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 inter-species 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.

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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
____	____		____
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____	____		____

GESP	POTENTIAL COMPETITION	with GESP

CHAPTER 5, Worksheet 2.1b

Quantifying competition between sympatric species

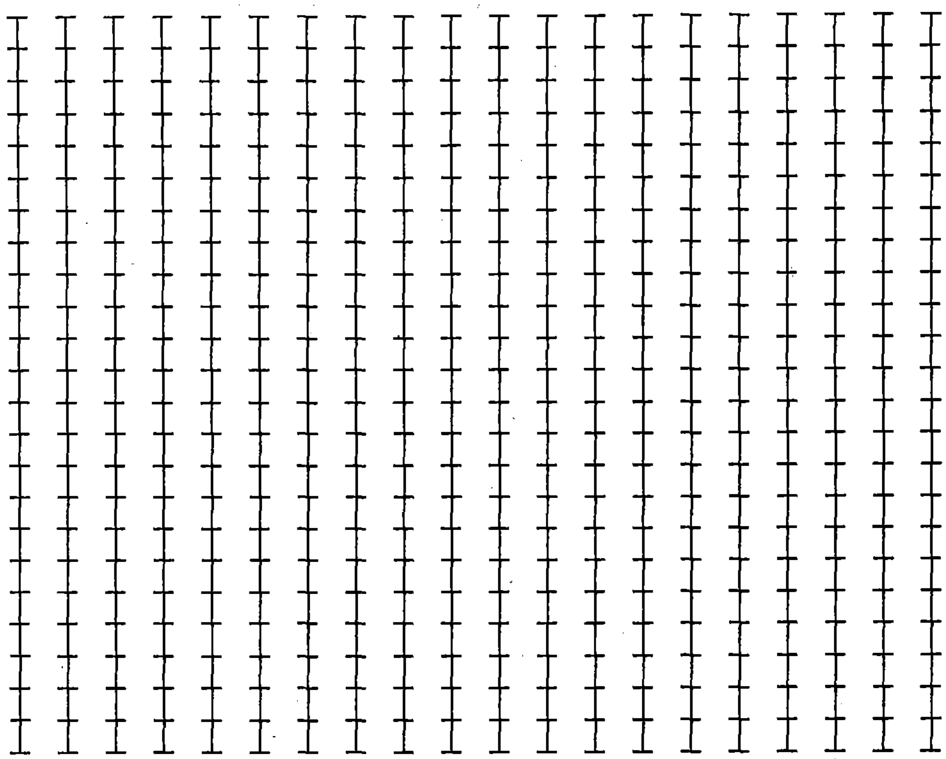
Knowing there is potential competition between species and evaluating the extent of the competition are two different things. The former is easy to accept the latter is difficult to do.

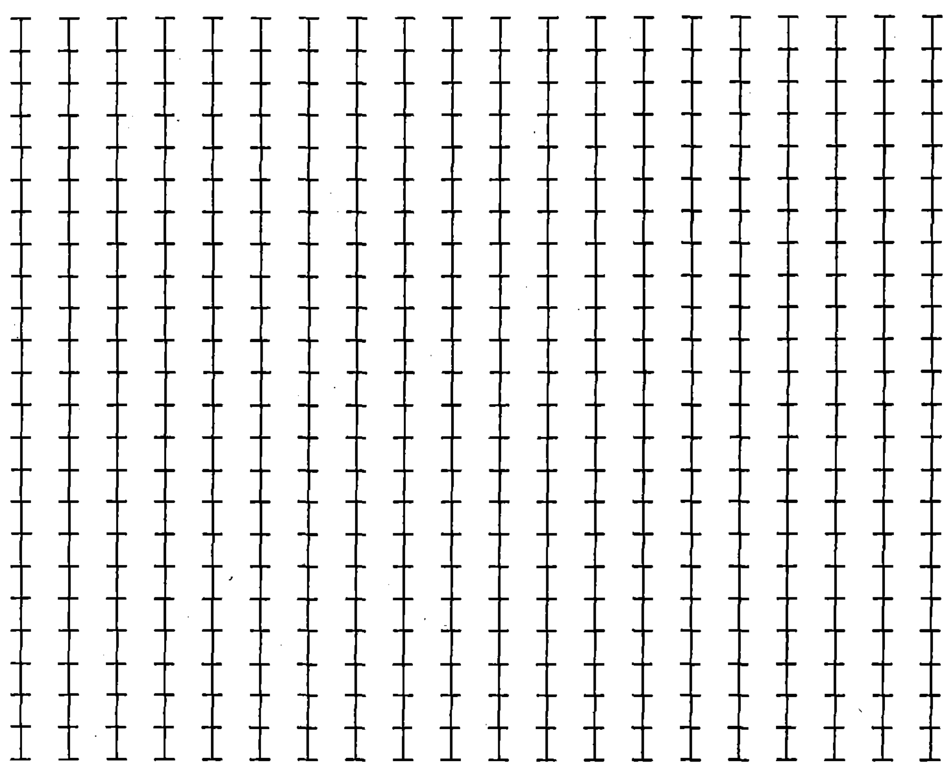
In the space below, list specifics, such as foods eaten, times active, etc. Convert foods eaten to metabolizable energy as discussed in PART III, CHAPTER 7. Consider the "coefficient of similarity" concept described by Oosting (1956) as a possible way to represent the extent of competition. Convert times 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.

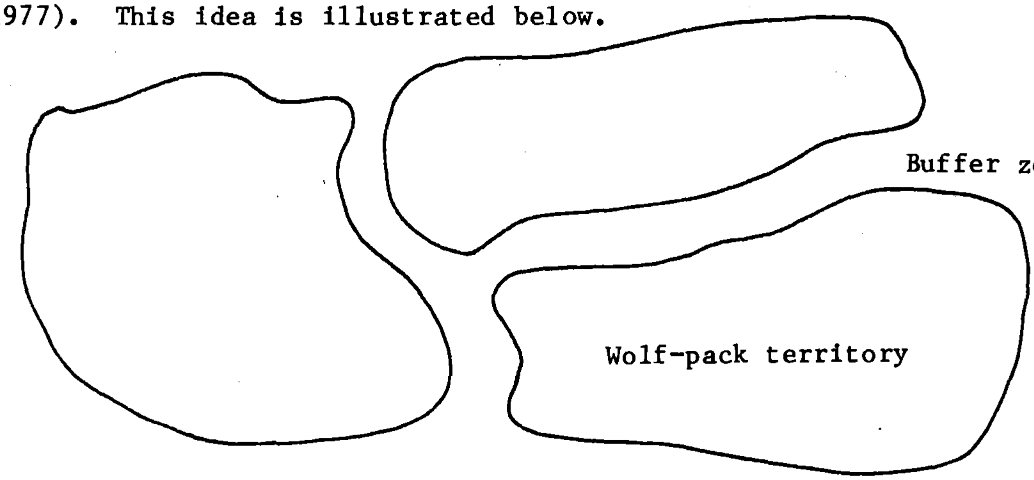
This is probably one of the oldest principles thought to govern prey selection. It seems logical, and Mech (1970), after reviewing the literature and investigating wolf predation on wild ruminants, states that ". . . wolf predation generally selects out the young, old, sick, weak, injured, and diseased 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).

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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.

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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.

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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.

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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.

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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.

	Abbreviation
CLASS: MAMMALIA	
ORDER: ARTIODACTYLA	
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