TOPIC 2. OBSERVED FORAGE CONSUMPTION AND PASSAGE RATES

There have been relatively few measurements of forage consumption by wild ruminants, and even fewer measurements of passage rates through the gastrointestinal tract. There are good reasons for this; consumption is very difficult to measure or estimate for free-ranging animals, and passage rates are even more difficult since quantities of both forage and marker must be known over time in order to determine passage rate.

Measurements of forage, water, and mineral consumption by free-ranging wild ruminants are very difficult to make because the animals make their own choices of forage species selected, and choose their own time and place for consumption. Estimates of forage consumption are often made indirectly by counting bites and attempting to calibrate the size of bites. The calibration has to be done indirectly too, often by relating twig diameter to twig weights when woody browse is being consumed.

The use of tame animals that can be accompanied by human observers in the field is a recent technique that provides additional insight into selection and consumption. Such animals may be used with the "bite count" method described above.

Grazing animals present a different kind of problem; larger masses of ingesta are taken with each bite. Esophageal fistulas have been used on domestic cattle and sheep, and amounts taken determined.

Water and mineral consumption may be estimated in only very crude ways. Relative consumption may be determined for different times of the year by frequencies and durations of time at water and mineral sources.

Lack of knowledge of forage consumption and passage rates must not minimize their importance. Suppose two forages were consumed in equal amounts and were equally digestible, but one had a passage rate two times faster than the other. The nutrients available per unit time would be two times greater for the rapid-passage forage. Since such events occur in a diet context, there are implications for the overall dietary composition from such differences in forages.

Units on forage consumption (UNIT 2.1) and passage and turnover rates (UNIT 2.2) follow with indications of the use and importance of consumption and passage rate data when working with nutrients available to the animal.

UNIT 2.1: FORAGE CONSUMPTION

There is relatively little information on the amounts of forage consumed by free-ranging wild ruminants. Most of the references on observed forage consumption describe amounts eaten under controlled experimental conditions. These experiments were valuable initially for providing estimates of the masses of different forages ingested, and are also valuable now for comparing with results of the calculations that are described in TOPICS 3, 4, and 5.

References with information on forage consumption can be used for comparing with predicted consumption if data on time of year, weights of animals, and digestibility of the forage consumed is given. Surprisingly few papers contain all of this information (Moen and Scholtz 1981). Those papers in the lists of references that do should be marked for later use when making calculations of daily consumption in TOPICS 3, 4, and 5.

LITERATURE CITED

Moen, A. N. and S. Scholtz. 1981. Nomographic estimation of forage intake by white-tailed deer. J. Range Manage 34(1):74-76.

REFERENCES, UNIT 2.1

FORAGE CONSUMPTION

SERIALS

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JWMAA	33--4	917	921	cerv	twig wt-diam related browse	telfer,es	1969
JWMAA	34--2	456	460	cerv	lgth-,wt-dia relat, serv-be	lyon,lj	1970
JWMAA	38--4	944	946	cerv	vertical distr of browsing	telfer,es	1974

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AGJOA	69--3	497	501	od--	est forg cons, wdlnd clrng	kalmbacher,rs; wa	1977
CAFGA	37--1	43	52	od--	deer range survey methods	dasmann,up	1951
JWMAA	9---4	319	322	od--	symptoms, malnutrition, de	harris,d	1945
NEJAA	39--2	3	4	od--	test rye for deer forage	toth,sj; mclain,/	1957
PCGFA	10---	53	58	od--	nutr prob, south pine type	lay,dw	1956
WSCBA	14--2	18	19	od--	starve, feeding stati, wis	stollberg,bp	1949

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
AZATA	75---	1	39	odvi	odhe, experimtl feed, deer	nichol,aa	1938
CJFRA	4---4	491	498	odvi	use brows in encl, n bruns	drolet,ca	1974
JANSA	45--2	365	376	odvi	nutrn wh-t throughout year	holter,jb; urban/	1977
JRMGA	26--5	372	375	odvi	est food intak, obs mastic	crawford,hs; whel	1973
JWMAA	20--3	221	232	odvi	nutr req, growth, antl dev	french,ce; mcewe/	1955
JWMAA	34--2	431	439	odvi	wint feed patterns, penned	ozoga,jj; verme,l	1970
JWMAA	34--4	863	869	odvi	dige, metab ener req, wint	ullrey,de; youat/	1970
JWMAA	35--4	723	731	odvi	food passage rate, w-t dee	mautz,ww; petride	1971
JWMAA	36--4	1052	1060	odvi	variat in determ dig capac	mothershead,cl; /	1972
JWMAA	39--1	67	79	odvi	feed analyses and digestio	robbins,ct; van /	1975
JWMAA	39--2	321	329	odvi	nutr in diff season, south	short,hr	1975
JWMAA	39--2	355	360	odvi	milk consumption & wt gain	robbins,ct; moen,	1975
JWMAA	39--3	596	600	odvi	rumen overload, rumenitis	wobeser,g; runge,	1975
JWMAA	39--4	692	698	odvi	energ, prot, blood urea ni	kirkpatrick,rl; /	1975
JWMAA	39--4	699	704	odvi	artif brws supplmn, penned	ullrey,de; youat/	1975
NAWTA	4----	268	274	odvi	results, feeding exp, mich	davenport,la	1939
NAWTA	22---	119	132	odvi	nutrient requirements, w-t	mcewen,lc; frenc/	1957
NAWTA	22---	179	188	odvi	feed req for growth, maint	cowan,imct; wood/	1957
NAWTA	34---	146	154	odvi	effects qual on food intak	nagy,jg; know kl/	1969
PAABA	600--	1	50	odvi	nutr req, growth, antl dev	french,ce; mcewe/	1955
PAABA	628--	1	21	odvi	nutr, gro, antl, exp resul	magruder,nd; fre/	1957
PAARA	262--	1	5	odvi	seas fluc in feed consumpt	long,ta; cowan,r/	1965
PCGFA	21---	24	32	odvi	seas var food cons, wt gai	fowler,jf; newso/	1967
XANEA	33---	1	37	odvi	brwsing hardwds, northeast	shafer,el,jr	1965

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
NOSCA	45--2	80	86	odhe	doug fir seedl heigh, brow	dimock,ej,II	1971
JRMGA	6---1	30	37	odhe	captv, cnsmp natv forg sum	smith,ad	1953
JWMAA	35--3	469	475	odhe	nutr intak, ariz chap, des	urness,pj; green/	1971
JWMAA	36--4	1025	1033	odhe	forag use, logging, colora	wallmo,oc; regel/	1972
JWMAA	38--3	508	516	odhe	est forag intak, cesiu-137	alldredge,aw; li/	1974
JWMAA	41--4	782	784	odhe	ceel, ponder pine for open	ffolliott,pf; th/	1977
NAWTA	22---	179	186	odhe	food requir growth & maint	cowan,imct; wood/	1957

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATRLA	17-15	187	202	ceel	caca, foo supply cons, pol	bobek,b; weiner,/	1972
BJNUA	40--2	347	357	ceel	dosh, comp intk, dig, fora	milne,ja; macrae/	1978
JAPEA	16--1	227	242	ceel	height, sp, determ browsng	rounds,rc	1979
JWMAA	42--4	799	810	ceel	diet, activ, ldgpl pne hab	collins,wb; urne/	1978
NATUA	263--	763	764	ceel	dosh, intk, dig, hill vege	milne,ja; macrae/	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATRLA	21--5	101	116	alal	food habits, poland	morow,k	1976
JOMAA	51--2	403	405	alal	character captiv mich moos	verme,lj	1970
JWMAA	37--3	279	287	alal	impnc nonbrows food, alask	leresche,re; davi	1973
JWMAA	39--2	368	373	alal	daily brows consum, quebec	crete,m; bedard,j	1975
WLMOA	48---	1	65	alal	habitat select, forest mgt	peek,jm; urich,d/	1976

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATYBA	55---	22	25	rata	birch consump, fin lapland	haukioja,e; heino	1974
BPURD	1----	71	79	rata	lichn ing rt, fllout cesiu	hanson,wc; whick/	1975
CJZOA	48--5	905	913	rata	seas cha, ener, nitr intak	mcewan,eh; whiteh	1970
NCANA	96---	333	336	rata	food hab, daily lichn cons	desmeules,p; heyl	1969

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
JRMGA	20--1	21	25	anam	dosh, food pref, wyo deser	severson,ke; may,	1967
JWMAA	34--3	570	582	anam	forg, watr consump, produc	beale,dm; smith,a	1970
WGFBA	12---	1	61	anam	food hab, abund, distribut	sundstrom,c; hep/	1973
XIBPA	1....	233		anam	field food consump studies	nagy,jg; hoover,j	1971

CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATRLA	22-14	225	230	bibi	fora intak, dig; doca, yak	richmond,rj; hud/	1977
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
FEPRA	27--6	1361	1366	rumi	regulation of feed intake	baile,ca	1968
JANSA	24--3	834	843	rumi	volun intk, herb, chem com	van soest,pj	1965
JOMAA	25--1	49	54	many	food req alaskan game mamm	palmer,lj	1944
JWMAA	38--4	944	946	many	vert distrib brwsng, canad	telfer,es	1974
QRBIA	52--2	137	154		optim fora: rev theor, tes	pyke,gh; pulliam/	1977
SZSLA	21---	77	87	ungu	investigate ung diets, zoo	bilby,lw	1968
XARRA	22---	1	6		meth estim rnge grass util	springfield,hw; p	1964
ZEJAA	20--1	63	67	wiru	det nutr intake, tame spec	nagy,jg	1974
CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
OIKSA	32--3	373	379	caca	dada, brws pressure, decid	bobek,b; perzano/	1979
CODEN	VO-NU	BEPA	ENPA	ANIM	KEY WORDS	AUTHORS	YEAR
ATRLA	12-25	367	376	bibo	food, for ecosyst, lit rev	borowski,s; kras/	1967

UNIT 2.2: PASSAGE AND TURNOVER RATES

Passage and turnover rates of ingesta of wild ruminants have given little attention. The potential importance of the rate of passage was illustrated with an example of differences in the turnover rate in relation to actual abundance in Moen (1973:158). Four different colored sets of marbles were used to illustrate different entry and turnover rates, with their abundance measured each day. The slow-moving, abundant black marbles had a 50% observed abundance but only 29% actual abundance because their passage rate was slow. The illustration shows how those materials with a slow turnover rate may appear to be more abundant than those with a fast turnover rate, simply because they stay in the rumen longer.

A WORKSHEET illustrates this concept, using hypothetical forage values. It is an important concept to be considered when evaluating diet digestibilities.

LITERATURE CITED

Moen. A. N. 1973. Wildlife ecology. W. H. Freeman Co., San Francisco. 458 pp.

REFERENCES, UNIT 2.2

PASSAGE AND TURNOVER RATES

SERIALS

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

JWMAA 35--4 723 731 odvi food passage rate mautz,ww; petride 1971

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

odhe

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

JWMAA 44--1 272 273 ceel passage rate of alfalfa dean,re; thorne,/ 1980

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

alal

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

rata

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

anam

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

bibi

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

ovca

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

ovda

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

obmo

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

oram

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

JANSA 25--2 283 289 dosh reln ad lib intk, gut fill ingalls,jr; thom/ 1966

CHAPTER 12, WORKSHEET 2.2a

Food passage rate and turnover time

The amount of different forage species in the rumen would be a true indication of their nutritive importances if they all had the same passage rate and turnover time. Such is not the case, however. Lower quality forages with a slower passage rate than higher quality forages are retained in the rumen longer, and hence may appear to be more important in the diet. The higher quality forages, digested in a short time, yield more nutrients per unit time, however. This is illustrated below with these forages consumed in equal amounts (10 units per day) each day through 5 days.

		Day 1	2	3	4	5		
Woody browse, 3-day passage rate:	10	10	10					
		10	10	10				
			10	10	10			
				10	10	10		
					10	10	10	
						10	10	10
Herbaceous leaves, 2-day passage rate:	10	10						
		10	10					
			10	10				
				10	10			
					10	10		
						10	10	
Flowers, 1-day passage rate:	10	10	10	10	10	10	10	
	Sums:		60	60	60	60	60	

Note that the relative quantities in the rumen after equilibrium is reached are different from the entry rate. The woody browse, herbaceous leaves, and flowers all enter at the same rate, 10 per day; the diet is composed of 33% of each. The rumen, however, contains 30/60 = 50% woody browse, 20/60 = 33% herbaceous leaves, and 10/60 = 17% flowers. The differences in passage rates result in different amounts in the rumen at one time, which are quite unlike the nutrient entry rate.

Should not more attention be given to passage rates and turnover times when analyzing rumen contents for food habits studies?