi	breeding behav, captv male	buckland,de; abl/	1973
VJSCA	26--2	60	60	odvi	aspcts, reprod behav, capt	vogelsang,rw; wa/	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	28--1	312	313	odhe	submissive signaling in mu	koutnik,dl	1980
CAFGA	20--3	181	282	odhe	life history, california	dixon,js	1934
CAFGA	26--2	137	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CAFNA	84--1	57	58	odhe	aberran beh, dominant male	miller,fl	1970
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JCECD	6---3	537	547	odhe	annual cycle of flehmen in	henderson,r; alt/	1980
JCECD	6---5	905	909	odhe	seas change, flehmen,urine	altieri,r; müller	1980
JOMAA	38--1	116	120	odhe	gest per, breed & fawn beh	golley,fb	1957
JOMAA	38--2	247	253	odhe	observatns, behavr, penned	browman,lg; hudso	1957
JOMAA	42--4	522	526	odhe	aggressive behavio in deer	cowan,imct; geist	1961
JOMAA	59--3	463	476	odhe	soc behav, breed syst, des	kucera,te	1978
SZSLA	21---	89	96	odhe	nutritio requireme, growth	nordon,hc; cowan/	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	27--1	211	225	ceel	adaptive aspects, fighting	clutton-brock,th/	1979
ANBEA	28--4	1163	1174	ceel	beh factrs, male repr succ	gibson,rm; guinn	1980
BEHAA	16--1	84	92	ceel	charactr of estrus, captiv	morrison,ja	1960
BEHAA	69--3	145	170	ceel	roarng, evol honest advrti	clutton-brock,th/	1979
EKIAA	6---1	100	102	ceel	biol signal field, roaring	nikol'skii,aa; n/	1975
HOBEA	3---4	375	396	ceel	testost, social sexual beh	lincoln,ga; guin/	1972
JBLPA	6....	83	95	ceel	[kinetics, stag roaring]	bubenik,a; brna,j	1967
JEZOA	182-2	233	250	ceel	role of antlers, behavior	lincoln,ga	1972
JOMAA	37--2	165	170	ceel	odhe, territorialism in de	graf,w	1956
JRPFA	S11--	71	103	ceel	social, sexual behav, stag	lincoln,ga; youn/	1970
JRPFA	S19--	271	285	ceel	reproductive performance	mitchell,b	1973
JRPFA	S19--	475	489	ceel	sexual significance of rut	lincoln,ga; guine	1973
JRPFA	54--2	325	334	ceel	factors affecting fertilit	guinness,fe; alb/	1978
JWMAA	9---4	295	319	ceel	roosvlt elk, olympic penin	schwartz,je,II; /	1945
JWMAA	24--1	15	21	ceel	on afognak island, alaska	troyer,wa	1960
JZOOA	163-1	105	123	ceel	seas reproduc change, stag	lincoln,ga	1971

ceel continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZETIA	24--1	80	114	ceel	behavior, during the rut	struhsaker,tt	1967
ZOOLA	41--8	65	71	ceel	pattrns,hrd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
CAFNA	87--3	321	321	alal	associatn of calf and bull	lynch,gm; labonte	1973
CAFNA	90--4	475	476	alal	behavior of calf, ontario	croskery,p	1976
IUNRA	24...	690	....	alal	social organization	geist,v,ed; houst	1974
JOMAA	39--3	412	416	alal	pre-rut behav, newfoundlan	dodds,dg	1958
JOMAA	40--3	420	424	alal	group dynam, rut seas, wyo	altmann,m	1959
JWMAA	13--3	313	313	alal	obser of courting behavior	thompson,wk	1949
JWMAA	35--1	63	71	alal	radiotelemet, ne minnesota	van ballenberghe/	1971
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
NCANA	101--	307	323	alal	review of rutting behavior	lent,pc	1974
NCANA	101--	371	377	alal	behav chng w/ age, domesti	knorre,ep	1974
TLPBA	14--1	76	104	alal	time-energ budget of a moo	belovsky,ge; jord	1978
ZOBEA	12--2	219	250	alal	etholog observatns, n amer	geist,v	1966
ZOOLA	41-14	105	118	alal	ecol, beh, pop dynam, wyom	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	12--1	159	163	rata	rutting behavi in reindeer	espmark,y	1964
ANBEA	13--2	259	264	rata	rut beh, barr-gr carib pop	lent,pc	1965
ANBEA	18--2	256	258	rata	consequeces of travel, rut	henshaw,j	1970
CAFNA	87--4	357	369	rata	movmnt, rut behavr, quebec	bergerud,at	1973
JWMAA	24--3	250	258	rata	behav bar grnd, calvng gnd	devos,a	1960
JWMAA	31--1	150	159	rata	results, tagging, manitoba	miller,dr; robert	1967
NATUA	224--	1036	1037	rata	antlers, bones of contentn	henshaw,j	1969
UABPA	3----	1	44	rata	behavior, barrn gr caribou	pruitt,wo,jr	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATICA	13--1	3	19	bibi	behv,socl org,wd buff n pk	fuller,wa	1960
PIAIA	74---	87	91	bibi	observ, beha, lone bull bi	fischer,wa	1968
PIAIA	76---	245	262	bibi	bull bison behavior traits	herrig,dm; hauge	1969
ZOOLA	43--1	1	40	bibi	social behviour, amer buff	mchugh,t	1958

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	17--4	700	705	ov--	copul beh I. normative stu	bermant,g; clegg/	1969
ANBEA	17--4	706	711	ov--	cop beh II. copu satiation	beamer,w; berman/	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of the mount sheep	mccann,lj	1956
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JWMAA	31--4	693	706	ovca	populat, desert game range	hansen,cg	1967
JWMAA	34--2	446	450	ovca	mvmnt,behav,smmr rang, wyo	woolf,a; oshea,t/	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CJZOA	46--5	899	904	ovda	ovca,delayd soc,phys matur	geist,v	1968
JTBIA	72--3	377	384	ovda	sexual selec, ornamn trait	williams,mb	1978
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955
JOMAA	45--4	551	568	oram	rutti behav of the mt goat	geist,v	1964
JWMAA	31--1	192	194	oram	fight injur, derma shields	geist,v	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZEJAA	14--3	97	106	caca	rel bet behav & repro perf	kurt,f	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZETIA	43--2	188	213	mure	socl behav captiv muntjacs	barrette,c	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZSAEA	39--2	115	127	cp--	courtship behav, wild goat	schaller,gb; laur	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AAAHA	8--35	649	652	dosh	breed,seas,competit,mating	lindsay,dr; ellsm	1968
ANBEA	13--1	75	78	dosh	olfct stim, matng behv,ram	lindsay,dr	1965
ANBEA	16--4	410	414	dosh	sensry invlvmnt matng behr	fletcher,ic; lind	1968
ANBEA	17--4	706	711	dosh	factors afft copul satiatn	beamer,w; berman/	1969
BEHAA	23--3	249	279	dosh	some aspects sexual behavi	banks,em	1964

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
AMZOA	14--1	205	220	ungl	relatnshp social evol,ecol	geist,v	1974
BHBLA	11--2	131	154	----	concept of social dominanc	rowell,te	1974
JTBIA	47--1	223	243	----	asses strat, evol fght beh	parker,ga	1974
MAMLA	36--3	315	341	mamm	role vomeronasal organ,rep	estes,rd	1972
NATUA	246--	15	18	----	logic of animal conflict	maynard smith,jm/	1973

OTHER PUBLICATIONS

Bergerud, A. T. 1960. Fall breeding behavior of woodland caribou. Rept. Dept. Mines, Agr., and Resources, Newfoundland. 103 p.

Geist, V. 1964. On the rutting behavior of the mountain goat. Univ. Idaho Bull. 33(22):43-49.

CHAPTER 5, Worksheet 1.1a

Male reproductive behavior

Locate a group of animals and observe the interactions of the males. If free-ranging wild ruminants are not available, observe a captive group or domestic ruminants if necessary. Practice on readily-available groups will enhance observations in the wild later.

List the actions and reactions below. The INDIVIDUAL column is for identification.

GESP	JDAY	TIME	INDIVIDUAL	ACTION	REACTION

GESP	JDAY	TIME	INDIVIDUAL	ACTION	REACTION

UNIT 1.2: FEMALE REPRODUCTIVE BEHAVIOR

Female ruminants have the very serious ecological responsibility of bearing the young and nursing them until they can be nutritionally weaned. Such direct reproductive responsibilities extend over 85% or more of the year.

Particularly important female reproductive behavior occurs at two times of the year. Breeding occurs in the fall when the female is receptive. At that time, hormone control is very strong and the female is compelled to stand for breeding. Conception is followed by a gestation period of several months (see PART I, CHAPTER 1, UNIT 3.4 and PART III, CHAPTER 6, UNIT 4.1) during which behavior is modified little until parturition approaches.

Parturition is anticipated differently by different species. Caribou travel to historic calving grounds. Female bison go off by themselves and give birth in isolation. White-tailed deer prepare very little for parturition, dropping their fawns wherever they happen to be. Shelter does not seem to be important; I have found birth sites in open fields, exposed in all directions. Michael (1964) reports observations of the births of two fawns in Texas, noting no special preparations, and other deer within 20 yards of one of the does. Dixon (1934) was surprised to find that a mule deer doe went out into an open meadow to give birth to her fawns rather than into a dense thicket. The fawns were well hidden in the dense sedge and marsh grass. The open meadow provided the female with good visibility, permitting her to see danger and move away before it approached too closely.

Maternal instincts are genetically controlled as a female giving birth for the first time is not dependent on being "taught" how to care for the newborn. Yet there are differences in the kind and amount of maternal care provided by females of different ages and experiences. This has been clearly observed in domestic sheep, for example, and such differences are expected to occur in wild ruminants as well. Maternal care of subsequent offspring likely improves after experiences with the first-born. There seems to be an inherited framework that is subject to individual variation, followed by learning that is based on experiences.

Maternal behavior is difficult to observe in the wild because of limited visibilities, night-time activity periods, and subtle communications between mother and young. The observations of Michael (1964) were made with spotting scope and binoculars from a platform 40 feet high in relatively open country. Female mule deer use their voice--a low bleat--to call their young (Dixon 1934). There are undoubtably many details to be learned about this important part of behavior.

Female reproductive behavior after parturition is very much related to the development of fawn behavior patterns. White-tail fawns are very quiescent in the first few days, bedding for 95% or more of the time (See CHAPTER 4, UNIT 2.1). The dam visits them periodically during the day to

allow them to nurse, but not "every four hours." Almost ten hours elapsed between feedings of twin mule deer fawns from birth to nine days old (Dixon 1934). The dam spends the rest of her time in the general area, much of the time foraging. About ten minutes were taken by fawns for nursing. The dam nursed her young while lying down in the first three to four days of life, which provided greater safety by being inconspicuous in the tall grass and may have also been necessary for the little fawns to reach the teats. By the time fawns are three months old, they may have to kneel while nursing.

Fawns acompany the dam more and more as they grow older and stronger, foraging more as they become less dependent on milk and more dependent on forage. They are also learning behavioral responses to danger and other relationships with the environment by association with the examples of the mother.

Weaning results in the breaking of the nutritional ties between mother and young, but the fawns may remain with the dam during the first winter, although not necessarily in constant daily contact. Thus a nutritional weaning precedes a social weaning. A more complete break in mother-young relationships of deer comes when parturition occurs again. Adult females are dominant over their young and others, and do not hesitate to drive them away from limited food supplies.

Lactating females must spend a lot of time foraging in order to meet the high metabolic requirements of lactation. This, plus the provision of maternal care for their offspring that results in higher levels of nervousness and environmental awareness than would be the case for barren females, places a high physiological drain on the female. This appears to be very pronounced as minimum weights in the annual cycle are often reached during lactation. After lactation ceases, the females need to forage to meet the costs of growth as they reach their peak weights in late fall or early winter. After that, winter is a time of reduced activity, followed by increases as the last 1/3 to 1/4 of the gestation period is reached, spring arrives and parturition approaches again.

Geist (1971: 105-107) reviews changes in mother-young relationships of several ungulates when the latter are yearlings and the former is about to give birth again. Two groups of species with different kinds of mother-young relationships are discussed. Moose, white-tailed deer, and mule deer exhibit a rather violent mother-young separation as the yearlings are chased away, several times if necessary, as parturition approaches. These yearlings may associate with other animals--adult males, for example--during the summer; red deer (elk), caribou, and mountain sheep do not exhibit such a violent mother-young separation, although yearlings may not be tolerated in close proximity to the newborn. A reasonable hypothesis for these differences is that ungulates which are more social as adults tend to have more gradual and less violent mother-young separations.

The mother-young separation results in another social pattern that appears to be characteristic of ungulates in general. Yearling males tend to wander more after separation, being subordinates in different groups before establishing a home range. Yearling females, however, wander less, likely

becoming residents of part or near their dam's home range. These social hierarchies are dependent on sex, age, and time of year, which are important factors in the roles of individual animals during the reproductive cycles.

LITERATURE CITED

Dixon, J. S. 1934. A study of the life history and food habits of mule deer in California. 20(3):181-282.

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

Michael, E. D. 1964. Birth of white-tailed deer fawns. J. Wildl. Manage. 28(1):171-173.

REFERENCES, UNIT 1.2

FEMALE REPRODUCTIVE BEHAVIOR

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965
edbo	jwis	nyny	349	many	maternal care in mammals	rheingold,hl,ed	1963

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	77--2	390	417	cerv	soc behav dur repro period	devos,a; brokx,p/	1967
ZOBEA	12--2	219	250	cerv	ethologicl obsrvtns,n amer	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	26--1	179	183	odvi	reprod behav, captive deer	warren,rj; vogel/	1978
AMZOA	10--4	480	481	odvi	partur, matrn, neonat beha	townsend,tw; bail	1970
ECOLA	53--2	262	270	odvi	activ patt, fawns, s texas	jackson,rm; whit/	1972
JOMAA	35--1	129	130	odvi	rutting behavior of the wh	pruitt,wo,jr	1954
JOMAA	38--3	420	421	odvi	partur, early react, fawns	haugen,ao; speake	1957
JOMAA	56--2	347	362	odvi	partur, matrn, neonat beha	townsend,tw; bail	1975
JWMAA	27--3	422	427	odvi	nocturnl mvmnt, actv rhyth	montgomery,gg	1963
JWMAA	28--1	171	173	odvi	birth of w-tail deer fawns	michael,ed	1964
JWMAA	34--2	407	419	odvi	social organization, w-t d	hawkins,re; klims	1970
JWMAA	36--3	897	906	odvi	dam-newb fawn beh,cap,mort	white,m; knowlto/	1972
JWMAA	39--4	679	683	odvi	actv pattrns during estrus	ozoga,jj; verme,l	1975
NFGJA	2---2	239	241	odvi	some obs on breeding behav	severinghaus,cw	1955
PCGFA	18---	140	152	odvi	telem, movem, behav, flori	jeter,lk; marchin	1964
TISAA	62--2	117	119	odvi	day location, beds, fawns	kjos,cg; montgome	1969
VJSCA	24--3	112	112	odvi	breedi behav, captv female	abler,wa; buckla/	1973
VJSCA	26--2	60	60	odvi	aspcts, reprod beh, captiv	vogelsang,rw; wa/	1975

ODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	20--3	181	282	odhe	life history, california	dixon,js	1934
CAFGA	26--2	139	166	odhe	calif deer,rcky mt mule de	mclean,dd	1940
JOMAA	38--1	116	120	odhe	gesta per, breed, fawn beh	golley,fb	1957
JOMAA	38--2	247	253	odhe	observatns, behavr, penned	browman,lg; hudso	1957
JOMAA	39--1	155	155	odhe	failure to wean offspring	hanson,wr	1958
JOMAA	42--4	522	526	odhe	aggressive behavior in dee	cowan,imc; geist,	1961
JOMAA	56--2	520	522	odhe	beh assoc parturitn, captv	halford,dk; alldr	1975
JOMAA	59--3	463	476	odhe	soc behav, breed syst, des	kucera,te	1978
JWMAA	18--4	537	538	odhe	use deer call, locat fawns	diem,kl	1954
JWMAA	29--3	629	631	odhe	behav assoc with parturiti	miller,fl	1965
JWMAA	41--1	150	151	odhe	birth, first day behavior	truett,jc	1977
NATUA	229--	55	56	odhe	olfctry imprnt,precoc mamm	muller-schwarze,/	1971
ZETIA	28--5	527	533	odhe	maternal behav, fawn death	miller,fl	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	27--2	536	544	ceel	mothr-offspring assoc,rhum	guinness,fe; hal/	1979
BEHAA	16--1	84	92	ceel	charact of estrus, captive	morrison,ja	1960
BEHAA	55--3	287	300	ceel	behavior at calving time	clutton-brock,th/	1975
JAECA	47--3	817	832	ceel	factors aff calf mortality	guinness,fe; clu/	1978
JRPFA	27--3	427	438	ceel	reprod cycle, female red d	guinness,f; linc/	1971
JRPFA	S19--	271	285	ceel	reproductive performance	mitchell,b	1973
JRPFA	37--1	87	90	ceel	partur, matrnl behav, capt	arman,p	1974
JRPFA	54--2	325	334	ceel	factors affecting fertilit	guinness,fe; alb/	1978
JWMAA	9---4	295	319	ceel	roosvlt elk, olympic penin	schwartz,je,II; /	1945
JZOOA	185-1	105	114	ceel	calving times in red deer	guinness,fe; gib/	1978
XARRA	240--	1	4	ceel	herbicid, elk calvng behav	ward,al	1973
XNFSA	4----	1	206	ceel	ecol, coyote, yllwstn n pk	murie,a	1940
ZETIA	24--1	80	114	ceel	behavior of during the rut	struhsaker,tt	1967
ZOOLA	41--8	65	71	ceel	pattrns,hrd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	6---3	155	159	alal	social integration of calf	altmann,m	1958
ANKIA	60--3	79	80	alal	life with mother	altmann,m	1957
BEHAA	20--3	377	416	alal	behavior, n amer moose, bc	geist,v	1963
CAFNA	87--3	321	321	alal	associati of calf and bull	lynch,gm; labonte	1973
CAFNA	90--4	475	476	alal	beh, calf, norfolk is, ont	croskery,p	1976
IUNRA	24...	690	....	alal	social organization	geist,v,ed; houst	1974
JOMAA	40--3	420	424	alal	group dynam, rut seas wyom	altmann,m	1959
JWMAA	13--3	313	313	alal	obser of courting behavior	thompson,wr	1949
JWMAA	35--1	63	71	alal	radiotelemet, ne minnesota	van ballenberghe/	1971
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
NCANA	101--	307	323	alal	a review of rutting behavr	lent,pc	1974
NCANA	101--	325	369	alal	mother infant relationship	stringham,sf	1974
NCANA	101--	371	377	alal	chng behv w/ age, domestic	knorre,ep	1974
TLPBA	14--1	76	104	alal	time-energ budget of a moo	belovsky,ge; jord	1978
ZOOLA	41-14	105	118	alal	ecol,behav,pop dynam,wyomi	denniston,rhII	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	10--4	481	481	rata	vocalization, behavior	erickson,ca	1970
ANBEA	13---	259	264	rata	ruttng behav, brn grnd pop	lent,pc	1965
ATICA	19--2	111	113	rata	functn brow tine, caribou	pruitt,wo	1966
BEHAA	54--1	50	59	rata	individua char, calls, cal	espmark,y	1975
BPURD	1----	387	397	rata	intrasp commun, mother-cal	ericson,ca	1975
BPURD	1----	398	408	rata	acoustic communicat, revi	lent,pc	1975
BPURD	1----	423	435	rata	socializat, calving ground	miller,fl; ander/	1975
BVJOA	125-1	48	50	rata	estrous behav in reindeer	barden,p	1969
CAFNA	81--1	63	66	rata	funct anat, tail, behavior	lewin,v; stelfox,	1967
CAFNA	87--1	21	25	rata	beh, mort, stress, maternl	miller,fl; brough	1973
CAFNA	87--4	357	369	rata	movmnt, rut behavr, quebec	bergerud,at	1973
JOMAA	49--4	778	778	rata	plactl remnts rumen matern	miller,fl; parker	1968

rata continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	24--3	250	258	rata	behav bar-gr cari, calv gr	de vos,a	1960
JWMAA	27--3	422	427	rata	comp sim, activ patter, en	bunnell,fl; whit/	
JWMAA	31--1	150	159	rata	results, tagging, manitoba	miller,dr; robert	1967
JWMAA	35--1	175	177	rata	antler shedding, parturitn	espmark,y	1971
UABPA	3----	1	44	rata	behavior, barre gr caribou	pruitt,wo,jr	1960
WMBAA	12---	1	148	rata	continued barren-grnd stud	kelsall,jp	1957
WMBAA	15---	1	145	rata	co-op studies barrn-ground	kelsall,jp	1960
XNFSA	5----	1	238	rata	the wolves of mt mckinley	murie,a	1944
ZETIA	23--6	701	756	rata	calvng & rel behav, bar gr	lent,pc	1966
ZETIA	29--1	42	81	rata	mother-young, ontogeny, be	espmark,y	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	30--4	221	241	anam	prnghrnd antlp, california	mclean,dd	1944
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JOMAA	47--4	708	709	anam	observation of parturition	howard,vw,jr	1966
JWMAA	6---4	281	286	anam	gath, transpl, care, young	nichol,aa	1942
JWMAA	37--3	343	352	anam	mortality, fawns, wst utah	beale,dm; smith,a	1973
XNFSA	4----	1	206	anam	ecol, coyote, yllwstn n pk	murie,a	1940

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of the mount sheep	mccann,lj	1956
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
JOMAA	18--2	205	212	ovca	prelim study, yllwstn n pk	mills,hb	1937
JOMAA	44--1	116	118	ovca	growth, behav, captiv lamb	forrester,dj; hof	1963

ovca continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	44--3	433	433	ovca	observa of lambing, desert	simmons,nm; levy/	1963
JOMAA	50--1	128	128	ovca	defensive behav in females	hornocker,mg	1969
JWMAA	34--2	446	450	ovca	mvmnt, behav,smmr rang,wyo	woolf,a; oshea,t/	1970
XNFSA	4----	1	206	ovca	ecol, coyote, yllwstn n pk	murie,a	1940

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
VILTA	6---6	461	540	caca	moth-young rela, behav dev	espmark,y	1969
ZEJAA	14--3	97	106	caca	rel bet behav & repro perf	kurt,f	1968
ZSAEA	30--1	65	128	caca	[birth, adu fema-juv rela]	bubenik,ab	1965

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZETIA	43--2	188	213	mure	socl behav captiv muntjacs	barrette,c	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZSAEA	39--2	115	127	cp--	courtship behav, wild goat	schaller,gb; laur	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JRMGA	19--4	200	204	doca	use of mountain slope	cook,cw	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ZETIA	23--5	588	592	dogo	matern imprint, role chemi	klopfer,ph; gambl	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	12--1	34	37	dosh	obs suckling habit twin lam	ewbank,r	1964
ANBEA	14--1	120	125	dosh	critical per, lamb attachm	smith,fv; van-to/	1966
ANBEA	14--4	419	424	dosh	mat behav ewe,eff mat effi	lindsay,dr	1966
ANBEA	15--2	251	258	dosh	nurse,suckling beh,ewes,lam	ewbank,r	1967
ANBEA	16--4	410	414	dosh	sensory invlvmnt matng beh	fletcher,ic; lind	1968
ANBEA	16--4	415	417	dosh	snsry recogn lambs by dams	lindsay,dr; fletc	1968
ANBEA	19--1	75	79	dosh	acc orphan lamb, tranq ewe	neathery,mw	1971
BEHAA	23--3	249	279	dosh	some aspects sexual behavi	banks,em	1964
ECOLA	37--2	228	239	dosh	dogo, analysis, socialzatn	collias,ne	1956
JANSA	21--4	870	874	dosh	mating behavior of the ewe	hulet,cv; blackw/	1962
PAANA	3----	105	114	dosh	maternal behav, merino ewe	alexander,g	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	14--1	205	220	ungl	relatnshp socal evol, ecol	geist,v	1974
MAMLA	36--3	315	341	mamm	role vomeronasl org, repro	estes,rd	1972
SCIEA	175--	82	84	----	prenatal stress, male beha	ward,jl	1972

OTHER PUBLICATIONS

Bergerud, A. T. 1960. Fall breeding behavior of woodland caribou. Rept. Dept. Mines, Agr., and Resources, Newfoundland. 103 p.

CHAPTER 5, Worksheet 1.2a

Female reproductive behavior

Locate a group of animals and observe the interactions of the females. If free-ranging wild ruminants are not available, observe a captive group or domestic ruminants if necessary. Practice on readily-available groups will enhance observations in the wild later.

List the actions and reactions below. The INDIVIDUAL column is for identification.

GESP	JDAY	TIME	INDIVIDUAL	ACTION	REACTION

GESP	JDAY	TIME	INDIVIDUAL	ACTION	REACTION

UNIT 1.3: SOCIAL HIERIRCHIES

Social hierarchies result from the abilities of animals in a group to recognize, exert, and maintain positions of dominance over other animals. The leader, or dominant animal, is recognized as such by subordinate animals. The position of dominance, however, is earned and must be maintained. We humans have difficulties recognizing the subtle cues which are perceived by individuals in a social group. Many of them are visual, but they may be accompanied by scent cues or auditory cues which we do not perceive.

Social hierarchies are established by aggressive assertions. These assertions seldom result in physical fights in most species. In most cases, non-contact assertions of dominance are made, especially after the dominant position has been established. Non-contact assertions of dominance have many similarities between species, with particular details that are characteristic of the species.

Wild sheep are perhaps the most physical of the wild ruminants. Bighorns, as the most active, are the most extreme example of both non-contact and contact assertions. They separate into functional groups, segregating by behavioral type rather than by sex as those acting like sexually immature sheep stay in female bands and those acting like males in male groups (Geist 1971). Horn size is of great importance in a band of sheep, "the largest-horned ram in a band automatically becomes the leader of the band since small rams follow him" (Geist 1971: 131).

What behavioral interactions are employed to establish social hierarchies in a band of sheep? Geist (1971) lists the following acts, which I have classified as non-contact and contact and summarized from Geist's description.

Butt	Contact	A physical butting with horns to move a subordinate aside, involving a downward blow with the head and the horns thrown forward and down.
Clash	Contact	Specialized, sophisticated form of the butt including two animals clashing head-on, with horn contact.
Front kick	Contact	Kick with extended front leg, performed mainly by dominant rams on all subordinate sheep.
Push	Contact	A push with the chest may accompany a front kick.
Horning	Non-contact	The horns are rotated or scrubbed with pressure on bushes, shrubs, and small trees.

Head-shake	Non-contact	Head-shaking is done by small sheep after being disturbed by a large sheep.
Horn-threat	Non-contact	An intention movement to butt, shown by dominants chasing any subordinates, or by subordinates toward approaching dominants.
Horn display: Low stretch	Non-contact	Very common display threat by dominant to subordinate; head low.
Horn display: Present	Non-contact	As above, but head held high.
Nuzzling	Contact	Subordinates nuzzle head of dominant.
Licking	Contact	Subordinates lick head of dominant while nuzzling.
Rubbing	Contact	Subordinate rubs face on face of dominant.
Threats	Non-contact	Social behavior that involves withdrawal from dangerous stimuli.
Threat-jump	Non-contact	An intention to clash.
Direct stare	Non-contact	Appears to be an aggressive posture.
Twist	Non-contact	An intensified low-stretch, with the head rotated, rapid flicks of tongue, and a harsh, loud growl.
Neck fight	Contact	Rams put chins and throats over the withers of opponent; no pushing or wrestling followed.

The effects of aggressive assertions may not be direct physical harm, but indirect by depriving subordinates of necessary resources. Adult deer will drive even their own young away in order to get at food themselves (Severinghaus 1974). As a result, the smaller deer, more closely coupled to the range resources, will suffer and die. Larger deer can hardly be "taught" to be more considerate; such behavioral characteristics have developed naturally and must be recognized and accepted.

Seasonal changes in social hierarchies occur as a result of changes in hormone levels, weights, weather conditions, food resources, and other factors. Social standings are not as subject to inviolate laws as physical characteristics are, and are subject to change out of necessity if current conditions warrent it. A subordinate animal, for example, may adjust its timing and location to feed without being harrassed by a dominant. The

smaller, subordinate animal cannot add one cm to its maximum reach for forage, however, so it will always have access to less total forage than the larger, dominant animal.

Changes in social hierarchies are often tied to the reproductive cycles of males and females. Male groups of white-tailed deer formed in Minnesota and Iowa after the breeding season but before the antlers were shed (Zagata and Moen 1974). Social hierarchies were not evident within the groups. My guess is that the largest male would be the dominant animal in the group, both before and after the antlers were shed, but that the position of dominance would become less important to the animals as winter progressed. Bull moose also formed groups in the winter, which tended to break up during the calving season (Geist 1971). Males of several species become much more solitary during the summer.

LITERATURE CITED

Geist, V. 1971. Mountain Sheep. The University of Chicago Press, Chicago. 383 p.

Severinghaus, C. W. 1974. Deer populations - a wildlife roller coaster. The Conservationist 29(5): 36-38.

Zagata, M. D. and A. N. Moen. 1974. Antler shedding by white-tailed deer in the midwest. J. Mammal. 55(3): 656-659.

REFERENCES, UNIT 1.3

SOCIAL HIERARCHIES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	olbd	loen	653	----	anim dispers,rel to soc be	wynne-edwards,vc	1962
aubo	plpc	nyny	183	----	aggressn,dom, indiv spacng	krames,l,ed	1978
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	stac	hapa	225	anam	hunting pronghorn antelope	popowski,b	1959
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NATUA	220--	813	814	cerv	horn-like str,rank,grd,wea	geist,v	1968
PZSLA	128-4	608	612	cerv	social habits british deer	delap,p	1957
ZOBEA	12--2	219	250	cerv	etholog ovbsrvtns, no amer	geist,v	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
WLSBA	3---2	82	83	od--	deer sociobiology	peterle,tj	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	43--4	462	469	odvi	soc dom,phys cond,pen fwns	robinson,wl	1962
JOMAA	46--2	314	327	odvi	hrd soc bhv,hypogndl males	thomas,jw; robins	1965
JWMAA	33--1	196	203	odvi	mvts,translocatd,grp accpt	hawkins,re; montg	1969
JWMAA	34--2	407	419	odvi	prelim study, social organ	hawkins,re; klims	1970
JWMAA	36--3	861	868	odvi	aggres beh, wintr cuttings	ozoga,jj	1972
JWMAA	40--3	429	441	odvi	migratn, role wolf predatn	hoskinson,rl; mec	1976
JWMAA	40--3	454	463	odvi	group size, composit, flor	hardin,jw; silvy/	1976
RWLBA	6---2	153	326	odvi	w-t deer of the adirondcks	townsend,mt; smit	1933
SWNAA	13--4	411	420	odvi	aggressive behavior, w-t d	michael,ed	1968
WLMOA	53---	1	55	odvi	soc behav, relatn to habit	hirth,dh	1977
WLSBA	4---4	181	182	odvi	sociobiology, secnd thghts	smith,ca	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BIBED	3---4	319	330	odhe	sparring by, during ruttng	wachtel,ma; beko/	1978
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CAFNA	85--4	295	301	odhe	mutual grooming, nw oregon	miller,fl	1971
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JOMAA	31--4	426	429	odhe	rel moon phas,occr salt lk	buss,io; harbert,	1950
JOMAA	37--2	143	164	odhe	behavior, ref to pop ecolo	dasmann,rf; taber	1956
JOMAA	38--2	247	253	odhe	observtns behavior, penned	browman,lg; hudso	1957
JOMAA	42--4	522	526	odhe	aggressive behavio in deer	cowan,imct; geist	1961
JOMAA	59--3	463	476	odhe	soc behav,breed sys,desert	kucera,te	1978
JWMAA	37--3	288	300	odhe	odvi, intrsp behav,disprsn	kraemer,a	1973

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	27--1	211	225	ceel	adaptive aspects, fighting	clutton-brock,th/	1979
ATRLA	19-32	509	514	ceel	role of antlrs, hrd hierar	topinski,p	1974
BEHAA	4---2	116	143	ceel	soc behav,jckson hole area	altmann,m	1952
BEHAA	69--3	145	170	ceel	roarng, evol honest advrti	clutton-brock,th/	1979
BEHAA	74--3	294	309	ceel	social rank & food access	appleby,mc	1980
CAFNA	94--2	148	153	ceel	aggregation behavior,manit	rounds,rc	1980
FVHFA	16---	1	80	ceel	aggres, reprod behav,red d	buetzler,w	1974
HOBEA	3---4	375	396	ceel	testost, social sexual beh	lincoln,ga; guin/	1972
JOMAA	56--1	102	118	ceel	soc orgnztn, hom ran,rsvlt	franklin,wl; mos/	1975
JWMAA	31--2	293	299	ceel	chrctr natrl licks, montan	knight,rr mudge,m	1967
JWMAA	33--3	465	481	ceel	pop ecol residnt,jksn hole	martinka,cj	1969
LUTAA	5---1	1	8	ceel	[social life of red deer]	eygenraam,ja	1963
RSZOA	72-24	434	440	ceel	[kin rel, herd form,red d]	schloeth,r	1966
ZOOLA	41--8	65	71	ceel	pattrns, herd behavior,wyo	altmann,m	1956
ZOOLA	45--1	35	39	ceel	alal, juvenile, socl dynam	altmann,m	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	6-3/4	155	159	alal	social integratn,moos calf	altmann,m	1958
BEHAA	20--3	377	416	alal	moos behav, british columb	geist,v	1963
CAFNA	92--3	223	227	alal	grouping charact, manitoba	rounds,rc	1978
JOMAA	39--1	128	139	alal	summr obsrvtns, behv,ontar	de vos,a	1958
JOMAA	40--3	420	424	alal	group dynam,rutt seas, wyo	altmann,m	1959
JOMAA	55--1	126	137	alal	aggregatn,alaska,minn,mont	peek,jm; leresch/	1974
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
ZOOLA	41-14	105	118	alal	ecol,behav,pop dynam, wyom	denniston,rh,II	1956
ZOOLA	43--1	35	39	alal	role, juvenile, socl dynam	altmann,m	1960

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AIATA	4----	1	52	rata	relat, peary, barr-gr cari	manning,th	1960
ANBEA	12--4	420	426	rata	dom-subord rel, semi-domes	espmark,y	1964
BPURD	1----	436	461	rata	antlrs, social life bar gr	bubenik,ab	1975
CAFNA	87--4	357	369	rata	movemnt, rut behav, quebec	bergerud,at	1973
JWMAA	35--1	175	177	rata	antler shedding, parturitn	espmark,y	1971
ZETIA	23--6	710	756	rata	calvng & rel behav, bar gr	lent,pc	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNTA	43--2	257	354	anam	lif hstry,ecol,rng use,tex	buechner,hk	1950
BEHAA	48--3	215	267	anam	soc behav relat to ecology	jarman,pj	1974
BMAEA	516--	1	63	anam	rng use, food hab, montana	cole,gf	1956
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
IZYBA	13---	217	220	anam	behav develop, hand reared	muller-schwarze,/	1973
JWMAA	31--4	843	844	anam	orphaned pronghrns survive	bromley,pt; ogara	1967
WLMOA	38---	1	96	anam	social behavior & ecology	kitchen,dw	1974
WLMOA	42---	6	111	anam	behavr, socializatn, fawns	autenrieth,re; f/	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATICA	13--1	2	19	bibi	beha, socl orgnzatn, canad	fuller,wa	1960
ZETIA	30--4	416	419	bibi	rel, dominance, play behav	lumia,ar	1972
ZOOLA	43--1	1	40	bibi	soc behav of ameri buffalo	mchugh,t	1958

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of the mount sheep	mccann,lj	1956
CAFGA	52--2	68	84	ovca	winter obse, sierra nevada	mccullough,dr; sc	1966
CAFNA	77--2	77	94	ovca	behavior of a bighorn herd	blood,da	1963
CJZOA	46--5	899	904	ovca	ovda,delayd soc,phys matur	geist,v	1968
CJZOA	51--9	987	993	ovca	oram, eff snow, soc behavr	petocz,rg	1973
CJZOA	55-11	1802	1810	ovca	rams,max repr fitns,segreg	geist,v; petocz,r	1977
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
JOMAA	50--1	128	128	ovca	defensive behavior, female	hornocker,mg	1969
ZSAEA	36--6	342	350	ovca	anal, mech brooming horns	shackleton,dm; hu	1971
ZETIA	25--2	199	215	ovca	extrnl appr,soc behv,struc	geist,v	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CJZOA	46--5	899	904	ovda	ovda delayd soc,phys matur	geist,v	1968
ZETIA	25--2	199	215	ovda	extrnl appr,soc behv,struc	geist,v	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	24--4	756	758	obmo	ruttng fight mortality,nwt	wilkinson,pf; sh/	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955

oram continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	19--4	417	429	oram	2 yr study crazy mts, mont	lentfer,jw	1955
JWMAA	31--1	192	194	oram	fightng injur, derm shield	geist,v	1967
MAMLA	39--2	241	249	oram	agonistic behavior, duiker	ralls,k	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NATUA	209--	1041	1042	dada	uncertainty, leadrshp-rank	gilbert,bk; hailm	1966
ZETIA	25--7	867	876	dada	devel socl behav, fallow d	gilbert,bk	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ANBEA	11--4	529	533	doca	soc postn, movement orders	beilharz,rg; mylr	1963
ANIPA	9---1	1	5	doca	behav dairy bulls in group	dalton,dc; pears/	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JCPPA	40...	255	264	dogo	lack corr,leadrshp-dom,hrd	stewart,jc; scott	1947

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
APANE	4---2	125	140	dosh	ef rearng cond,aggres, dom	zlto,ca; wilson,/	1978
ANBEA	11--4	507	513	dosh	behav of indiv relatd grou	hunter,rf; milner	1963
ANIPA	5---2	183	194	dosh	eff meth rearing soc behav	hunter,rf; davis,	1963
ECOLA	37--2	228	239	dosh	dogo, anal, socialization	collias,ne	1956
SZSLA	18---	179	210	dosh	soc grpng,home range,feral	grubb,p; jewell,p	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMZOA	14--1	205	220	ungl	relatn social evol, ecolog	geist,v	1974
ANBEA	24--2	261	274	mamm	soc systms: struct & funct	crook,jh; ellis,/	1976
ANKIA	64--2	41	44	----	"teen-age" problms,wildern	altmann,m	1961
ARECB	8----	193	207	ungl	soc adap, ecol, gall birds	geist,v	1977
BEHAA	49--4	227	267	----	obsrv study beh, samp meth	altmann,m	1974
BHBLA	11--2	131	154	----	concept of social dominanc	rowell,te	1974
JTBIA	47--1	223	243	----	asses strat, evol fght beh	parker,ga	1974
NATUA	220--	813	814	----	horn-lik str,rank,gurd,wea	geist,v	1968
NATUA	246--	15	18	----	logic of animal conflict	maynard smith,jm/	1973
NATUA	250--	354	354	----	on fighting strategies	geist,v	1974
NAWTA	21---	538	544	biga	patterns of social behavio	altmann,m	1956
PHZOA	17--1	83	123	vert	aggressive behav, vertebra	collias,ne	1944
QRESA	1....	283	315	ungl	socl evol,dispersl, pleist	geist,v	1971
SCAMA	205-6	112	122	----	fighting behavr of animals	eibl-eibesfeldt,i	1961
SZSLA	18---	85	107	mamm	concept of home range	jewell,pa	1966

OTHER PUBLICATIONS

Dane, B. 1967. Social behavior of the mountain goat. Bulletin of the Ecological Society of America 48(3): 134.

TOPIC 2. INTERSPECIES INTERACTIONS

Interspecies interactions are of interest in the study of wild ruminant populations as closely related species, such as white-tailed and mule deer often occur together. Subtle differences in activities, spacings, and food habits separate them ecologically. Another interaction between species is predation. Predation may be spectacular--a pack of wolves surrounding a moose, rushing in to tear at the flanks, the moose wheeling, eventually becoming exhausted and succumbing--such is predation in its most wilderness form.

Other less spectacular interspecies interactions are of much greater potential importance, however. After all, wolf predation on moose and all other predator-prey interactions are as natural as life and death, limited by the resources and adaptive strategies of both predator and prey. Man, with an ability to impact the environment at rates very much faster than wild ruminants can develop adaptive strategies, has the potential to drastically alter the distribution and numbers of wild ruminants.

Man's greatest impacts may be subtle and indirect. The introduction of chemicals into the environment causes metabolic disturbances (these are discussed in PART III, CHAPTER 10) that may also affect behavior. The introduction of physical objects and machines may affect both behavior and physiology. Some machines--airplanes for example--do not affect some species--wolves for example--very much, which prey on caribou, moose and deer. These wild ruminants are, therefore, indirectly affected by the response of another species to man.

Hunting technology can become so advanced that reverberations are sent throughout the food chain. All-terrain vehicles, snow machines, airplanes. . . all of these can behave like predators with unlimited kinetic energy, moving through different habitats and possibly chasing animals until they can no longer endure. This potential has been recognized as laws regulating hunting usually provide strict control over the mobility of hunters.

The UNITS in this TOPIC include discussions of the behavioral interactions between wild ruminant species (UNIT 2.1), and wild ruminants and other species, including predators (UNIT 2.2), insects (UNIT 2.3), humans (UNIT 2.4), and others (UNIT 2.5).

UNIT 2.1: SYMPATRIC SPECIES

Interactions between closely-related species that live in the same area are among the most subtle and difficult to recognize of all interspecies interactions. The three most common ecological differences separating sympatric species are differential spacial use of the habitat, different food preferences, and different patterns of temporal activity (Pianka 1978). All three may occur in wild ruminants, with the magnitude of known differences being dependent on the depth to which animals of each species are studied.

The two most closely-related sympatric species of wild ruminants are white-tailed and mule deer. Both are in the genus Odocoileus, and they are morphologically, physiologically, behaviorally, and ecologically similar. Interactions are expected between such sympatric species, unless differences in behavior result in the use of the range resources at different times. Such differences do not occur between whitetails and mule deer; their daily activity patterns are similar.

Groups of white-tailed and mule deer did not avoid each other at distances over 50 yards (Kramer 1973). Interspecific deer aggregations were less common than species aggregations at distances less than 25 yards. Kramer also observed segregation of the two species in the winter, in Alberta.

Hybridization appeared to be prevented by a behavioral block in pair formation for white-tailed and mule deer. Behavioral blocks are subtle rather than conspicuous, and it may be difficult for humans to recognize them.

Competition for forage may become a problem among sympatric species. Elk used moose range in Yellowstone heavily enough to be considered potentially damaging to the moose population (McMillan 1953). Little spatial overlap between moose and white-tailed deer occurred in Ontario, especially in spring and summer (Kearney and Gilbert 1976). Moose and deer overlapped very little in the winter in New Brunswick (Telfer 1970). Moose and cattle did not compete significantly in Montana (Dorn 1970). As wild ruminant species become less similar (deer: moose compared to elk: moose), and wild: domestic ruminants are compared, competition for forage appears to decline.

LITERATURE CITED

Dorn, R. D. 1970. Moose and cattle food habits in southwest Montana. J. Wildl. Manage. 34(3):559-564.

Kearney, S. R. and F. F. Gilbert. 1976. Habitat use by white-tailed deer and moose on sympatric range. J. Wildl. Manage. 40(4):645-657.

Kramer, A. 1973. Interspecific behavior and dispersion of two sympatric deer species. J. Wildl. Manage. 37(3):288-300.

McMillan, J. F. 1953. Measures of association between moose and elk on feeding grounds. J. Wildl. Manage. 17(2):162-166.

Pianka, E. R. 1978. Evolutionary Ecology. Harper and Row, Publishers, N.Y. 397 p.

Telfer, E. S. 1970. Winter habitat selection by moose and white-tailed deer. J. Wildl. Manage. 34(3):553-559.

REFERENCES, UNIT 2.1

SYMPATRIC SPECIES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	stac	hapa	238	----	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	copr	nyny	364	----	genetics & origin of speci	dobzhansky,t	1951

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JRMGA	10--1	34	37	od--	livestock, deer activ, tex	grelen,je; thomas	1957

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
COVEA	52--	431	438	odvi	doca, associatn of, wiscon	trainer,do; hanso	1962
JOMAA	10--2	101	115	odvi	formerly in yellwston n pk	skinner,mp	1929
JWMAA	31--3	418	425	odvi	alal,compar,wntr rng, n sc	telfer,es	1967
JWMAA	34--3	553	559	odvi	alal, wintr habitat, selec	telfer,es	1970
JWMAA	37--3	288	300	odvi	odhe,interspcif beh,disprn	kramer,a	1973
TNWSD	25---	41	69	odvi	alal, distrib, assoc, n br	telfer,es	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JCECD	1---1	125	131	odhe	subsp specif rspns,soc odr	muller-schwarze,/	1975
JOMAA	43--4	539	541	odhe odvi	hybridization between	cowan,imt	1962
JWMAA	17--2	101	112	odhe	domst sheep,competitn,utah	smith,jg; julande	1953

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JAECA	29---	375	384	ceel	dada,caca relatns, scotlnd	batcheler,cl	1960
JWMAA	17--2	162	166	ceel alal	meas,assoc, feed grnd	mcmillan,jf	1953
NAWTA	38---	327	337	ceel	beh,doca graz,for rec,traf	ward,al; cupal,j/	1973
NCANA	101--	505	516	ceel	rcky mt elk,shirs moos rel	stevens,dr	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	31--3	418	425	alal	odvi,compar,wntr rng, n sc	telfer,es	1967
JWMAA	34--3	553	559	alal	odvi, wintr habitat, selec	telfer,es	1970
JWMAA	34--3	559	564	alal	domst cattle,food,sw montn	dorn,rd	1970
JWMAA	40--4	645	657	alal	odvi, sympatric range, use	kearney,sr; gilbe	1976
NCANA	101--	437	456	alal	ovrview coactns, othr anim	wolfe,ml	1974
NCANA	101--	493	504	alal	odvi, odhe interrelations	prescott,wh	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	40--1	151	162	rata	obmo, surrm range rel, nwt	wilkinson,pf; sh/	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNTA	43--2	257	354	anam	lif hstry,ecol,rng use,tex	buechner,hk	1950
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	91--4	418	419	bibi ceel	harassmnt of elk calf	mahan,br	1977

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	84--4	388	390	ovda	rata, conflict between car	henshaw,j	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	40--1	151	162	obmo	rata, summr range rel, nwt	wilkinson,pf; sh/	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
CGFPA	8----	1	23	oram	literature review, ecology	hibbs,ld	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ECOLA	26--3	297	302	----	measrs,amt ecol assoc,spec	dice,lr	1945
ECOLA	30--4	411	424	----	measrmnt,interspecif assoc	cole,lc	1949

CHAPTER 5, Worksheet 2.1a

Competition between sympatric species

This WORKSHEET provides a format for listing potential competition between closely-related species living in the same area.

List the ecological characteristics that may be competitive below. Then quantify the extent of competition in the next WORKSHEET.

GESP	POTENTIAL COMPETITION	with	GESP

GESP	POTENTIAL COMPETITION	with	GESP

CHAPTER 5, Worksheet 2.1b

Quantifying competition between sympatric species

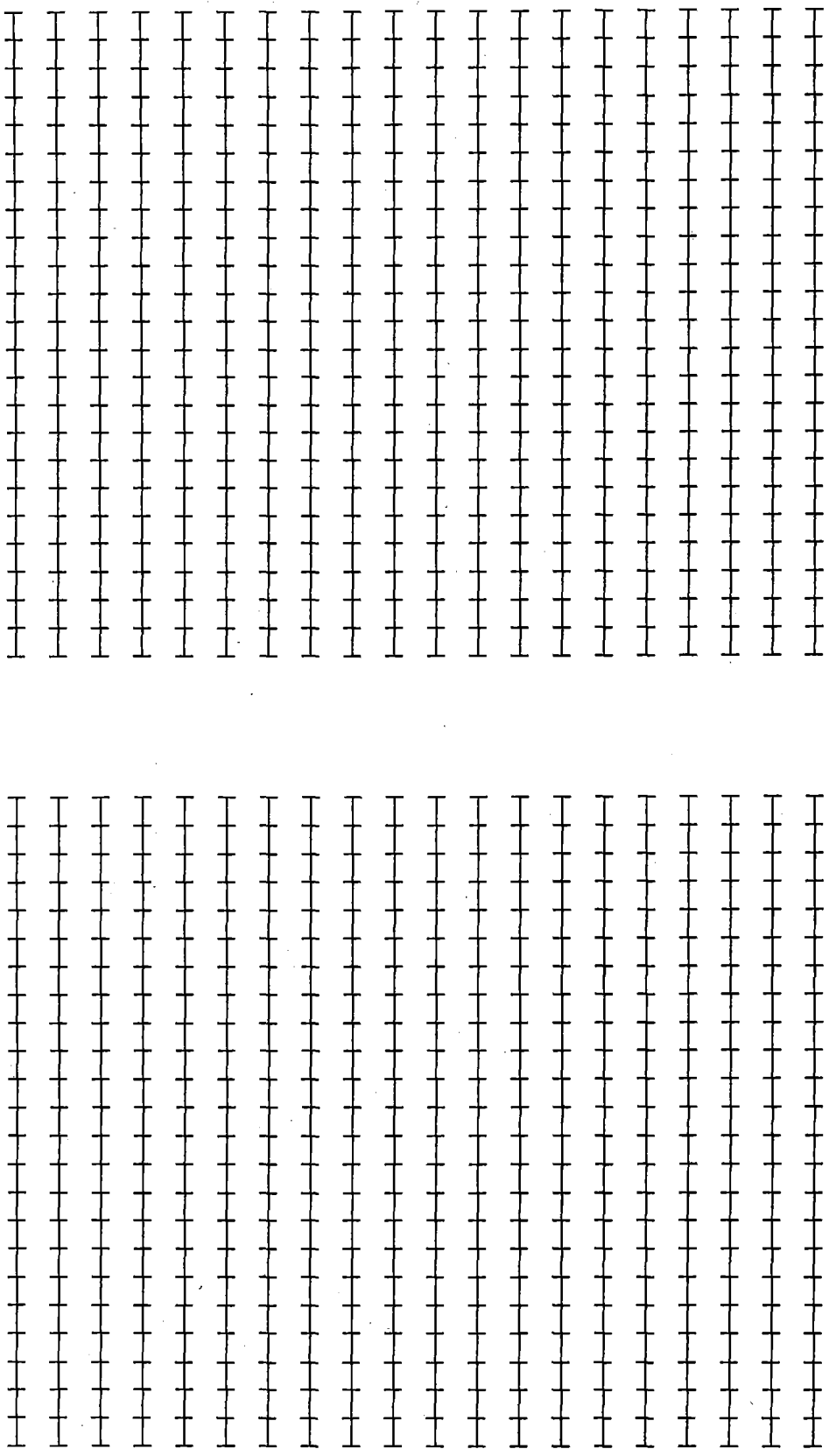
Knowing there is potential competition between species and evaluating the extent of the competition are two different things. The former is easy to accept the latter is difficult to do.

In the space below, list specifics, such as foods eaten, times active, etc. Convert foods eaten to metabolizable energy as discussed in PART III, CHAPTER 7. Consider the "coefficient of similarity" concept described by Oosting (1956) as a possible way to represent the extent of competition. Convert times active to daily and seasonal equations. Plot the patterns on the grids on the next page.

GESP	POTENTIAL COMPETITION	with	GESP
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____
____	_____		____

LITERATURE CITED

Oosting, H. J. 1956. The study of Plant Communities. W. H. Freeman and Co., San Francisco. 440 p.



UNIT 2.2: PREDATOR-PREY RELATIONSHIPS

Predators eat prey, but the ecological interactions that lead up to that act and result from it are very complex indeed. The compensatory behavioral and range relationships that result from predation make ecological arithmetic obsolete. Thus, one cannot simply subtract 1 (one) from the population every time an animal is killed by a predator.

Several behavioral interactions should be considered in predator-prey relationships, including:

The role of learning by both predator and prey,
The ways in which predators hunt (opportunistic, stalking, single, groups),
Defensive behavior by the prey, and
Flight distances of the prey (speed and stamina).

What general principles govern behavioral interactions of predator and prey? Consider the following list.

1. Predators tend to take relatively larger proportions of the less fit animals and relatively smaller proportions of the more fit ones.
2. Predator pressure and prey vulnerability vary through the year and under different habitat conditions.
3. Prey distribution in relation to predator distribution may result in some populations being affected much and others little by predation.
4. Predators are not everywhere all the time. They have intraspecies relationships of their own that regulate social relationships and numbers.

Each of these is considered briefly in the following paragraphs.

1. Predators tend to take larger proportions of the less fit animals and smaller proportions of the more fit ones.

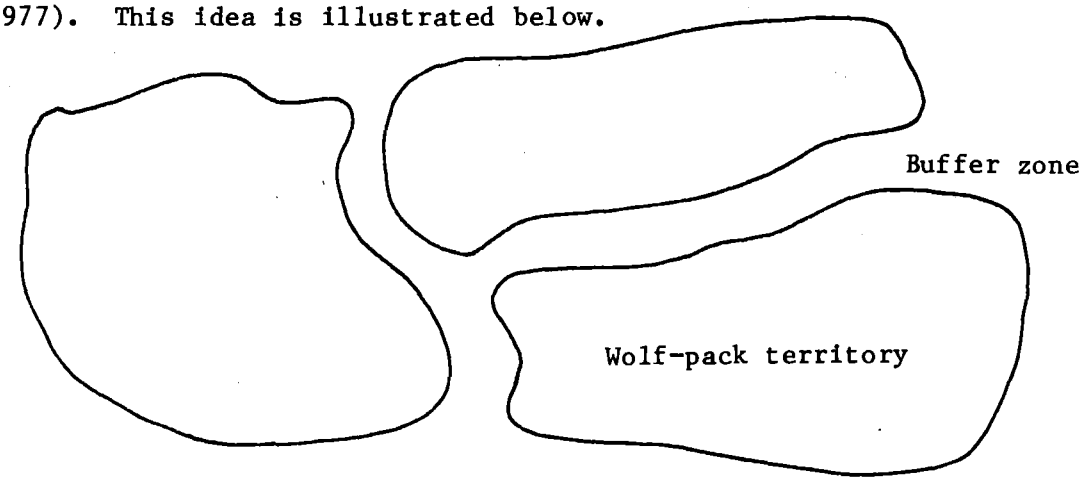
This is probably one of the oldest principles thought to govern prey selection. It seems logical, and Mech (1970), after reviewing the literature and investigating wolf predation on wild ruminants, states that ". . . wolf predation generally selects out the young, old, sick, weak, injured, and diseased members of prey populations . . ." He also points out that such selection is primarily a matter of success against prey with excellent sensory capabilities. In fact, wolf predation on moose results in a kill rate of less than 10% of those tested. Note above that both age and health are factors in prey selection. Young animals are inexperienced as well as being physically inferior to prime-age animals.

2. Predator pressure and prey vulnerability vary through the year and under different current conditions.

There are differences between seasons in the life styles of both predator and prey. In the spring and summer, both are spaced out more with more definite individual home ranges than in the fall and winter. This is due to the necessary care of young which are confined to a den, dependent on one or both parents, and not yet capable of more extensive adult-type movements. In the winter, deep snow may make prey more vulnerable. Predators such as wolves also have difficulty moving in snow, however. Wolf runways are described by Mech (1970). Deep snow tends to concentrate prey too, making larger numbers available in smaller areas.

3. Prey distribution in relation to predator distribution may result in some populations being affected much and others little by predation.

The locations of summer and winter ranges of white-tailed deer in relation to the geometry of wolf-pack territories may be a factor determining the likelihood of deer-wolf encounters and subsequent predation (Hoskinson and Mech 1976). Wolf-pack territory edges are rather stable, reducing strife between packs, and such buffer zones may serve as prey reservoirs (Mech 1977). This idea is illustrated below.



4. Predators are not everywhere all the time. They have intraspecies relationships of their own that regulate social relationships and numbers.

Predators cannot be everywhere all the time, because metabolic efficiencies are such that the predators must be less abundant than the prey, and the amount of predator biomass supported can only be a fraction of the prey biomass. If this were not the case, predator and prey populations could not be sustained. They are, however, in a dynamic balance when left alone. Since most predator and prey populations are either directly or indirectly impacted by man, it is sometimes difficult to recognize what that balance should be. Sheep losses as a result of coyote predation may be too high in the minds of some as soon as the first sheep is killed. The presence of sheep, however, provides a supplementary prey base that may take some pressure off wild prey species. The sheep act as a "buffer" species.

How do prey behave when being hunted or stalked, and how do predators hunt, attack, and kill? Field observations are not many, but there are reports of both isolated incidents and systematic field research designed to provide information on predator-prey interactions.

Predators may be opportunistic. Any individual that happens to be in their travel path becomes fair game. The healthier and more experienced prey will likely escape; 90% or more of moose tested by wolves escaped (Mech 1970).

Predators may stalk. An adult mule deer in good condition was killed by a bobcat just fourteen feet from her bedding site (Dill 1947). The bobcat had apparently stalked the deer, grabbed her by the throat, and brought her down in less than five yards. Outweighed four to one, the bobcat could hardly have been successful if it had not been for the element of surprise.

Prey may also fight back and attack the predator. Pronghorn and mule deer were frequently observed by Robinson and Cummings (1947) chasing coyotes, and found one coyote that had been stomped to death. Cahalane (1947) observed a mule deer being killed by three coyotes, while a group of seven other deer watched. Then, the largest doe attacked the coyotes, striking vigorously with the front hooves. The deer retreated, however, leaving the coyotes to finish off the victim. Severinghaus and Cheatum (1956) report an observation of a whitetail doe running after and striking a red fox with her forefeet.

Wolves on Isle Royal hunt moose by traveling single file until they see a moose, which usually occurs within 300 yards downwind from the animal (Mech 1966). Single-file travel on ridges is used when hunting elk in the Canadian Rockies, locating and choosing quarry below the ridges (Cowan 1947). Other methods have been reported for wolves elsewhere. Wolf packs were observed to split into small groups when hunting deer in swamps in Ontario (Dunne 1939) and when hunting deer on islands and points of land extending out into lakes in Minnesota (Stenlund 1955).

Large prey such as wild ruminants can exhibit two basic reactions to approaching predators: flee, or take a stand. On Isle Royal, wolves harrass a moose standing its ground for periods of time ranging from 1/2 to 5 minutes, trying to force it to run (Mech 1966). If the moose runs, the wolves will chase it for a few minutes, but seem able to judge when chases are useless (Mech 1966 and Crisler 1958).

It is interesting to note that moose that stand their ground when wolves approach are not killed; all observed encounters on Isle Royale that ended in a kill occurred after the victim initially ran from wolves. For unknown reasons, vulnerable moose do not stand and face wolves when first approached. While chasing a moose, wolves apparently respond to vulnerability cues that are not obvious to aerial observers; sometimes they quit immediately and at other times the chase might last for long distances (Peterson 1977).

LITERATURE CITED

Calahane, V. H. 1947. A deer-coyote episode. J. Mammal. 28(1):36-39.

Cowan, I. M. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Can. J. Res. 25: 139-174.

Crisler, L. 1958. Arctic Wild. Harper and Bros., N. Y. 301 p.

Dill, H. H. 1947. Bobcat preys on deer. J. Mammal. 28(1):63.

Dunne, A. C. 1939. Report on wolves followed during February and March 1939. Can. Field Nat. 53: 117-118.

Hoskinson, R. L. and L. D. Mech. 1976. White-tailes deer migration and its role in wolf predation. J. Wildl. Manage. 40(3): 429-441.

Mech, L. D. 1966. The Wolves of Isle Royal. Fauna of the National Parks of the United States, Fauna Series 7. 210 p.

Mech, L. D. 1970. The Wolf: The Ecology and Behavior of an Endangered Species. The Natural History Press, Garden City, N. Y. 384 p.

Mech, L. D. 1977. Wolf pack buffer zones as prey reservoirs. Science 198: 320-321.

Peterson, R. O. 1977. Wolf ecology and prey relationships on Isle Royale. National Park Service Scientific Monograph Series; No. 11. 210 p.

Robinson, W. B. and M. W. Cummings. 1947. Notes on behavior of coyotes. J. Mammal. 28(1):63-65.

Severinghaus, C. W. and E. L. Cheatum. Life and times of the white-tailed deer. Pages 57-186 In The Deer of North America, W. P. Taylor, Ed. The Stackpole Company, Harrisburg, PA. 668 p.

Stenlund, M. H. 1955. A field study of the timber wolf (Canis lupus) on the Superior National Forest, Minnesota. Minn. Dept. Cons. Tech. Bull. 4. 55 p.

REFERENCES, UNIT 2.2

PREDATOR-PREY RELATIONSHIPS

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	qupr	oton	166	obmo	muskoxen,biol,taxon,canada	tener,js	1965

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	15--1	73	75	od--	mt lion seen killing deer	wade,jg	1929
JOMAA	9---1	64	65	od--	bobcat kills deer	young,sp	1928
JOMAA	29--1	69	70	od--	cats kill deer	matson,jr	1948
JOMAA	29--4	406	409	od--	decoy coyotes, deer,fwning	benson,sb	1948
PCGFA	24---	64	73	od--	studie, deer rel dog activ	perry,mc; giles,r	1970
UTSCB	36--3	87	90	od--	coyotes and deer	nielsen,db	1975

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNTA	111--	31	42	odvi	ungu, evol of alarm signls	hirth,dh; mccullo	1977
CJZOA	56--5	1207	1210	odvi	fwn heart rates, wolf howl	moen,an; dellafe/	1978
JOMAA	29--1	69	70	odvi	cats kill deer, pennsylvan	matson,jr	1947
JOMAA	46--2	314	327	odvi	hrd soc bhv,hypogndl males	thomas,jw; robins	1965
JOMAA	59--4	860	861	odvi	unusual long pursuit, wolf	mech,ld; korb,m	1978
JWMAA	6---4	328	337	odvi	winter relns bobcat, maine	marston,ma	1942
JWMAA	14--2	246	247	odvi	escape behavior of the whi	barkalow,fs,jr; k	1950
JWMAA	22--2	184	192	odvi	mobili,dog harras, missour	progulske,dr; bas	1958
JWMAA	32--3	615	618	odvi	summer flight beha, adiron	behrend,df; lubec	1968
JWMAA	35--4	707	716	odvi	rspn radio mntrd,hntng dgs	sweeney,jr; marc/	1971
JWMAA	36--2	357	369	odvi	wolf predat,winter,ontario	kolenosky,gb	1972
JWMAA	40--3	429	441	odvi	migration, wolf predation	hoskinson,rl; mec	1976
JWMAA	44--1	253	258	odvi	distrib,wolf territo edges	mech,ld; dawson,/	1980

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NFGJA	1---1	98	109	odvi	wariness, age killd, huntr	maguire,hj; sever	1954
PCGFA	25---	69	77	odvi	eff dogs,radio-equip,mount	corbett,rl; marc/	1971
RWLBA	6---2	153	326	odvi	w-t deer of the adirondcks	townsend,mt; smit	1933
SWNAA	12--2	156	162	odvi	behav interac deer, mammls	michael,ed	1967

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	20--3	181	282	odhe	life history, california	dixon,js	1934
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
CNDRA	53--4	178	185	odhe	relatnshps between birds &	riney,t	1951
ECMOA	25--1	1	37	odhe	feeding pattrns of coyotes	fichter,e; shild/	1955
JOMAA	28--1	36	39	odhe	a deer-coyote episode	calahane,vh	1947
JOMAA	28--1	63	63	odhe	bobcat preys on deer	dill,hh	1947
JOMAA	28--1	63	65	odhe	anam, notes on coyote beha	robinson,wb; cumm	1947
JOMAA	53--2	393	394	odhe	resp young, predator odors	muller-schwarze,d	1967
JWMAA	22--2	207	209	odhe	flight distnce,free-rangng	altmann,m	1958
JWMAA	23--3	261	273	odhe	food habits, cougar, utah	robinette,wl; ga/	1959
WLMOA	21---	1	39	odhe	ceel,mount lion pred,idaho	hornocker,mg	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	52--1	199	202	ceel	predtn by black bear, male	barmore,wj; strad	1971
JWMAA	22--2	207	209	ceel	flight distnce,free-rangng	altmann,m	1958
WLMOA	21---	1	39	ceel	odhe, anal mt lion predatn	hornocker,mg	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BEHAA	20--3	377	416	alal	behavr no amer moose in bc	geist,v	1963
JWMAA	22--2	207	209	alal	flight distnce,free-rangng	altmann,m	1958

alal continued on the next page

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934
NCANA	101--	457	466	alal	relns w/ predators, sweden	haglund,b	1974
NCANA	101--	481	492	alal	snw cndtns,moos-wolf relns	peterson,ro; all	1974
XNFSA	7----	1	210	alal	wolves of isle royale	mech,ld	1966

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	46--2	350	351	rata	flight releaser, wolf-cari	pruuitt,wo	1965

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NAWTA	8----	117	122	anam	history, wartime mgt, wyom	allred,wj	1943
CAFGA	30--4	221	241	anam	prng-hrnd antlp of califor	mclean,dd	1944
JWMAA	11--4	348	349	anam	golden eagle attckng antlp	lehti,rw	1947
JWMAA	13--3	313	314	anam	predation on antelope	thompson,wk	1949
JWMAA	31--3	496	501	anam	odhe,est pred, golden eagl	mcgahan,j	1967
CGFPA	3----	1	28	anam	literature review,behavior	prenzlow,ej	1965
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	56--2	297	324	ovca	ecology of the mount sheep	mccann,lj	1956
CAFGA	15--1	73	73	ovca	close encounter, mt sheep	scofield,nb	1929
CAFGA	56--3	206	207	ovca	desert bighorns, predators	weaver,ra; mensch	1970
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954
JOMAA	29--1	68	68	ovca	mt lion preys on bighorn	cronemiller,fp	1947
JOMAA	29--1	68	68	ovca	golden eagle kills lamb	kennedy,ca	1948
JOMAA	49--4	770	770	ovca	bighorn, coyote encountrs	woolf,a; o'shea,t	1968
JOMAA	58--2	243	244	ovca	cooperative defense, bigho	shank,cc	1977

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5----	1	238	ovda	the wolves of mt mckinley	murie,a	1944

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
MUOXD	14...	25	29	obmo	defense formation, musk-ox	gray,dr	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	81--1	1	22	oram	obsrvtns,kootenay nt pk,bc	holroyd,jc	1967
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955
JWMAA	19--4	417	429	oram	2 yr study,crazy mts, mont	lentfer,jw	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	4----	1	206	many	ecol coyote in yellowstone	murie,a	1940

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	26--2	133	136	caca	predation in sweden, roe d	borg,k	1962

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	102-1	q97	199	ungu	predatr haras,defens strat	berger,j	1979

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NAWTA	39---	257	291	wldl	impact of uncontrolld dogs	denney,rn	1974
NAWTA	6----	283	287	wldl	coyote-wildlife relationsh	horn,ee	1941

CHAPTER 5, Worksheet 2.2a

Mathematical representation of predator-prey interactions

Predators eat prey. But how many? How often? What factors regulate predation efficiencies? How is predation efficiency affected by population densities? Habitat conditions?

Convert your thoughts to numerical statements in the space below. There are clues in the literature, but there are no specific examples to follow. Illustrations are given in PART VI, CHAPTER 19, UNITS 2.1 and 2.2 of age- and weight-related mortality rates. Predation efficiency is related to both. In time, subroutines will be added to population analyses in Part VI and decision-making considerations in PART VII.

UNIT 2.3: INSECT HARRASMENT

Insects have the potential to disturb and harass wild ruminants greatly. Twitching ears, shaking heads, and kicks are common sights to all of us who observe free-ranging wild ruminants. Bed sites in the open are credited with being more insect-free than those in sheltered areas.

Detailed studies of responses to insect harassment have not been done for most wild ruminants. Espmark (1968) describes defense reactions of semidomestic forest reindeer to nostril and warble flies; large economic losses to the reindeer industry make such studies imperative. These reactions are summarized below.

Reactions of reindeer to warble flies and nostril flies include twitching, rapid movements, and panic. Constant insect aggrevation in the summer results in reindeer activities being of short duration. The responses of reindeer depend on the timing of the harassment in relation to the activity-time of the reindeer. Just after bedding, reactions are greater than when a reindeer has been bedded for a shile and is ruminating. Then, reactions are slight as the reindeer are less alert.

Warble flies cause a bedded animal to rise, shake its body, and chew its coat where attacked. A standing animal will shake its body, fling its head, and run. Young calves exhibit similar reactions. The sense of touch seems to be the chief detection mechanism, and the chewing of the coat is probably a means of mitigating the irritation caused by the fly (Espmark 1968).

Nostril flies are apparently detected by hearing, shown by Espmark's examination of films. The larviparous nostril fly ejects larvae into the nostril, presumably after flying into position just in front of the nostril. The attacked animal sneezes repeatedly, shakes its head, paws its nose with its fore-feet, and pushes its nose into the vegetation. These violent reactions can be avoided if the reindeer detects the fly soon enough and makes the nostrils inaccessible.

The descriptions above indicate extreme aggravation and subsequent hosting of fly larvae after successful attacks. No such violent responses have been reported for wild ruminants on the North American continent. The importance of quarantines and strict regulations to prevent immigrations of alien pests is a point worth considering.

LITERATURE CITED

Espmark, Y. 1968. Observations of defense reactions to oestrid flies by semidomestic forest reiendeer (Rangifer tarandus L.) in Swedish Lapland. Zoologische Beigrage 14(2):155-167.

REFERENCES, UNIT 2.3

INSECT HARRASMENT

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS----------	AUTHORS/EDITORS--	YEAR
aubo	oxup	loen	215	ceel	herd red deer,study, behav	darling,ff	1937
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953
aubo	stac	hapa	238	anam	prnghrn antlp & its mngmnt	einarsen,as	1948
aubo	usda	wadc	780	wldl	p 708-24, insects: yrbk ag	linduska,jp; lind	1952

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
NYCOA	8---3	32	32	od--	deer fly, mechan dee repel	lee,j	1953

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
GRLEA	8---1	1	29	odvi	the deer flies of indiana	burton,jjs	1975
RWLBA	6---2	153	326	odvi	w-t deer of the adirondcks	townsend,mt; smit	1933

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
CAFGA	20--3	181	182	odhe	life history, california	dixon,js	1934
CAFGA	26--2	139	166	odhe	calif deer, rcky mt mule d	mclean,dd	1940

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS----------	AUTHORS----------	YEAR
JOMAA	40--3	455	455	alal	usng water as refuge,flies	flook,dr	1959
MUZPA	25---	1	44	alal	moose of isle royale	murie,a	1934

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
UABPA	3---- 1		44	rata	behav barrn-ground caribou	pruitt,wo,jr	1960
ZOBEA	14--1	155	167	rata	defns react, oestrid flies	espmark,y	1968

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	3---- 1		28	anam	literature review,behavior	prenzlow,ej	1965

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JOMAA	19--1	88	94	ovca	summr activty, yellowstone	davis,wb	1938

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
XNFSA	5---- 1		238	ovda	the wolves of mt mckinley	murie,a	1944

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

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

OTHER PUBLICATIONS

Banfield, A. W. F. 1951. Barren ground caribou. Canadian Dept. of Resources & Development. Northern Administration & Lands Branch, Ottawa. 52 p.

CHAPTER 5, Worksheet 2.3a

Quantifying insect harassment

It may be difficult to locate wild ruminants being harassed by insects. As an exercise, use domestic ruminants on a hot summer day or some time when insect harassment is present and try to quantify responses with the format below.

GESP	JDAY	TIME	HARASSMENT	RESPONSE

GESP	JDAY	TIME	HARASSMENT	RESPONSE

UNIT 2.4: HUMAN DISTURBANCES

Human disturbances of wild ruminants range from picking up "lost and orphaned" young to creation of reservoirs that eliminate parts of their habitat. Some of the potential disturbances are described below.

A very interesting reaction to humans occurs in the newborn white-tail fawn, and presumably in some of the other species of wild ruminants too. Fawns are well-known for their ability to remain bedded and motionless when danger is present. They extend their head and neck on the ground and lay the ears back. Bradycardia also occurs (see PART III, CHAPTER 6, UNIT 2.1). A 2-3-day-old fawn, born to a doe in the 6-acre deer yard at the Wildlife Ecology Laboratory at Cornell, was observed running behind the dam for a distance of about 300 yards when I tried to capture the fawn. I followed the two, and walked right up to the fawn as it hid in the grass. When I picked the fawn up it was as limp as a wet rag, and appeared to be lifeless. Knowing its "act," I carried it to a small pen in the yard and within minutes the fawn was up and active. Such a behavioral response must surely contribute to the number of fawns picked up by well-meaning people who think they are lost, weak, and probably orphaned. The advice given about leaving them alone should be heeded; their survival instincts and the maternal instincts of does are sufficient for the survival of the species.

Snowmobiles have become a potentially important disturbance to most species of wild ruminants. The rapid growth in the number of machines in the late 60's and early 70's was remarkable. The growth was apparently halted by increasing gasoline costs and general inflation. At the time of this writing in February, 1982, very few machines are noted, except in local areas where club activities promote their use.

Why does the snowmobile present a potential problem to wintering deer? Because the evidence for a metabolic depression in the winter is clear (Moen 1978) and snowmobile activity in wintering areas causes the deer to be more alert and often to run. Since snowmobiles can behave as "predators with unlimited kinetic energy," they do not tire out. Further, their densities are not regulated by intrinsic biological factors as are densities of natural predators, so there is a potential for many and continued disturbances. Their effect is simply contrary to the energy conservation adaptive stragegy employed by deer (Moen 1976).

A field study by Dorrance et al. (1975) indicated that free-ranging deer were disturbed by increased snowmobile activity. Such disturbance almost certainly results in greater energy expenditure. A controlled study at the Richard E. Reynolds Game Farm, Ithaca, N.Y. showed that captive deer did not become habituated to regular snowmobile activity (Moen et al. 1982). Heart rate responses ranged up to 2.62 times prerun rates, with no tendency to decline over thirteen tests from early December to late March.

An interesting apparent contradiction between the results of Moen et al. (1982) and those of Eckstein et al. (1979) appears to exist, but is logically explained on the basis of conditioning. Eckstein et al. (1979)

did not note a difference in home-range size or habitat use in relation to snowmobile use. Their study area included some logging, and it is reasonable to surmise that the sound of chain saws and resulting forage supplies from felled trees produced a positive response to such noise, and the effects of that carried over to the snowmobile study. It is not the noise per se that disturbs the deer, but the noise and movement. Chain saws do not move through the woods at thirty or more miles per hour.

There are activities more fundamental to human existence than snowmobiling that have potentials for disturbing wild animal populations. Radio-tracked white-tailed deer reacted to cattle round-ups in Texas (Hood and Inglis 1974). Bucks enlarged or left their home ranges for varying periods of time, while does usually took a circuitous flight path that began and ended within their home range.

An interstate highway through forested and agricultural areas in Pennsylvania provided grass, vetch, and clover forage on the right-of-way that was particularly attractive to white-tailed deer; most of the deer seen in the forested areas were on the highway right-of-way (Carbaugh et al. 1975). In the agricultural area most of the deer were seen in harvested hayfields rather than unharvested ones; few were seen on the highway right-of-way.

Restricted highways such as interstates present barriers to movement of large free-ranging animals such as wild ruminants. An underpass built for use by migratory mule deer was evaluated by Reed et al. (1975) in Colorado. They estimated that about 61% of the local population used the underpass, an average of 345 passes per year. Use increased over the years, but they did not attribute that to adaptation of the deer to the structure alone; other factors not measured may have contributed to the increased use.

Mule deer and elk avoided areas within 200 m of roads on Colorado winter range. Avoidance was greater for deer in shrub habitats compared to pine and juniper habitats (Rost and Bailey 1979). Altmann (1958) states that the flight distance of moose and elk is suddenly stepped up at the beginning of the hunting season, and that individual experience and clues of general excitement contribute to this change. No evidence of directional movements from hunted to unhunted areas, or recruitment from nonhunted areas were observed for moose in Ontario, however (Goddard 1970). Thus population levels must be sustained by production rather than immigration.

The effects of intense development, especially of oil resources, on caribou became a major concern in the 1970's. Klein (1971) summarized effects of highway and railroad development on reindeer in Scandinavia. Lent and Child (1973) used pipeline simulations to study responses of caribou and reindeer. Crossing facilities were used more by large than small groups, and groups with experienced individuals crossed more readily. Pipeline-related abnormalities in caribou distribution and group composition were observed by Cameron et al. (1979). Cows with young calves were affected by the pipeline more than others; this is expected because of the strength of maternal behavior. Long-term effects on herd productivity are not known yet, but there are times when a conservative approach is ecologically the most reasonable.

These examples of reactions to human disturbances provide baseline information for management decisions. Economic considerations of costs and benefits are discussed in CHAPTER 24. Note in the above paragraph that a conservative approach is ecologically the most reasonable.

LITERATURE CITED

Altmann, M. 1958. The flight distance of free-ranging big game. J. Wildl. Manage. 22(2):207-209.

Cameron, R. D., K. R. Whitten, W. T. Smith, and D. D. Roby. 1979. Caribou distribution and group composition associated with construction of the Trans-Alaska Pipeline. Canadian Field-Naturalist 93(2):155-162.

Carbaugh, B., J. P. Vaughan, E. D. Bellis, and H. B. Graves. 1975. Distribution and activity of white-tailed deer along an interstate highway. J. Wildl. Manage. 39(3):570-581.

Dorrance, M. J., P. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39(3):563-569.

Eckstein, R. G., and F. O'Brien, O. J. Rongstad, and J. G. Bollinger. 1979. Snowmobile effects on movements of white-tailed deer: a case-study. Environ. Cons. 6(1):45-52.

Goddard, J. 1970. Movements of moose in a heavily hunted area of Ontario. J. Wildl. Manage. 34(2):439-445.

Hood, R. E. and J. M. Inglis. 1974. Behavioral responses of white-tailed deer to intensive ranching operations. J. Wildl. Manage. 38(3):488-498.

Klein, D. R. 1971. Reaction of reindeer to obstructions and disturbances. Science 173:393-398.

Lent, P. C. and K. Child. 1973. Responses of caribou and reindeer to pipeline simulations: an applied behavior study. American Zoologist 13:1269-1270.

Moen, A. N., S. Whittemore, and B. Buxton. 1982. Effects of disturbance by snowmobiles on heart rate of captive white-tailed deer. N. Y. Fish Game J. (In Press).

Reed, D. F., T. N. Woodard, and T. M. Pojar. 1975. Behavioral responses of mule deer to a highway underpass. J. Wildl. Manage. 39(2):361-367.

Rost, G. R. and J. A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. J. Wildl. Manage. 43(3):634-641.

Schultz, R. D. and J. A. Bailey. 1978. Responses of national park elk to human activity. J. Wildl. Manage. 42(1):91-100.

REFERENCES, UNIT 2.4

HUMAN DISTURBANCES

BOOKS

TYPE	PUBL	CITY	PGES	ANIM	KEY WORDS	AUTHORS/EDITORS	YEAR
aubo	ucap	beca	567	odhe	a herd of mule deer	linsdale,jm; tomi	1953

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
BISNA	15--2	100	104	od--	respn, drive census, radio	tester,jr; heezen	1965

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
EVCNA	6---1	45	51	odvi	snowmobil effcts, mvts w-t	eckstein,rg; o'b/	1979
JWMAA	32--3	615	618	odvi	summr flight behav, adiron	behrend,df; lubec	1968
JWMAA	38--3	488	498	odvi	beha respn, intensv ranchi	hood,re; inglis,j	1974
JWMAA	39--3	563	569	odvi	eff snowmobile on w-t deer	dorrance,mj; sav/	1975
JWMAA	39--3	570	581	odvi	distr, activ, intersta hwy	carbaugh,b; vaug/	1975
MGQPA	32--3	139	146	odvi	eff snowmobile on distrib	kopischke,ed	1972
NFGJA	1---1	98	109	odvi	warinss,age comp,hntr kill	maguire,hf; sever	1954
RWLBA	6---2	153	326	odvi	w-t deer of the adirondcks	townsend,mt; smit	1933

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	20--3	181	282	odhe	life history, california	dixon,js	1934
CGFPA	7----	1	26	odhe	literature review,behavior	dorrance,mj	1966
JWMAA	39--2	361	367	odhe	behav respon, hwy undrpass	reed,df; woodard/	1975
JWMAA	43--3	634	641	odhe	distribu relation to roads	rost,gr; bailey,j	1979

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	22--2	207	209	ceel	flight distan free-ranging	altmann,m	1958
JWMAA	42--1	91	100	ceel	resp, humn activ,rcky mt p	schultz,rd; baile	1978
JWMAA	43--3	634	641	ceel	distribu relation to roads	rost,gr; bailey,j	1979
ZOOLA	41--8	65	71	ceel	pattrns,hrd beh,free-rngng	altmann,m	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AMNAA	52--2	392	399	alal	observ in yellowstone park	mcmillan,jf	1954
JWMAA	22--2	207	209	ceel	flight distan free-ranging	altmann,m	1958
JWMAA	34--2	439	445	alal	mvts, heavily huntd, ontar	goddard,j	1970
VILTA	4---1	1	42	alal	hand-reared moose calves	markgren,g	1966
ZOOLA	41-14	105	118	alal	ecol,behav,pop dynam, wyom	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AIATA	25--3	193	202	rata	grp cohes,ldrshp, barriers	miller,fl; jonke/	1972
AMZOA	13--4	1269	1270	rata	respons, pipeline simulatn	lent,pc; child,k	1973
ATICA	29--4	201	212	rata	react bar gr car, aircraft	calef,gw; debock/	1976
BPURD	1----	14	19	rata	react reindee to pipelines	child,k	1975
CAFNA	93--2	155	162	rata	dist, group comp, alas pip	cameron,rd; whit/	1979
SALKA	27--1	158	158	rata	mvts, beh,trans alas pipln	roby,do; cameron/	1976
SCIEA	173--	393	398	rata	react, obstrctns, disturbn	klein,dr	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFGA	30--4	221	241	anam	prnghrnd antlp, california	mclean,dd	1944
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968
JWMAA	37--3	343	352	anam	mortalit, fawns, west 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
CAFGA	15--1	73	73	ovca	close encounter, mt sheep	scofield,nb	1929
IGWBA	1----	1	154	ovca	status,life hist,man,idaho	smith,dr	1954

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CAFNA	94--1	52	60	obmo	behav resp,cargo slng,heli	miller,fl; gunn,a	1980

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
IGWBA	2----	1	142	oram	life history, manag, idaho	brandborg,sm	1955

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
WLSBA	6---1	8	13	----	interstate hwy road killed	case,rm	1978

OTHER PUBLICATIONS

Singer, F. J. 1975. Behavior of mountain goats, elk and other wildlife in relation to U.S. Highway 2, Glacier National Park. Prepared for Federal Highway Administration and Glacier National Park, West Glacier, Montana. 96 p.

SEE PART VI, CHAPTER 19, TOPIC 5 FOR ADDITIONAL REFERENCES

CHAPTER 5, Worksheet 2.4a

Base-line behavior and use information relative to man-made structures

Record in the space below relevant facts about the responses of wild ruminants to man-made structures. Mule deer use of a highway underpass and whitetail foraging on interstate seedings are two examples. Set up a format for your choice of response and compile the biological base-line information necessary for a cost analysis in CHAPTER 24.

CHAPTER 5, Worksheet 2.4b

White-tailed deer responses to snowmobiles

Undisturbed home ranges and activity patterns provide base-line information on the time distances traveled by deer in the winter. Evaluate descriptions of deer responses in Dorrance et al. (1975) and Moen et al. (1982) for later use in quantifying the additional energy expenditures that can be attributed to such disturbances.

LITERATURE CITED

Dorrance, M. J., P. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39(3):563-569.

Moen, A. N., S. Whittemore, and B. Buxton. 1982. Effects of disturbance by snowmobiles on heart rate of captive white-tailed deer. N. Y. Fish Game J. (In Press).

UNIT 2.5: OTHER INTERACTIONS

This unit provides a place for literature on other interactions between species not discussed in the four previous units. Some are surprising; Michael (1967a) concludes that the presence of coyotes and bobcats may be detrimental to deer in the Welder Wildlife Refuge in Texas, and likewise the presence of deer may be detrimental to coyotes and bobcats. Deer sometimes ran from coyotes, and sometimes followed them. He also noted that deer were very aware of horses and riders; they noticed them when 800-1000 yards away, and rarely let them approach closer than 300 yards. This was an interesting observation to me as marked heart rate response to horses have also been observed in our studies at the Wildlife Ecology Laboratory, Cornell University. The highest multiples of pre-stimulus heart rate was observed in reactions to horses (up to 2.69), except for rustling grass in a wolf-howl experiment (Moen and Chevalier 1977).

A variety of interactions were described for mule deer and birds by Riney (1951). Some are predators, some are carrion eaters, deer hair is used as nest material, ectoparasites are taken by birds, and a scrub jay was observed sleeping on a doe's back. Birds also alerted deer to the presence of coyotes, and bird sounds provided the stimulus that permitted a deer to abandon an alert attitude and resume its undisturbed activity.

Deer and wild turkeys in Texas tolerated each other in close proximity (Michael 1967b). They also responded to danger signals given by other species. A photo of whitetails and wild turkey (Moen 1973: 330) indicate a similar relationship exists in New York State. Relations among deer and most birds seemed to be neutral or beneficial to each species (Michael 1967).

A number of other interspecies interactions are described in the references in the SERIALS list.

LITERATURE CITED

Michael, E. D. 1967a. Behavioral interactions of deer and some other mammals. The Southwestern Naturalist 12(2):156-162.

Michael, E. D. 1967b. Behavioral interactions of birds and white-tailed deer. The Condor 69(4):431-432.

Moen, A. N. and S. Chevalier. 1977. Analyses of telemetered ECG signals from white-tailed deer. Pages 118-125 In F. M. Long, Ed., Proceedings, First International Conference on Wildlife Biotelemetry. 159 p.

Riney, T. 1951. Relationships between birds and deer. The Condor 53(4):178-185.

REFERENCES, UNIT 2.5

OTHER INTERACTIONS

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CNDRA	69--4	431	432	odvi	behavi interactions, birds	michael,ed	1967
SWNAA	12--2	156	162	odvi	behav interactins, mammals	michael,ed	1967
SWNAA	13--4	411	420	odvi	aggressive behav of w-t de	michael,ed	1968
WILBA	90--2	291	291	odvi	cattle egret deer mutualsm	halley,mr; lord,w	1978

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CNDRA	53--4	178	185	odhe	relatnshps bet birds, deer	riney,t	1951

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NCANA	101-3	437	456	alal	coactions with other anmls	wolfe,ml	1974
ZOOLA	41-14	105	118	alal	ecol,behav,pop dynam, wyom	denniston,rh,II	1956

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CJZOA	48--3	605	605	rata	interact barr-gr, muskrats	kelsall,jp	1970

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
CGFPA	17---	1	16	anam	some behavior patterns of	prenzlow,ej; gil/	1968

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

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
SWNAA	22--4	540	543	ovca	feral equids, grand canyon	berger,j	1977

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			

CLOSING COMMENTS

This CHAPTER concludes PART II, Behavior of Wild Ruminants. It does not conclude one's thinking about behavior, however, for the locations of activities, temporal patterns of activity, and changes in activities may all be used in analyses of energetics described in PART III, forage in PART IV, and weather in PART V. The results of analyses of behavior and physiology are used to evaluate effects of weather and thermal exchange on behavior, effects of behavioral responses in productivity and populations, and the role of behavior considerations in management of wild ruminants in a comprehensive way.

February 26, 1982
Aaron N. Moen

GLOSSARY OF SYMBOLS USED - CHAPTER 5

GESP = Genus and species

JDAY = Julian Day

TIME = Time of Day

GLOSSARY OF SERIAL CODENS - CHAPTER 5

SERIALS are identified by five-character, generally mnemonic codes called CODEN, listed in 1980 BIOSIS, LIST OF SERIALS (BioSciences Information Service, 2100 Arch Street, Philadelphia, PA 19103).

The headings for the lists of SERIALS are:

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

The volume and issue numbers (VO-NU) are given after the CODEN entry, followed by beginning page (BEPA), ending page (ENPA), species discussed (ANIM), KEY WORDS from the title, AUTHORS [truncated if necessary, slash (/) indicates additional authors], and year.

AAAHA Australian Journal of Experimental Agriculture and Animal Husbandry (Australia)
AELRA Advances in Ecological Research
AIATA Arctic Institute of North America Technical Paper
AMNAA American Midland Naturalist (US)
AMNTA American Naturalist (US)
AMZOA American Zoologist (US)
ANBEA Animal Behaviour (England)
ANIPA Animal Production
ANKIA Animal Kingdom, New York Zoological Society Bulletin
APANE* Applied Animal Ethology (made up - there is no BIOSIS coden)
ARECB Annual Review of Ecology and Systematics
ATICA Arctic (Canada)
ATRLA Acta Theriologica (Poland)
AZWBA Arizona Game and Fish Department Wildlife Bulletin (US)

BEHAA Behaviour (Netherlands)
BHBLA Behavioral Biology
BIBED Biology of Behavior
BISNA Bioscience
BMAEA Montana Agricultural Experiment Station Bulletin
BPURD Biological Papers of the University of Alaska Special Report
BVJOA British Veterinary Journal

CAFGA California Fish and Game (US)
CAFNA Canadian Field Naturalist (Canada)
CFGGA California Department of Fish and Game, Game Bulletin
CGFPA Colorado Division of Game, Fish, and Parks Special Report (US)
CJZOA Canadian Journal of Zoology (Canada)
CNDRA Condor
COVEA Cornell Veterinarian
CWRSB Canadian Wildlife Service Report and Management Bulletin Series

ECMOA Ecological Monographs (US)
ECOLA Ecology
EKIAA Ekologiya (USSR)
EVCNA Environmental Conservtion
EVOLA Evolution (US)

FUNAA Fauna (Oslo)
FVHFA Fortschritte der Verhaltensforschung

GRLEA Great Lakes Entomologist

HOBEA Hormones and Behavior

IGWBA Idaho Department of Fish and Game Wildlife Bulletin
IUNRA International Union for Conservation of Nature and Natural Resources Annual Report (Switzerland)
IZYBA International Zoo Year Book

JAECA Journal of Animal Ecology
JANSA Journal of Animal Science (US)
JBLPA Jelen
JCECD Journal of Chemical Ecology (US)
JCPPA Journal of Comparative and Physiological Psychology
JEZOA Journal of Experimental Zoology
JOMAA Journal of Mammalogy (US)
JRMGA Journal of Range Management (US)
JRPFA Journal of Reproduction and Fertility (England)
JTBIA Journal of Theoretical Biology
JWMAA Journal of Wildlife Management (US)
JZOOA Journal of Zoology (London)

LUTAA Lutra

MAMLA Mammalia (France)
MDCBA Minnesota Department of Conservation Technical Bulletin
MDCRA Michigan Department of Conservation Game Division Report
MGQPA Minnesota Department of Natural Resources Game Research Project Quarterly Report
MRLTA Murrelet, The
MUOXD Musk-ox
MUZPA Miscellaneous Publications, Museum of Zoology, University of Michigan

NATUA Nature (England)
NAWTA North American Wildlife and Natural Resources Conference, Transactins of the
NCANA Naturaliste Canadien, Le
NFGJA New York Fish and Game Journal
NPSMD United States National Park Service Scientific Monograph Series
NYCOA New York State Conservationist

PAANA Proceedings of the Australian Society of Animal Production
PCGFA Proceedings of the Southeastern Association of Game and Fish Commissioners (US)
PHZOA Physiological Zoology
PIAIA Proceedings of the Iowa Academy of Science (US)
PZSLA Proceedings of the Zoological Society of London

QRBIA Quarterly Review of Biology
QRESA Quaternary Research (New York)

RSZOA Revue Suisse de Zoologie
RWLBA Roosevelt Wild Life Bulletin

SALKA Science in Alaska Proceedings Alaskan Science Conference
SCAMA Scientific American (US)
SCBUB Sierra Club Bulletin
SCIEA Science
SCZFA Schweizerische Zeitschrift fuer Forstwesen
SWNAA Southwestern Naturalist (US)
SZSLA Symposia of the Zoological Society of London (England)

TISAA Transactions of the Illinois State Academy of Science (US)
TLPBA Theoretical Population Biology
TNWSD Transactions of the Northeast Section, The Wildlife Society (US)

UABPA Biological Papers of the University of Alaska
UCPZA University of California Publications in Zoology
UTSCB Utah Science (US)

VILTA Viltrevy (Sweden)
VJSCA Virginia Journal of Science
VLUBB Vestnik Leningradskogo Universiteta Biologiya

WCDBA Wisconsin Conservation Department Technical Bulletin
WGFBA Wyoming Game and Fish Commission Bulletin
WILBA Wilson Bulletin
WLMOA Wildlife Monographs (US)
WLSBA Wildlife Society Bulletin
WMBAA Wildlife Management Bulletin (Ottawa) Series 1 (Canada)

XARRA U S Forest Service Research Note RM (US)
XNFSA U S National Park Service Fauna of the National Parks of the United States, Fauna Series

ZEJAA Zeitschrift fuer Jagdwissenschaft
ZETIA Zeitschrift fuer Tierpsychologie
ZOBEA Zoologisch Beitraege
ZOGAA Zoologische Garten
ZOOLA Zoologica (New York)
ZSAEA Zeitschrift fuer Saeugetierkunde

LIST OF PUBLISHERS - CHAPTER FIVE

The headings for the lists of BOOKS are:

TYPE PUBL CITY PAGE ANIM KEY WORDS---------- AUTHORS/EDITORS-- YEAR

All essential information for finding each book in the library is given on just one line. The TYPE of book could have either AUTHORS (aubo) of EDITORS (edbo). Publishers (PUBL) and CITY of publication are given with four-letter mnemonic symbols defined below. The PAGE column gives the number of pages in the book; ANIM refers to the species discussed in the book (given as a four-letter abbreviation of genus and species), and KEY WORDS listed are from the title. The AUTHORS/EDITORS and YEAR of publication are given in the last two columns.

aakn	Alfred A. Knopf	New York, NY	nyny
acpr	Academic Press	New York, NY	nyny
bhup	Belknap Press of Harvard University Press	Cambridge, MA	cama
blsp	Blackwell Scientific Publications	Oxford, England	oxen
cite	Cambridge Institute of Terrestrial Ecology	Cambridge, England	caen
copr	Columbia University Press	New York, NY	nyny
dodo	Doubleday Doran	New York, NY	nyny
dohr	Dowden, Hutchinson, & Ross	Stroudsburg, PA	stpa
dove	Dover Pub. Co.	New York, NY	nyny
fost	Forest and Stream Publishing Co.	New York, NY	nyny
isup	Iowa State University Press	Ames, IA	amia
iucn	International Union for the Conservation of Nature and Natural Resources	Morges, Switzerland	mosw
jwis	John Wiley and Sons, Inc.	New York, NY	nyny
macm	MacMillan Co.	New York, NY	nyny
meth	Methuen & Co., Ltd.	London, England	loen
mhbc	McGraw-Hill Book Company, Inc.	New York, NY	nyny

nags	National Geographic Society	Washington, DC	wadc
olbd	Oliver & Boyd	London, England	loen
olbo	Oliver & Boyd	Edinburgh, Scotland	edsc
oxup	Oxford University Press	London, England	loen
plpc	Plenum Publishing Corporation	New York, NY	nyny
plpr	Plenum Press	New York, NY	nyny
prha	Prentice-Hall, Inc.	Englewood Cliffs, NJ	nyny
qupr	Queen's Printer	Ottowa, Ontario	oton
saco	Saunders Publishing Co.	Philadelphia, PA	phpa
stac	Stackpole Company, The	Harrisburg, PA	hapa
ucap	University of California Press	Berkeley, CA	beca
uchp	University of Chicago Press	Chicago, IL	chil
unbp	University of Nebraska Press	Lincoln. NE	line
uopr	University of Oklahoma Press	Norman, OK	nook
usda	U S Department of Agriculture	Washington, DC	wadc
utop	University of Toronto Press	Toronto, Ontario	toon
uwyp	University of Wyoming Press	Laramie, WY	lawy
whfr	W. H. Freeman Company	San Francisco, CA	sfca
wile	Wiley	New York, NY	nyny
wimi	Wildlife Management Institute	Washington, DC	wadc
wiso	Wildlife Society, The	Washington, DC	wadc
wiwi	Williams and Wilkins	Baltimore, MD	bama

GLOSSARY OF ANIMAL CODE NAMES

Wild ruminants are referred to in this CHAPTER by a 4-character abbreviation from the family, genus and genus-species. These are listed below under Abbreviation.

Scientific names of North American wild ruminants are those used in BIG GAME OF NORTH AMERICA, edited by J.C. Schmidt and D. L. Gilbert (1979: Stackpole Books, Harrisburg, PA 17105, 494 p.), and may be different from the scientific names given in the original literature.

The abbreviations used for North American wild ruminants are listed below.

CLASS: MAMMALIA

ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: Odocoileus (deer)	od--
SPECIES: O. virginianus (white-tailed deer)	odvi
O. hemionus (mule deer)	odhe
GENUS: Cervus (Wapiti, elk)	ce--
SPECIES: C. elaphus	ceel
GENUS: Alces (moose)	
SPECIES: A. alces	alal
GENUS: Rangifer (caribou)	
SPECIES: R. tarandus	rata
FAMILY: ANTILOCAPRIDAE	
GENUS: Antilocapra	
SPECIES: A. americana (pronghorn)	anam
FAMILY: BOVIDAE	bovi
GENUS: Bison (bison)	bi--
SPECIES: B. bison	bibi
GENUS: Ovis (sheep)	ov--
SPECIES: O. canadensis (bighorn sheep)	ovca
O. dalli (Dall's sheep)	ovda
GENUS: Ovibos	
SPECIES: O. moschatus (muskox)	obmo
GENUS: Oreamnos	
SPECIES: O. americanus (mountain goat)	oram

The abbreviations used for European wild ruminants are listed below.

CLASS: MAMMALIA	
ORDER: ARTIODACTYLA	Abbreviation
FAMILY: CERVIDAE	cerv
GENUS: Capreolus (roe deer)	ca--
SPECIES: C. capreolus	caca
GENUS: Dama (fallow deer)	da--
SPECIES: D. dama	dada
GENUS: Cervus (Wapiti, elk)	ce--
SPECIES: C. elaphus (red deer)	ceel
GENUS: Alces (moose)	
SPECIES: A. alces	alal
GENUS: Rangifer (caribou)	
SPECIES: R. tarandus	rata
FAMILY: BOVIDAE	
GENUS: Bison (bison)	
SPECIES: B. bonasus	bibo
GENUS: Capra (ibex, wild goat)	cp--
SPECIES: C. aegargrus(Persian ibex)	cpae
C. siberica (Siberian ibex)	cpsi

OTHERS

Abbreviations for a few other species and groups of species may appear in the reference lists. These are listed below.

Ammotragus lervia (Barbary sheep)	amle
Axis axis (axis deer)	axax
Elaphurus davidianus (Pere David's deer)	elda
Cervus nippon (Sika deer)	ceni
Hydropotes inermis (Chinese water deer)	hyin
Muntiacus reevesi (Chinese muntjac)	mure
Moschus moschifer (Chinese musk deer)	momo
Ovis nivicola (snow sheep)	ovni
Ovis musimon (moufflon)	ovmu
Ovis linnaeus (Iranian sheep)	ovli
Rupicapra rupicapra (chamois)	ruru
big game	biga
domestic sheep	dosh
domestic cattle	doca
domestic goat	dogo
domestic ruminant	doru
herbivore	hrbv
mammals	mamm
three or more species of wild ruminants	many
ruminants	rumi
ungulates	ungu
vertebrates	vert
wildlife	wldl
wild ruminant	wiru

JULIAN DAY: MONTH AND DAY EQUIVALENTS*

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	001	032	060	091	121	152	182	213	244	274	305	335	1
2	002	033	061	092	122	153	183	214	245	275	306	336	2
3	003	034	062	093	123	154	184	215	246	276	307	337	3
4	004	035	063	094	124	155	185	216	247	277	308	338	4
5	005	036	064	095	125	156	186	217	248	278	309	339	5
6	006	037	065	096	126	157	187	218	249	279	310	340	6
7	007	038	066	097	127	158	188	219	250	280	311	341	7
8	008	039	067	098	128	159	189	220	251	281	312	342	8
9	009	040	068	099	129	160	190	221	252	282	313	343	9
10	010	041	069	100	130	161	191	222	253	283	314	344	10
11	011	042	070	101	131	162	192	223	254	284	315	345	11
12	012	043	071	102	132	163	193	224	255	285	316	346	12
13	013	044	072	103	133	164	194	225	256	286	317	347	13
14	014	045	073	104	134	165	195	226	257	287	318	348	14
15	015	046	074	105	135	166	196	227	258	288	319	349	15
16	016	047	075	106	136	167	197	228	259	289	320	350	16
17	017	048	076	107	137	168	198	229	260	290	321	351	17
18	018	049	077	108	138	169	199	230	261	291	322	352	18
19	019	050	078	109	139	170	200	231	262	292	323	353	19
20	020	051	079	110	140	171	201	232	263	293	324	354	20
21	021	052	080	111	141	172	202	233	264	294	325	355	21
22	022	053	081	112	142	173	203	234	265	295	326	356	22
23	023	054	082	113	143	174	204	235	266	296	327	357	23
24	024	055	083	114	144	175	205	236	267	297	328	358	24
25	025	056	084	115	145	176	206	237	268	298	329	359	25
26	026	057	085	116	146	177	207	238	269	299	330	360	26
27	027	058	086	117	147	178	208	239	270	300	331	361	27
28	028	059	087	118	148	179	209	240	271	301	332	362	28
29	029	[060]	088	119	149	180	210	241	272	302	333	363	29
30	030		089	120	150	181	211	242	273	303	334	364	30
31	031		090		151		212	243		304		365	31

* For leap year, February 29 = JDAY 60. Add 1 to all subsequent JDAYs.

LIST OF WORKSHEETS - CHAPTER 5

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