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.

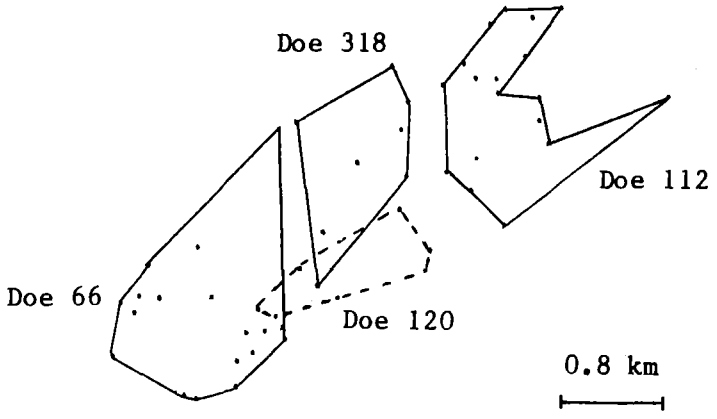
UNIT 3.1: DAILY HOME RANGES

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.

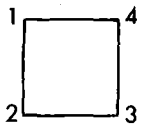
The illustration below illustrates the effect of topography on the geometry of white-tailed deer home ranges. The concave home range of Doe 112 (Nelson 1979) was due to a lake on the right-side border. Note also that the home ranges tended to fit together rather than overlap. These locations were determined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



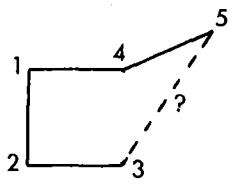
The calculation of home range may be difficult because the distance travelled each day may not be indicative of the land area covered. A resident white-tail deer, for example, may zig-zag and criss-cross considerably, traveling some distance but spending all of the time within a rather small area. A 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.

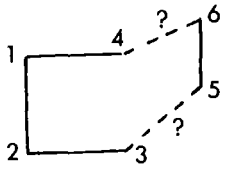
Accurate calculations of the area of the home range are more difficult to make as the home range departs from symmetry. The drawings below illustrate this point.



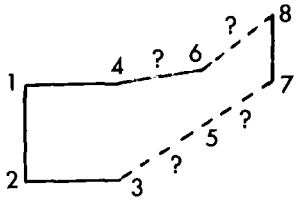
Four successive locations



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, wmt 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.

LIST OF WORKSHEETS - CHAPTER THREE