Plant preference by Mouflon (Ovis ammon musimon Pal.) and Axis deer (Axis axis Erx.) in the forest community of Holm oak and Manna ash (Fraxino orni-quercetum ilicis H-ić/1956/1958)

Krapinec, Krešimir

Source / Izvornik: **Glasnik za šumske pokuse: Annales Experimentis Silvarum Culturae Provehendis, 2002, 39, 67 - 102**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:108:847641

UDK: 630*151

Original scientific paper
Izvorni znanstveni članak

PLANT PREFERENCE BY MOUFLON (*OVIS AMMON MUSIMON* PAL.) AND AXIS DEER (*AXIS AXIS* ERX.) IN THE FOREST COMMUNITY OF HOLM OAK AND MANNA ASH (*FRAXINO ORNI-QUERCETUM ILICIS* H-IĆ /1956/ 1958)

PREFERABILNOST BILJNIH VRSTA ZAJEDNICE HRASTA CRNIKE I CRNOGA JASENA (*FRAXINO ORNI-QUERCETUM ILICIS* H-IĆ /1956/ 1958) U MUFLONA (*OVIS AMMON MUSIMON PAL.*) I JELENA AKSISA (*AXIS AXIS ERX.*)

KREŠIMIR KRAPINEC

Department of Forest Protection and Wildlife Management, Faculty of Forestry, University of Zagreb, Svetošimunska 25, HR – 10000 Zagreb

Received – *Prispjelo*: 15. 9. 2001. Accepted – *Prihvaćeno*: 5. 11. 2002.

The paper presents the results of analysis of mouflon (*Ovis ammon musimon* Pal.) and axis deer (*Axis axis* Erx.) browsing in the forest community of holm oak and manna ash (*Fraxino orni-Quercetum ilicis* H-ić /1956/ 1958). In the course of 1999, three damage assessments were made in different sample plots each at the beginning of May, the beginning of July and in mid-October. At the cited density of 8 heads of big game per 100 ha in the hunting ground (mouflon and axis deer together), the game did not cause any considerable economic damage. With respect to game - forest interaction, it was found that cleaning was the main determinant for the increase in browse for game, because this treatment raises the browsing feeding capacities for the game manifoldly. The cleaning procedure may yield up to 52,000 plants of palatable species per hectare by the beginning of summer. Game was found to display seasonal preference for plant species and to favour plants from stumps over those from seeds. Similarly, the vertical growth of plants increases the probability of their being damaged by game. The summer-autumn season is the period in which forest stands are at most risk by game, because drought induces game to consume juicy shoots of woody plants.

Of woody plants, game avoided the common myrtle (*Myrtus communis*) and the mastic tree (*Pistacia lentiscus*), but also the seedlings of all woody species.

Key words: mouflon, axis deer, preference, eu-Mediterranean, damage status, preference ratio index, forest of holm oak and manna ash (*Fraxino orni-Quercetum ilicis* H-ić /1956/ 1958), carrying capacity

INTRODUCTION
UVOD

Vegetation plays a crucial role in hunting management. Not only does it act as a nutritive resource for herbivorous game, but it also provides shelter for animals. Each individual animal species has specific requirements with regard to the way of life, habitat and food. Therefore, it is important to discriminate different vegetation types or cultures in terms of their suitability for the growth of animal species. One of the main problems in assessing game habitats lies in the qualitative relation of crop fields, meadows, pastureland and forests from the standpoint of hunting management. In the case of the first three habitats, so far only the quality of artificially produced game food in the form of concentrates, silage or hay have been studied from the hunting management aspect (Grubešić 1996, cit. Manojlović 1992), leaving natural nutritive potentials for further study.

According to Grubešić (1996), the relative area importance ratio in Central Croatia, from the hunting management aspect, would be as follows: crop fields 20 %, meadows 15 %, pastureland 15 %, forests 50 %.

In the nature, game has much more food at its disposal than it really needs. This refers primarily to herbaceous vegetation, but only during vegetation periods (although grazing game also feed on dry plants in dormant vegetation stages), while outside the vegetation period, some wildlife species find food exclusively in forests. Consequently, the game-habitat interaction in Croatia and in the world has been dealt with mostly by foresters. Although many nature protectors blame foresters for the degradation of habitats of some animal species, it is important to mention that it has long been known that modern forestry improves habitats for certain animal species. Namely, progressive vegetation succession enlarges the growing area of wild herbivores both spatially and qualitatively not only in terms of food, but also shelter.

Compared to the primeval forest, the quantity and diversity of available biomass and shelter in commercial forests increase in accordance with the occurrence of the initial stage (enclosure) (Adamič 1990, cit. Mlinšek 1985). So, for example, the main reason for the increase in the moose population (*Alces alces* L.) in Northern Minnesota lies in more intensive forest exploitation and a change in felling methods. The final cut resulted in bare areas of over 100 ha, which provided the moose with optimal conditions for nutrition and shelter (Adamič 1990, cit. Peek *et al.* 1976).

The problem of forest damage should also be mentioned here. In recent times, West European countries, particularly Germany, are faced with over-numerous game populations. This problem is solved with reduction kills of excessive game. Detrimental impacts of game on

forest regeneration are seen by some authors as the main problem of Central European forestry (Adamič 1990, cit. Čop 1982). To prove that damage by game is not exclusively linked to excessive game populations and is not a new notion, Adamič (1990) cites the results of research by Mlinšek (1969), who analysed the increment cores taken from the bottom parts of adult firs (*Abies alba* Mill.) in Kočevski Rog. He found that in the period from mid-17th century to mid-19th century, the terminal buds in 75% of the analysed adult trees had been bitten off at the trees' young stage, not only once but as many as 35 times. Therefore, "damage" to forests also occurred in the past, when the number of game was low.

For this reason, it is very important to classify damage. Some authors mention *allowable damage* (Adamič 1990), according to them, allowable damage is the degree of damage which does not affect the increment of a stand. Different authors (Adamič 1990, cit. Eiberle 1965, 1985, Perko 1982, Eiberle and Reidi 1985, etc.) propose that an amount of economically allowable damage be determined for each developmental stage of a stand.

Critical damage is the degree of a stand's damage caused by excessive game numbers at which a stand is beyond regeneration. In other words, apart from young tree species, game also inflicts considerable damage on bushy and herbaceous species. In this case, critical damage is an *ecological determinant* (Adamič 1990, cit. Kotar 1987a).

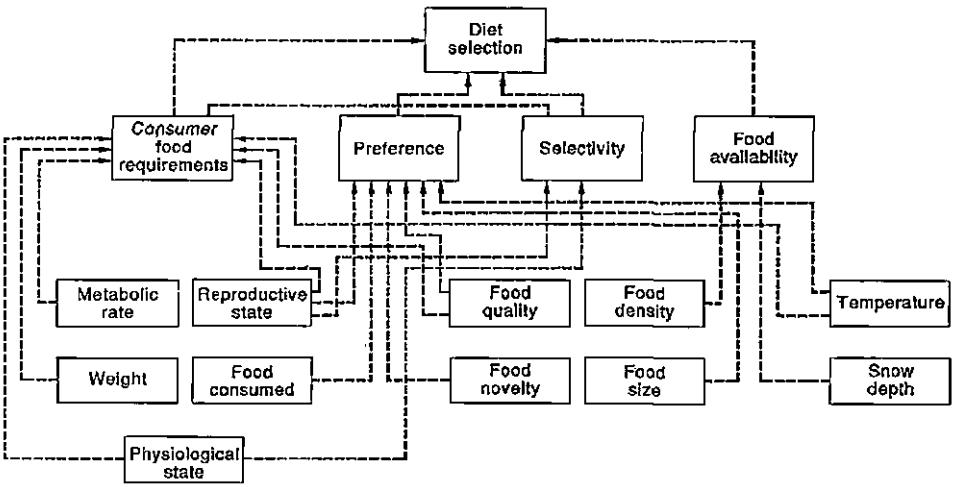
It is the lack of understanding of the role of the fauna in a forest ecosystem that causes misapprehensions of the above forestry concepts. This is directly connected to the concepts of *biotic site capacity* and *commercial site capacity* (Lovački priručnik 1976).

The present study of game nutrition deals with two completely different approaches:

- E u r o p e a n (with the exception of Scandinavia and Great Britain) - directed at adjusting and mitigating game damage and studying the importance and rationalisation of winter game feed (Adamič 1990, cit. Stenin 1969, Pheiffer & Hartfiel 1984, König 1970, Diekman 1983, etc.). This principle is a product of treating hunting as an inferior economic activity subordinated to agriculture and forestry. In connection with this, the problem of over-intensive use of space arises.
- N o r t h - A m e r i c a n - S c a n d i n a v i a n - primarily directed at studying the nutritive ecology of herbivores, competition among sympatric species and competition between wild and domestic animal species in large areas. This approach to hunting management is aimed at forming strategies for game population management in the nature respecting the biotic site capacity.

Therefore, while the second concept is aimed at respecting habitat management in the sense of increasing the site capacity based on the knowledge of game feeding patterns, the European concept focuses on decreasing game population densities in order to adjust them to commercial capacities, which in turn represent *biotic capacities reduced for the productive function of European forests and agricultural areas.*

Essentially, the value of studying the feeding behaviour lies in detecting and realising the importance of individual components within the entire nutritive spectre of a given animal species (Figure 1). Hunting operative is concerned not only with which plant species is used as food by game, but also which parts of a plant is consumed by a given game species.



Source/*Izvor:* Krebs, C.J., 1989; 405 pp.

Fig 1. Factors influencing animal feeding behaviour
Slika 1. Prikaz čimbenika koji uvjetuju hranidbeno ponašanje životinja

Extensive research in the interaction of herbivorous game and their nutritive base has so far been done mostly by Swedish (Danell, K., Bergoström, R., Palo, R. T. and others) and North American researchers (Risenhoover, K. L.). Thus, Risenhoover (1987) applied the preference index ratio (Pi) to find that the moose (*Alces alces* L.) showed different degrees of preferences for willow *Salix alexensis* and *Salix glauca* in different habitat types. The same author found no correlation between preference for the same willows and their number in the studied area (Denali National Park and Preserve, Alaska), but found a correlation between the preference index ratio and the chemical composition of food (e.g., the correlation coefficient between P_i and the astringent content[1] was -0.733, lignin -0.624, while between P_i and the cellulose content it was 0.570).

Danell *et al.* (1987) found a positive correlation between the intensity of silver birch (*Betula pendula* Roth.) browsing by moose and the number of plants in a site. Bergström (unpublished) analysed browsing intensity on the plants of silver birch by height classes and found that on the trees between 1.0 and 2.5 m, the most moose browsing was done on the trees in the 0.5 to 1.5 m height class.

The initial results of research (Viličić *et al.* 1998) on the influence of fallow deer on the habitat in the forest of holm oak (*Fraxino orni - Quercetum ilicis* H-ić (1956) 1958) in the hunting ground "Punta Križa" on the island of Cres showed that apart from holm oak (*Quercus ilex* L.), fallow deer also browsed on other elements of holm oak forests, such as, for example *Phillyrea* sp., manna ash (*Fraxinus ornus* L.) laurustinus (*Viburnum tinus* L.), common myrtle (*Myrtus communis* L.), Dalmatian blackberry (*Rubus dalmaticus* Tratt), evergreen rose (*Rosa sempervirens* L.) and green briar (*Smilax aspera* L.).

[1] astringent - causes contraction of body tissue, has antiinflamatory effects

MATERIAL AND METHODS
MATERIJAL I METODE

Research on the wild herbivore - habitat interaction in the Mediterranean region of Croatia began in the enclosed part of the state hunting ground VIII/6 "Kalifront", covering an area of 1351.22 ha. The hunting ground is located on the island of Rab. Of big game, the ground contains mouflon (*Ovis ammon musimon* Pall.) and axis deer (*Axis axis* Erx.). Since the whole hunting ground is located on the peninsula, the central part of the ground was divided with a partition (3.4 km long). In this way the north-western part of the ground (840 ha) and the game remained isolated from domestic cattle, which had browsed uncontrollably in the forests over the entire area of the hunting ground "Kalifront". This partition had the same effect that an enclosure around the whole ground would have, since the ground is surrounded by the sea on the three remaining sides. For this reason, the term the enclosed part of the hunting ground will be used further on in the paper. Thus, the prerequisites for the study of natural game growth were established (Table 1).

Table 1. Site class, carrying capacity and growing area (GA) for mouflon and axis deer in the hunting ground "Kalifront"

Tablica 1. Bonitet, kapacitet staništa te LPP za muflona i jelena aksisa u lovištu "Kalifront"[1]

Parameters *Parametri*	Mouflon *Muflon*		Axis deer *Jelen aksis*	
	From the working *Plan iz osnove*	Concrete situation *Stvarno stanje*	From the working *Plan iz osnove*	Concrete situation *Stvarno stanje*
ga *LPP*[1]	861 ha	840 ha	930 ha	840 ha
Site class *Bonitet*	First *Prvi*		Second *Drugi*	
Number of heads per 100 ha *Broj grla na 100 ha*	5	5	3	3
Commercial capacity *Gospodarski kapacitet*	43	45	28	22
Hunting capacity *Lovnogosp. Kapacitet*	57	51	36	28

At the time of collecting data for this paper, there were a total of 45 heads of mouflon and 22 heads of axis deer in the enclosed part of the hunting ground. Taken as a whole, this means that big game population density was 8 heads per 100 ha of the total ground area. According to Table 1, in the year of assessment, the game population corresponded to the carrying capacity. The difference in the growth area was caused by partitioning the hunting ground in two parts. The partitioned part in which research was done has an area of 840 ha, and the concrete number of heads relates to this part of the hunting ground.

[1] 01. April 1999

[2] GA=growing area/*LPP=lovnoproduktivna površina*

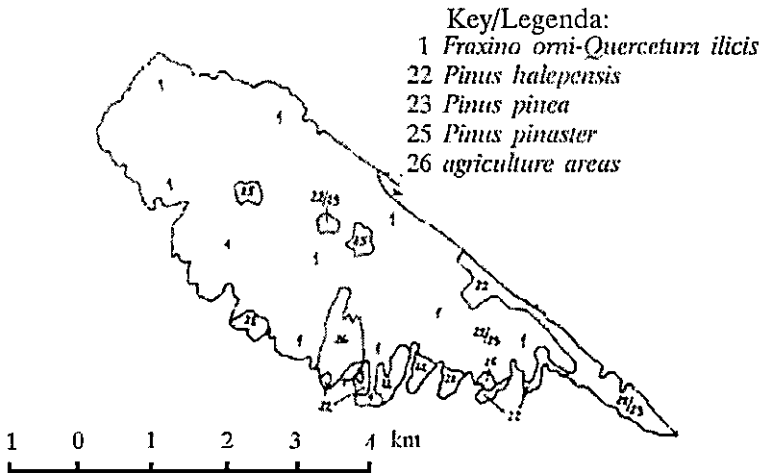
Based on the data from the Hunting Ground Establishment Act, the total ground area is 1,475 ha. The classification of the areas by cultures and land ownership ratio are given in Table 2.

Table 2. Hunting ground areas by cultures and ownership
Tablica 2. Površine lovišta po kulturama i zemljovlasničkim razmjerom

Name *Naziv*	Kind *Vrsta*	Culture *Kultura*	Ownership Zemljovlasničko razmjerje	Data from the foundation act *Podaci iz akta o ustanovljenju*	Data from the working plan *Podaci iz osnove*
Areas within the hunting ground (ha) *Zemljište unutar lovišta (ha)*	Forested *Šumsko*	Covered *Obraslo*	State/*Državno*	1287	1228.63
			Private/*Privatno*	77	90.37
			Total/*Ukupno*	1364	1319.00
		Uncovered *Neobraslo*	State/*Državno*	0	0
			Private/*Privatno*	0	0
			Total/*Ukupno*	0	0
		Overall/*Sveukupno*:		1364	1319.00
	Agricultural *Poljoprivredno*	Crop fields *Oranice*	State/*Državno*	0	0
			Private/*Privatno*	0	0.25
			Total/*Ukupno*	0	0.25
		Meadows *Livade*	State/*Državno*	0	0
			Private/*Privatno*	0	0
			Total/*Ukupno*	0	0
		Pastures *Pašnjaci*	State/*Državno*	78	14.25
			Private/*Privatno*	33	7.86
			Total/*Ukupno*	111	22.11
		Orchard and vineyards (not enclosed) *Višegodišnji nasadi (neograđeni)*	State/*Državno*	0	0.28
			Private/*Privatno*	0	1.97
			Total/*Ukupno*	0	2.25
		Other *Ostalo*	State/*Državno*	0	0.66
			Private/*Privatno*	0	7.01
			Total/*Ukupno*	0	7.67
		Overall/*Sveukupno*:		111	32.00

Name *Naziv*	Kind *Vrsta*	Culture *Kultura*	Ownership Zemljovlasničko razmjerje	Data from the foundation act *Podaci iz akta o ustanovljenju*	Data from the working plan *Podaci iz osnove*
Water within the hunting ground (ha) *Vode unutar lovišta (ha)*	Running water *Tekućice*	Natural *Prirodne*	Rivers/*Rijeke*	0	0
			Streams/*Potoci*	0	0
			Total/*Ukupno*	0	0
		Artificial *Umjetne*	Canals etc. *Kanali i dr.*	0	0
		Overall/*Sveukupno*:		0	0
	Stagnant water *Stajaćice*	Natural *Prirodne*	Lakes/*Jezera*	0	0
			Swamps and ponds/ Močvare i bare	0	0
			Other/*Ostalo*	0	0
			Total/*Ukupno*	0	0
		Artificial *Umjetne*	Accummulations/ *Akumulacije*	0	0
			Retentions/ *Retencije*	0	0
			Other/*Ostalo*	0	0
			Total/*Ukupno*	0	0
		Overall/*Sveukupno*:		0	0
Overall hunting ground (ha)/*Sveukupno lovište (ha)*				1475	1351.28
Enclosed areas outside the hunting ground *Površine izvan lovišta opisane granicom (ha)*	Building land and areas up to 300 m from settlements *Građevinsko zemljište i površine do 300 m od naselja*			0	123.78
	Public areas (roads and other)/*Javne površine (ceste i dr.)*			0	0
	Specially protected matural sites/*Posebno zaštićeni objekti prirode*			0	0
	Enclosed orchard and vineyards/ *Ograđeni višegodišnji nasadi*			0	0
	Commercial fisheries/*Privredni ribnjaci*			0	0
	Other/*Ostalo*			0	0
	Total/*Ukupno*:			0	123.78

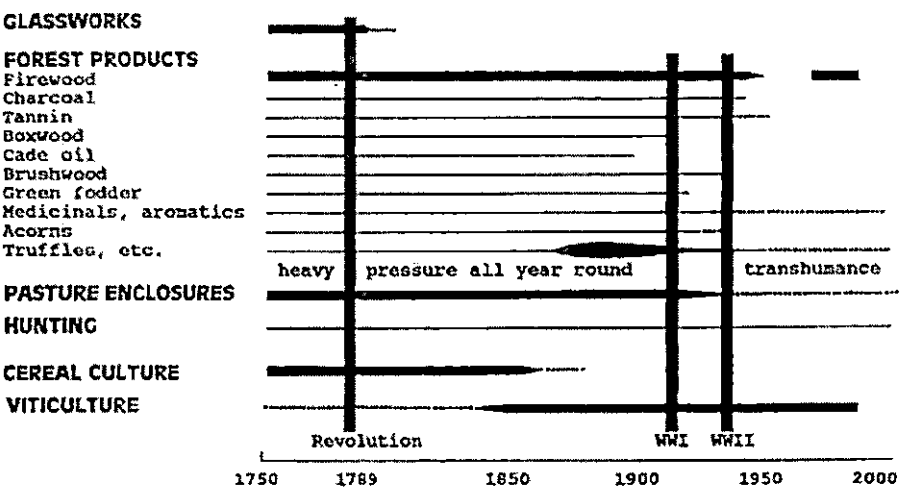
According to Table 2, the largest part of the hunting ground is taken by a forest of holm oak and manna ash (*Fraxino orni - Quercetum ilicis* H-ić1956/1958), which is exceptionally well preserved on Rab, and particularly in this hunting ground, unlike other forests of this phytocoenosis in the rest of the Croatian part of the Mediterranean, which are in different degradation stages from maquis to wasteland. In the MU Kalifront, different species of allochthonous pines are present to a lesser extent, either in the form of cultures or dispersed within natural holm oak stands. The present species include aleppo pine (*Pinus halepensis*), stone pine (*Pinus pinea*) and maritime pine (*Pinus pinaster*).



Source/Izvor: Španjol, Ž., 1995 prema Morton, F, 1915; Horvatić, S., Hodak, N., 1964; Hodak - Horvatić, 1983, Ilijanić, Lj., 1987 88p.

Figure 2. Vegetation map of the State Hunting Ground VIII/6 "Kalifront"

Slika 2. Vegetacijska karta Državnog lovišta VIII/6 "Kalifront"



Source/*Izvor:* Blondel & Aronson 1999, acc. to Bouneval 1990, Soulier 1993, 229 p.

Fig. 3. The utilisation of forest products in Mediterranean forests over the part 250 years

Slika 3. Korištenje pojedinih šumskih proizvoda sredozemnih šuma tijekom zadnjih 250 godina

METHODOLOGY OF DATA COLLECTING
METODOLOGIJA PRIKUPLJANJA PODATAKA

The choice of methods of studying the feeding behaviour should be suited to the goal of research. The following groups of methods are currently used to solve this problem matter:

1. Direct monitoring of game in the wilderness,
2. Monitoring the behaviour of domesticated wild animals in the nature:
3. Reconstructing a species' feeding activities and preference by traces in the snow,
4. Making inventories and quantifying animals' feeding choices with a list of visibly damaged plants in sample plots,
5. Observing the feeding choices of captured animals within a given offer with regard to a programmed meal content,
6. Analysing samples of the rumen content of killed or perished animals,
7. Analysing the remains of plant species collected from droppings.

Although the most reliable data on the feeding behaviour can be obtained with the methods listed under items 1 to 6, the type of methodology cited under item 4 has been used in this paper for two reasons. The first reason was that, according to field observation, game consumed different species, which would be very difficult to establish with the rumen analysis. The second reason was that it was impossible to kill a sufficient number of animals in such a small area in order to obtain a relatively satisfactory sample size.

The rumen content of common deer in the hunting grounds of Baranja has been analysed so far by Danon, Blaženčić and Bogović (1966, 1969). They found that deer fed on about 35 plant species in that site, and that in winter the dominant portion of food in the rumen came from the feeding points (meadow hay, alfalfa and corn).

A methodology of studying the impact of game on forest ecosystems in Croatia has been developed by Medvedović (1989, 1992) and Viličić (1992).

In a detailed study of the herbivore - site interaction (that is, nutritive base), research can be divided into several stages:

1. Studying the preference for individual plant species,
2. Studying the preference for individual parts of palatable plant species,
3. Measuring the biomass of palatable parts of individual plant species,
4. Determining chemical and mechanical contents of available resources.

A modified method by Viličić was used to study forest vegetation browsing. Modifications related only to a change in the intensity scale of plant damage (Adamič 1990), because it is difficult to accurately assess damage intensity on a 10%-scale in evergreen vegetation with numerous stump sprouts.

Viličić's method consists of the following: sample strips are pegged off in a forest and all the plants are listed and classified according to the following criteria:

- Plant species
- Height class - plants are divided into the following height classes:
  1. Up to 30 cm – plants of one year
  2. Plants of several years
  3. 31 – 60 cm
  4. 61 – 130 cm
  5. 131 – 150 cm
  6. 151 – 200 cm
  7. 201 – 250 cm
  8. 251 cm <
- Origin
  1. From seed
  2. From butt
  3. From stump
- Kind of damage
  1. Damaged bark
  2. Damaged lateral shoots
  3. Damaged bark and lateral shoots
  4. Damaged terminal shoot (shoots)
  5. Damaged terminal and lateral shoots
  6. Damaged bark and terminal shoot
  7. Damaged bark, terminal and lateral shoots.
- Damage intensity - the scale has been modified because in the original version it was divided into 10 degrees of 10% each (from 1 to 100%):
  1. Undamaged plants
  2. Moderately browsed plants (up to 30%)
  3. Severely browsed plants (from 31 to 50%)
  4. Critically browsed plants (from 51 to 100%).

The preference for game-damaged plants was estimated using the **preference ratio index** (P_i) given by the equation:

$$P_i = \frac{\frac{N_i}{\sum N_j}}{\frac{E_i}{\sum E_j}}$$

where:

N_i – the number of resource items i used in the sample,
ΣN_j – the total number of resource items used,
E_i – the number of resource items i in the environment,
ΣE_j – the total number of resource items in the environment.

In sample taking, the first step included defining game visitation patterns. After that, game was monitored, and when a spot of more intensive browsing was found, the plots were fenced (*Table 3*), and vegetation damage status was recorded in different seasons (spring, summer, autumn) according to the table given above. In compartments 18 and 22b, the plots were fenced in such a way that their edges bordered with the openings. This was done because it was assumed that browsing game remained close to the openings, where the browse was of better quality due to more light. It is also important to mention that this kind of browsing contributes to successful hunting because game is more easily detected on the edges than deep in the forest. The points where samples were collected are given in Map 1.

Table 3. Sample plots
Tablica 3. Podaci o primjernim plohama

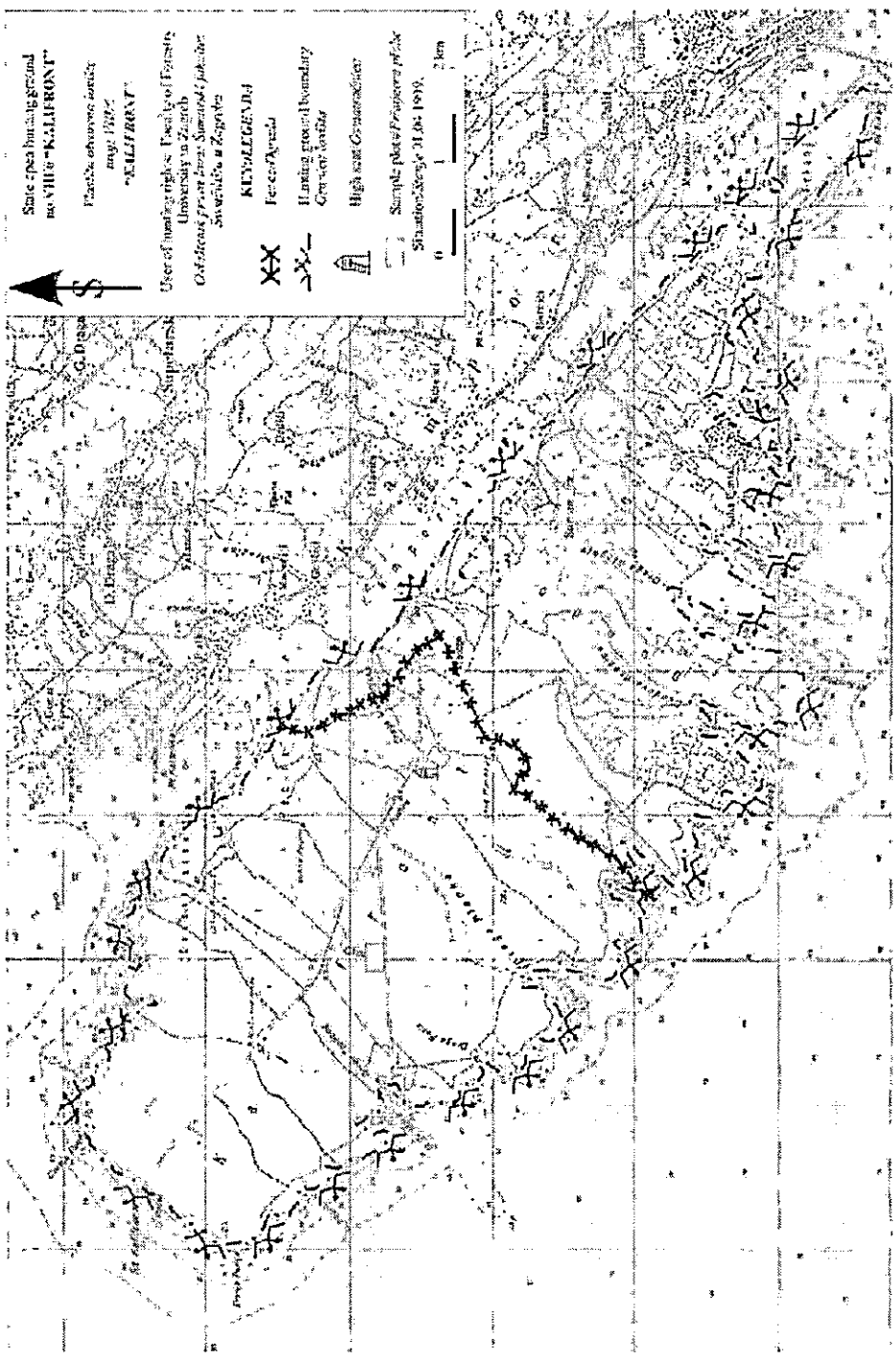
Compartment, subcompartment *Odjel odsjek*	Age (years) *Dob odjela (godine)*	Area (ha) *Površina odjela (ha)*	Size of sample plot (m²) *Veličina prim. plohe m²)*	Year of last cleaning *Godina zadnjeg čišćenja*	Date of measurement *Datum izmjere*
3	61	30.19	50	1999	06.07.1999.
4	36	19.42	600	1999	14.10.1999.
18	21	62.59	114	1996	15.05.1999.
22 b	17	34.55	86	1997	15.05.1999.

RESEARCH RESULTS
REZULTATI ISTRAŽIVANJA

Species preference cannot be studied with one recording of a given area. It has been long known that animals' feeding behaviour changes, among other things, during the year, that is, from season to season. Therefore, to study the feeding behaviour of game, more recordings should be made annually.

Forest vegetation was not browsed intensively until March 1999. It was only later, with increased stand recognisance that initial browsing in compartment 8 (managed by the NPŠO Rab) was noted, as well as in compartments 18 and 22. Compartment 8 is located immediately next to the nursery A. Petračić, while compartments 18 and 22b are located next to the nursery Topolje. Evidently, game kept close to the nurseries for browsing. Sample plots were immediately set up in compartments 18 and 22 b and the first recordings were made in mid-May (Tables 4, 5, 6, 7, 8, 9, 10, 11 and 12).

At the beginning of 1999, light strips ("snipe strips") were made in compartments 3, 4, 5 and 6 in the MU "Kalifront". A total of 4,440 m of strips averaging 4 m in width were cleared, totalling 1.78 ha. This management procedure was immediately put to use for browse recording, as it can serve as a model of monitoring the game-forest relationship when a stand is in the regeneration stage (in the case of clearcutting).



Map 1. The State Hunting Ground VIII/5 "Kalifront"
Karta 1. Državno lovište VIII/5 "Kalifront"

Table 4. Summary presentation of the number of undamaged and damaged plants per hectare by compartments, origin, height classes, damage type and intensity in the hunting ground "Kalifront"

Tablica 4. Sumarni prikaz brojnosti neoštećenih i oštećenih biljaka na jedan hektar po odjelima, načinu postanka, visinskim razredima, vrsti i intenzitetu oštećenja u lovištu "Kalifront"

Compartment, subcompartment *Odjel/Odsjek*		Only consumed species *Samo konzumirane vrste*	Origin *Način postanka*			Height classes *Visinski razredi*					Damage type *Visinski razredi*			Damage intensity *Intenzitet oštećenja*		
			From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)	2	4	5	1 – 30 %	31 – 50 %	51 – 100 %
3	damaged *oštećeno*	4600	2000	2600	4600	1600	2400	600	0	0	200	1600	2800	1400	1000	2200
	undamaged *neoštećeno*	47400	68800	9200	78000	72800	4200	1000	0	0	0	0	0	0	0	0
	total *ukupno*	52000	70800	11800	82600	74400	6600	1600	0	0	200	1600	2800	1400	1000	2200
4	damaged *oštećeno*	6983	5133	1850	6983	5133	917	883	17	33	0	917	6067	617	250	6117
	undamaged *neoštećeno*	19117	18783	1117	19900	18700	467	617	100	17	0	0	0	0	0	0
	total *ukupno*	26100	23917	2967	26883	23833	1383	1500	117	50	0	917	6067	617	250	6117
18	damaged *oštećeno*	14298	4474	9825	14298	1140	6404	5439	1228	88	263	2368	11667	5877	3860	4561
	undamaged *neoštećeno*	12544	7368	7193	14561	4561	5088	4298	614	0	0	0	0	0	0	0
	total *ukupno*	26842	11842	17018	28860	5702	11491	9737	1842	88	263	2368	11667	5877	3860	4561
22b	damaged *oštećeno*	9419	3256	6163	9419	581	6163	2326	349	0	698	3953	4767	5698	1512	2209
	undamaged *neoštećeno*	2791	2093	930	3023	1512	814	581	0	116	0	0	0	0	0	0
	total *ukupno*	12210	5349	7093	12442	2093	6977	2907	349	116	698	3953	4767	5698	1512	2209

Table 5. Plant damage in the sample plot (calculated by hectare) in Compartment 18 of the Management Unit "Kalifront"

Tablica 5. Prikaz oštećenosti biljaka na primjernoj plohi (preračunato na hektar) u odjelu 18 Gospodarske jedinice "Kalifront"

No.	Area= 114 m² *Površina= 114 m²*	Compartment age: 21 YEARS *Dob odjela: 21 GOD.*								Cleaning: 1996. *Čišćenje: 1996.*		Measurement: may1999 *Izmjera: svibanj 1999.*			
	Species	Origin *Način postanka*			Height classes *Visinski razredi*					Damage type *Vrsta oštećenja*			Damage *intensity* *Intenzitet oštećenja*		
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)	2	4	5	1 – 30 %	31 – 50 %	51 – 100 %
1	*Quercus ilex*	0	526	526	88	175	175	88	0	0	88	439	526	0	0
2	*Fraxinus ornus*	263	351	614	0	175	263	175	0	0	175	439	351	88	175
3	*Arbutus unedo*	0	175	175	0	0	88	88	0	88	88	0	175	0	0
4	*Viburnum tinus*	351	6491	6842	614	4035	2018	175	0	0	789	6053	2456	2281	2105
5	*Rubus dalmaticus*	88	0	88	0	0	88	0	0	0	0	88	0	88	0
6	*Rosa sempervirens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	*Clematis* sp.	88	0	88	0	0	88	0	0	0	88	0	88	0	0
8	*Pistacia lentiscus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	*Phillyrea latifolia*	175	2018	2193	0	526	1404	263	0	0	351	1842	702	1053	439
10	*Ruscus aculeatus*	789	0	789	0	526	263	0	0	0	0	789	0	88	702
11	*Asparagus acutifolius*	1316	0	1316	351	439	351	175	0	175	614	526	1228	88	0
12	*Erica arborea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	*Smilax aspera*	351	0	351	0	175	88	88	0	0	88	263	175	88	88
14	*Coronilla emeroides*	1140	0	1140	0	351	614	175	0	0	0	1140	0	88	1053
15	*Spartium junceum*	0	88	88	0	0	0	0	88	0	0	88	88	0	0
16	*Rubia peregrina*	0	88	88	88	0	0	0	0	0	88	0	88	0	0
	Total *Ukupno*	4474	9825	14298	1140	6404	5439	1228	88	263	2368	11667	5877	3860	4561

Table 6. Plant damage in the sample plot (calculated by hectare) in Compartemnt 22b of the Management Unit "Kalifront"

Tablica 6. Prikaz oštećenosti biljaka na primjernoj plohi (preračunato na hektar) u odjelu 22b Gospodarske jedinice "Kalifront"

No.	Area= 86 m² *Površina= 86 m²*	Compartment age: 17 years *Starost odjela: 17 god.*								Cleaning: 1997 *Čišćenje:* 1997.			Measurement: may 1999 *Izmjera: Svibanj 1999.*		
	Species	Origin *Način postanka*			Height classes *Visinski razredi*					Damage type *Vrsta oštećenja*			Damage *intensity* *Intenzitet oštećenja*		
		Srom seeds *Iz sjemena*	From *stumps Iz* panja	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)	2	4	5	1 – 30 %	31 – 50 %	51 – 100 %
1	*Quercus ilex*	0	349	349	0	233	116	0	0	0	349	0	349	0	0
2	*Fraxinus ornus*	0	349	349	0	0	116	233	0	116	0	233	233	116	0
3	*Arbutus unedo*	116	233	349	0	116	233	0	0	0	349	0	349	0	0
4	*Viburnum tinus*	349	5000	5349	465	3953	930	0	0	116	2326	2907	3837	465	1047
5	*Rubus dalmaticus*	1395	0	1395	0	1047	349	0	0	349	116	930	581	349	465
6	*Rosa sempervirens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	*Clematis* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	*Pistacia lentiscus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	*Phillyrea latifolia*	116	233	349	116	0	233	0	0	0	233	116	233	0	116
10	*Ruscus aculeatus*	233	0	233	0	233	0	0	0	0	233	0	0	0	233
11	*Asparagus acutifolius*	349	0	349	0	233	116	0	0	116	116	116	0	349	0
12	*Erica arborea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	*Smilax aspera*	698	0	698	0	349	233	116	0	0	233	465	116	233	349
	Total *Ukupno*	3256	6163	9419	581	6163	2326	349	0	698	3953	4767	5698	1512	2209

Table 7. Plant damage in the sample plot (calculated by hectare) in Compartment 3 of the Management Unit "Kalifront"
Tablica 7. Prikaz oštećenosti biljaka na primjernoj plohi (preračunato na hektar) u odjelu 3 Gospodarske jedinice "Kalifront"

No.	Area= 86 m² *Površina= 86 m²*	Compartment age: 61 years *Starost odjela: 61 god.*								Cutting: 1997. *Sječa: 1997.*		Measurement: 06.07.1999. *Izmjera: 06.07.1999.*			
	Species	Origin *Način postanka*			Height classes *Visinski razredi*					Damage type *Vrsta oštećenja*			Damage intensity *Intenzitet oštećenja*		
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)	2	4	5	1 – 30 %	31 – 50 %	51 – 100 %
1	*Quercus ilex*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	*Fraxinus ornus*	0	800	800	0	600	200	0	0	0	400	400	400	0	400
3	*Arbutus unedo*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	*Viburnum tinus*	0	800	800	400	400	0	0	0	0	600	200	200	200	400
5	*Rubus dalmaticus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	*Rosa sempervirens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	*Clematis* sp.	0	200	200	0	200	0	0	0	0	0	200	200	0	0
8	*Erica arborea*	0	1000	1000	600	400	0	0	0	0	0	1000	200	400	400
9	*Phillyrea latifolia*	0	600	600	0	400	200	0	0	0	200	400	400	200	0
10	*Ruscus aculeatus*	200	0	200	0	0	200	0	0	0	0	200	0	200	0
11	*Solanum nigrum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	*Picris hieracioides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	*Asparagus acutifolius*	200	0	200	0	200	0	0	0	0	200	0	0	0	200
14	*Smilax aspera*	600	0	600	400	200	0	0	0	200	0	400	0	0	600
15	*Stenactis annua*	200	0	200	200	0	0	0	0	0	200	0	0	0	200
16	*Tamus communis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total *Ukupno*		1200	3400	4600	1600	2400	600	0	0	200	1600	2800	1400	1000	2200

Table 8. Plant damage in the sample plot (calculated by hectare) in Compartment 4 of the Management Unit "Kalifront"
Tablica 8. Prikaz oštećenosti biljaka na primjernoj plohi (preračunato na hektar) u odjelu 4 Gospodarske jedinice "Kalifront"

No.	Area= 600 m² *Površina= 600 m²*	Compartment age: 36 years *Dob odjela: 36 god.*								Cutting: January 1999 *Sječa: Siječanj 1999.*			Measurement: 14.10.1999 *Izmjera: 14.10.1999.*		
	Species	Origin *Način postanka*			Height classes *Visinski razredi*					Damage type *Vrsta oštećenja*			Damage intensity *Intenzitet oštećenja*		
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)	2	4	5	1 – 30 %	31 – 50 %	51 – 100 %
1	*Quercus ilex*	50	1067	1117	117	417	550	17	17	0	217	900	433	150	533
2	*Fraxinus ornus*	83	117	200	83	67	50	0	0	0	33	167	0	17	183
3	*Arbutus unedo*	0	133	133	0	0	117	0	17	0	67	67	50	17	67
4	*Viburnum tinus*	50	267	317	233	67	17	0	0	0	0	317	0	0	317
5	*Erica arborea*	0	133	133	133	0	0	0	0	0	0	133	17	17	100
6	*Phillyrea latifolia*	0	100	100	33	33	33	0	0	0	0	100	0	0	100
7	*Rubus dalmaticus*	283	0	283	200	0	83	0	0	0	17	267	117	0	167
8	*Rosa sempervirens*	333	33	367	333	17	17	0	0	0	33	333	0	33	333
9	*Solanum nigrum*	1833	0	1833	1817	17	0	0	0	0	250	1583	0	0	1833
10	*Clematis sp.*	17	0	17	17	0	0	0	0	0	0	17	0	0	17
11	*Smilax aspera*	2400	0	2400	2083	300	17	0	0	0	300	2100	0	17	2383
12	*Ruscus aculeatus*	83	0	83	83	0	0	0	0	0	0	83	0	0	83
	Total *Ukupno*	5133	1850	6983	5133	917	883	17	33	0	917	6067	617	250	6117

Table 9. Undamaged plants in the sample plot in Compartment 18 of the MU "Kalifront"
Tablica 9. Prikaz neoštećenih biljaka na primjernoj plohi u odjelu 18 GJ "Kalifront"

No.	SPECIES	Origin *Način postanka*			Height classes *Visinski razredi*				
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)
1	*Quercus ilex*	175	526	702	263	175	263	0	0
2	*Fraxinus ornus*	3158	1228	4386	1491	1491	1140	263	0
3	*Arbutus unedo*	88	789	877	88	175	351	263	0
4	*Viburnum tinus*	877	877	1754	1228	439	88	0	0
5	*Rubus dalmaticus*	1404	1140	2544	877	1491	175	0	0
6	*Rosa sempervirens*	0	0	0	0	0	0	0	0
7	*Clematis* sp.	351	0	351	263	0	88	0	0
8	*Pistacia lentiscus*	0	789	789	0	175	614	0	0
9	*Phillyrea latifolia*	263	614	877	175	439	263	0	0
10	*Ruscus aculeatus*	0	0	0	0	0	0	0	0
11	*Asparagus acutifolius*	965	0	965	88	439	439	0	0
12	*Erica arborea*	0	1228	1228	0	263	877	88	0
13	*Smilax aspera*	0	0	0	0	0	0	0	0
14	*Coronilla emeroides*	88	0	88	88	0	0	0	0
15	*Spartium junceum*	0	0	0	0	0	0	0	0
16	*Rubia peregrina*	0	0	0	0	0	0	0	0
	Total *Ukupno*	7368	7193	14561	4561	5088	4298	614	0

Table 10. Undamaged plants in the sample plot in Compartment 22b of the MU "Kalifront"
Tablica 10. Prikaz neoštećenih biljaka na primjernoj plohi u odjelu 22b GJ "Kalifront"

No.	Species	Origin *Način postanka*			Height classes *Visinski razredi*				
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)
1	*Quercus ilex*	1512	116	1628	1395	233	0	0	0
2	*Fraxinus ornus*	0	0	0	0	0	0	0	0
3	*Arbutus unedo*	0	465	465	0	0	349	0	116
4	*Viburnum tinus*	0	233	233	0	233	0	0	0
5	*Rubus dalmaticus*	349	0	349	0	116	233	0	0
6	*Rosa sempervirens*	116	0	116	116	0	0	0	0
7	*Clematis* sp.	0	0	0	0	0	0	0	0
8	*Pistacia lentiscus*	0	0	0	0	0	0	0	0
9	*Phillyrea latifolia*	116	0	116	0	116	0	0	0
10	*Ruscus aculeatus*	0	0	0	0	0	0	0	0
11	*Asparagus acutifolius*	0	0	0	0	0	0	0	0
12	*Erica arborea*	0	116	116	0	116	0	0	0
13	*Smilax aspera*	0	0	0	0	0	0	0	0
	Total *Ukupno*	2093	930	3023	1512	813	581	0	116

Table 11. Undamaged plants in the sample plot in Compartment 3 of the MU "Kalifront"
Tablica 11. Prikaz neoštećenih biljaka na primjernoj plohi u odjelu 3 GJ "Kalifront"

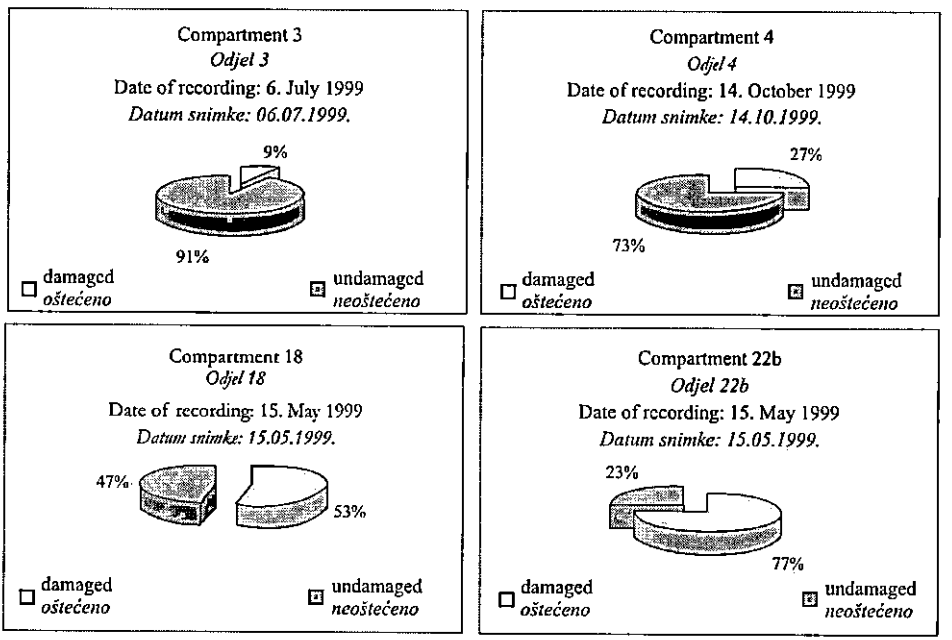
No.	Species	Origin *Način postanka*			Height classes *Visinski razredi*				
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)
1	*Quercus ilex*	1400	4000	5400	4400	600	400	0	0
2	*Fraxinus ornus*	31600	400	32000	32000	0	0	0	0
3	*Arbutus unedo*	0	1200	1200	200	800	200	0	0
4	*Viburnum tinus*	2400	2200	4600	3800	800	0	0	0
5	*Rubus dalmaticus*	1000	0	1000	1000	0	0	0	0
6	*Rosa sempervirens*	200	0	200	200	0	0	0	0
7	*Clematis sp.*	200	0	200	200	0	0	0	0
8	*Erica arborea*	0	0	0	0	0	0	0	0
9	*Phillyrea latifolia*	2400	1400	3800	3000	600	200	0	0
10	*Ruscus aculeatus*	1800	0	1800	800	1000	0	0	0
11	*Solanum nigrum*	22000	0	22000	22000	0	0	0	0
12	*Picris hieracioides*	400	0	400	400	0	0	0	0
13	*Asparagus acutifolius*	200	0	200	200	0	0	0	0
14	*Smilax aspera*	4200	0	4200	3600	400	200	0	0
15	*Stenactis annua*	600	0	600	600	0	0	0	0
16	*Tamus communis*	400	0	400	400	0	0	0	0
	Total *Ukupno*	68800	9200	78000	72800	4200	1000	0	0

Table 12. Undamaged plants in the sample plot in Compartment 4 of the MU "Kalifront"
Tablica 12. Prikaz neoštećenih biljaka na primjernoj plohi u odjelu 4 GJ "Kalifront"

No.	Species	origin *Način postanka*			Height classes *Visinski razredi*				
		From seeds *Iz sjemena*	From stumps *Iz panja*	Total *Ukupno*	1 – 30 (cm)	31 – 60 (cm)	61 – 130 (cm)	131 – 150 (cm)	151 – 200 (cm)
1	*Quercus ilex*	1367	200	1567	1367	133	67	0	0
2	*Fraxinus ornus*	4717	83	4800	4717	50	33	0	0
3	*Arbutus unedo*	100	650	750	100	100	433	100	17
4	*Viburnum tinus*	17	0	17	17	0	0	0	0
5	*Rubus dalmatinus*	2350	50	2400	2400	0	0	0	0
6	*Rosa sempervirens*	117	17	133	133	0	0	0	0
7	*Solanum nigrum*	8483	0	8483	8483	0	0	0	0
8	*Myrtus communis*	183	117	300	150	117	33	0	0
9	*Inula viscosa*	200	0	200	100	50	50	0	0
10	*Clematis flammula*	483	0	483	483	0	0	0	0
11	*Smilax aspera*	433	0	433	417	17	0	0	0
12	*Ruscus aculeatus*	50	0	50	50	0	0	0	0
13	*Pinus pinaster*	283	0	283	283	0	0	0	0
	Total *Ukupno*	18783	1117	19900	18700	467	617	100	17

To calculate the percentage of damaged plants, only those plant species carrying browsing traces were used (consumed species). Other species were excluded from the calculation since they were not consumed by game.

During winter and early spring, game damaged a larger share of plants (53% in compartment 18 and 77% in compartment 22), in spring and early summer game damaged only 9% of the plants, while during summer and early autumn, 27% of the plants of consumed species were damaged.

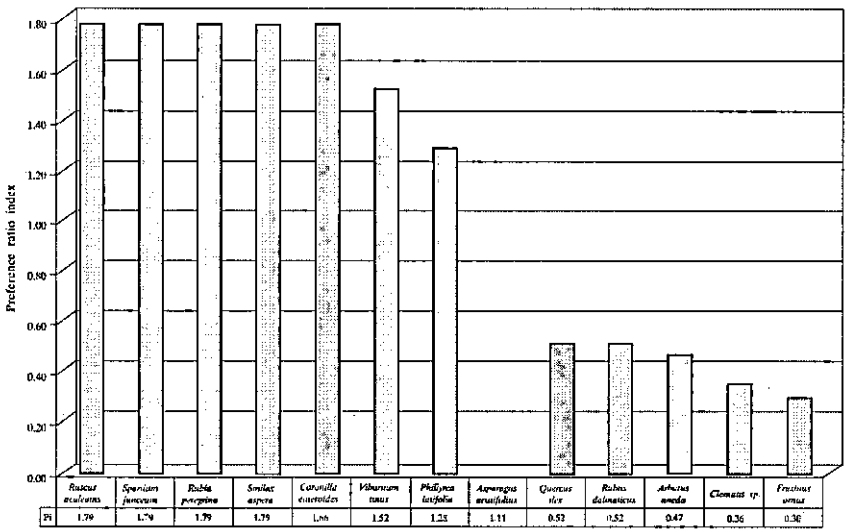


Graph 1. The share of damaged and undamaged plants in sample plots
Grafikon 1. Udio oštećenih i neoštećenih biljaka na primjernim plohama

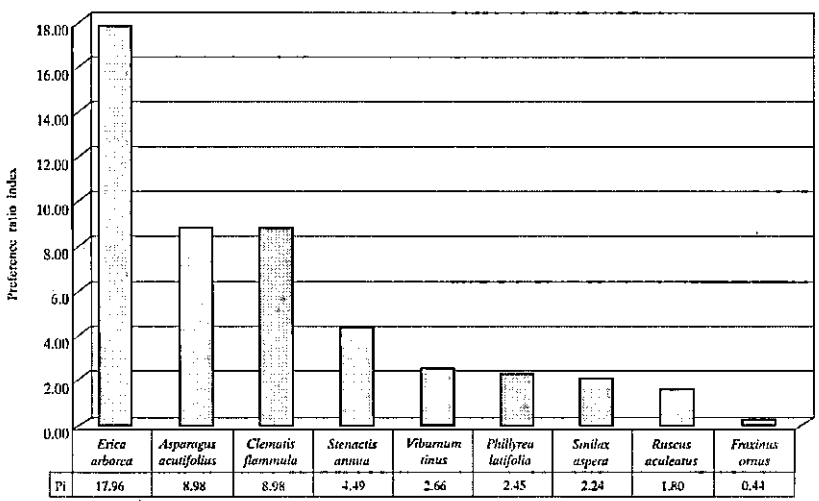
PLANT SPECIES PREFERENCE
PREFERABILNOST BILJNIH VRSTA

According to Tables 5, 6, 7, and 8, the species preference changed over seasons. During winter and spring (*Graph 2*) game preferred young tops of butcher's broom (*Ruscus aculeatus*), Spanish broom (*Spartium junceum*), wild madder (*Rubia peregrina*) and green briar (*Smilax aspera*). These four species had the same preference index of 1.79. Of a total of 16 plant species recorded in the plot, game consumed 13. Evergreen rose, mastic tree and tree heath were not browsed. It is interesting that in the recordings made during the remaining

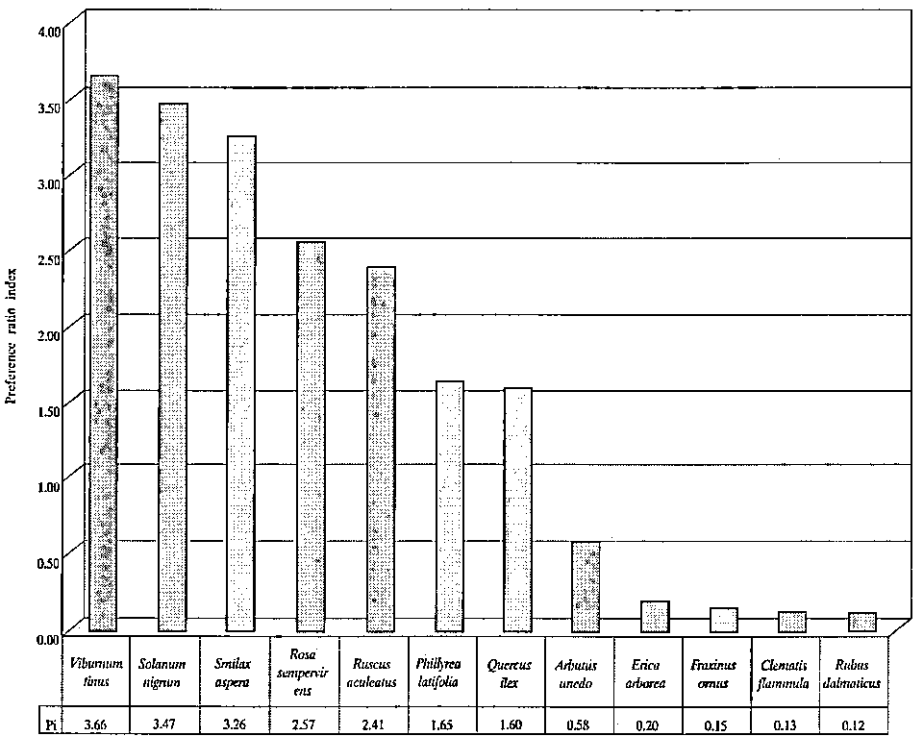
part of the year, game browsed on tree heath and evergreen rose. Spanish broom, scorpion senna and wild madder were not found in other sample plots.



Graph 2. Species preference by mouflon and axis deer for the winter-spring period
Grafikon 2. Preferabilnost vrsta u muflona i jelena aksisa za razdoblje zima-proljeće



Graph 3. Species preference by mouflon and axis deer for the spring-summer period
Grafikon 3. Preferabilnost vrsta u muflona i jelena aksisa za razdoblje proljeće-ljeto



Graph 4. Species preference by moudlon and axis deer for the summer-autumn period
Grafikon 4. Preferabilnost vrsta u muflona i jelena aksisa za razdoblje ljeto-jesen

During spring and early summer, the most preferred species was the tree heath (*Erica arborea*) - P_i=17.96 (Graph 3). Other woody species, such as laurustinus, phillyrea and manna ash achieved slightly lower preference. Of a total of 16 plant species, damage was recorded on 9. Game did not browse holm oak, strawberry tree, rose, black nightshade, hawkweed ox-tongue (*Picris hieracioides*) and black bryony (*Tamus communis*).

During summer and early autumn, the most damaged plant species was laurustinus (Pi=3.66, *Graph 4*). Black nightshade was also intensively damaged - Pi=3.46. Of a total of 14 species, game damaged 12. No damage was found on sticky fleabane (*Inula viscosa)* and maritime pine (*Pinus pinaster*). Maritime pine was represented only with seedlings up to 20 cm tall in the plot.

During spring, holm oak as a dominant species in the community took the sixth place, during summer it was not browsed by game, while browsing began only in late summer and early autumn. Field recognisance did not reveal any mastic tree (*Pistacia lentiscus*) and common myrtle (*Myrtus communis*) browsing anywhere in the hunting ground. This could support the claim that the habitat is still not over-capacitated with game, since mastic tree is damaged in Brijuni National Park, while myrtle is damaged by game (fallow deer) in the hunting ground of Punta Križa on Cres, where the habitat is over-capacitated.

In terms of seasonal changes in the preference for woody plants of the phytocoenosis *Fraxino orni-Quercetum ilicis*, no regular patterns were found, in other words, the preference changes over the season. Globally speaking, laurustinus is the most highly preferred woody species, followed by broad-leaved phillyrea, tree heath, holm oak strawberry tree and manna ash.

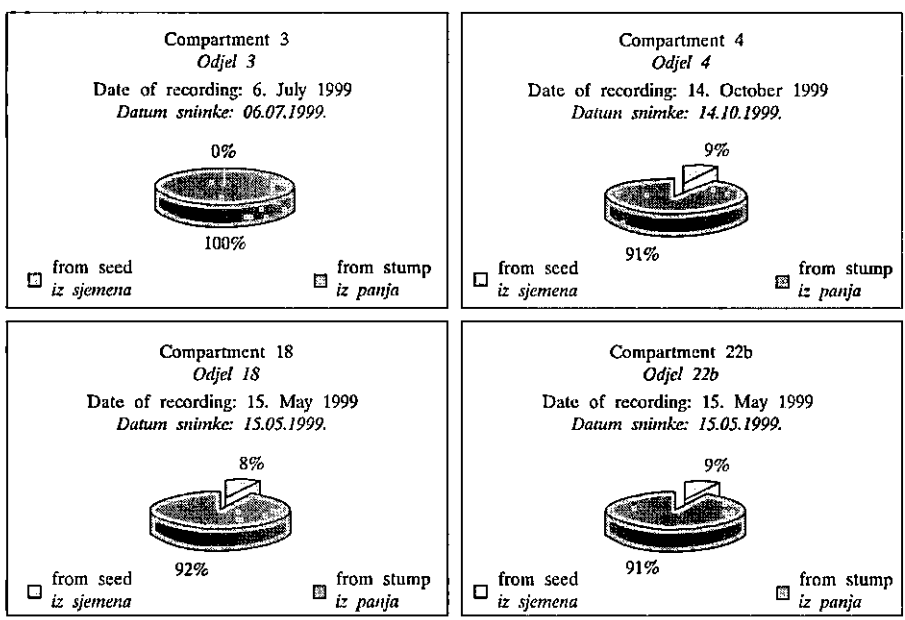
The hunting ground recognisance at the beginning of 2000 showed that Spanish broom was most game-damaged in winter. As for scorpion senna, since it grows mostly along paths, the game inflicted considerable damage in light strips.

Of 12,442 plants/ha of all species in compartment 22 b, the number of preferred species is 12,210/ha, of 28,860 plants/ha in compartment 18, the number of preferred plants is 26,842, of 82,600 plants/ha in compartment 3 there are 52,000/ha of preferred plants, and of 26,883 plants/ha in compartment 4, there are 26,100 preferred plants.

PLANT DAMAGE WITH REGARD TO ORIGIN

OŠTEĆENOST VRSTA S OBZIROM NA NAČIN POSTANKA

Since woody species of the community *Fraxino orni-Quercetum ilicis* can sprout from stumps or from seeds, the analysis of damage status was made based on the origin. The following species were encompassed by the analysis (Graph 5): holm oak, tree heath, laurustinus, phillyrea, strawberry tree and manna ash. The calculation (column "the consumed species only" in Table 4) was made for them.



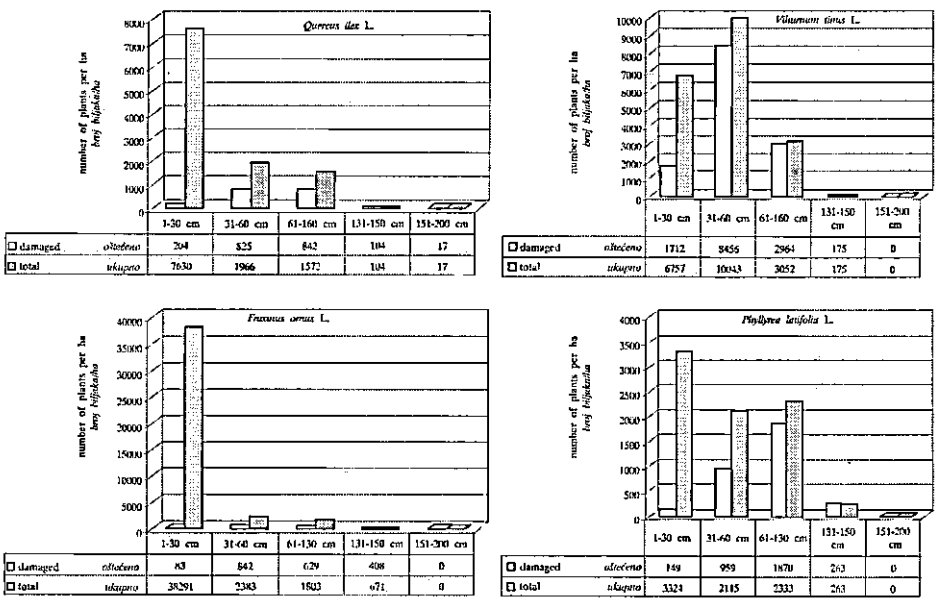
Graph 5. Distribution of damaged plants from seeds and from stumps
Grafikon 5. Distribucija oštećenih biljaka iz sjemena i iz panja

In compartment 3, all damaged plants originated from stumps. In compartment 4 there were 91% of damaged plants from stumps and 9% of plants from seeds. In compartment 18, 92% of the damaged plants sprouted from stumps and 8% from seeds. 91% of damaged plants in compartment 22 came from stumps, while 9% originated from seeds. It is evident that game prefers stump sprouts and that damage to seed sprouts is much smaller.

PLANT DAMAGE BY HEIGHT CLASSES

OŠTEĆENOST BILJNIH VRSTA S OBZIROM NA VISINSKE RAZREDE

Damage analysis by height classes was not done for tree and strawberry tree, because the former has numerous shoots and the latter lower preference. Generally, Graph 6 shows that the share of damaged plants increases with their height. In the last height class (151 to 200 cm), only plants of holm oak were registered.



Graph 6. Summary distribution of the total number of plants and damaged plants of a given plant species by height classes

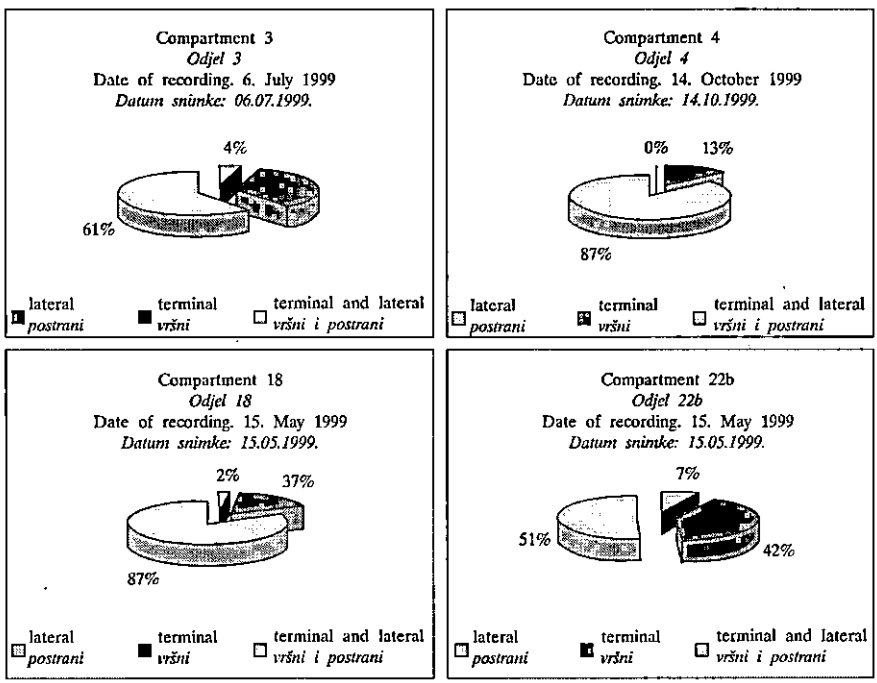
Grafikon 6. Sumarna distribucija ukupnog broja biljaka i oštećenih biljaka pojedine biljne vrste po visinskim razredima

A large quantity of plants of manna ash is the result of a high number of ash seedlings in plot 3 (31,600 plants). The major part of the seedlings later decayed so that by autumn the number had fallen considerably (4,800 plants).

PLANT DAMAGE BY DAMAGE TYPE

OŠTEĆENOST BILJAKA S OBZIROM NA NAČIN OŠTEĆENJA

The analysis of damage type was made summarily for all plants per compartments and seasons. In the majority of cases, game bites off both terminal and lateral shoots on a plant (from 51 to 87%). In the entire sample, the percentage of plants showing damage only on terminal shoots ranged from 13 to 35%, while that of the plants showing damage only on lateral shoots ranged from 0 to 7% (Graph 7).



Graph 7. Plant distribution by damage type

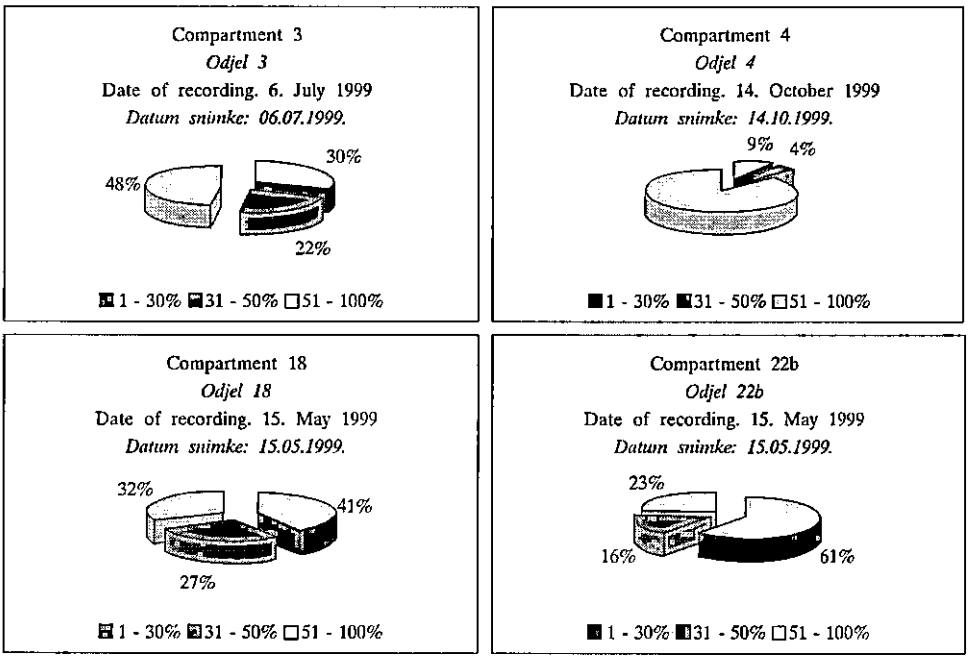
Grafikon 7. Distribucija biljaka po vrsti oštećenja

DAMAGE INTENSITY

INTENZITET OŠTEĆENJA

In winter and early spring, a larger proportion of plants (41% in compartment 18 and 61% in compartment 22b) was moderately damaged by game (from 1 to 30% of the shoots were damaged). By the beginning of summer, game inflicted critical damage to plants, so that 48% of the plants in compartment 3 were critically damaged. During summer and early autumn 87%

of the plants were critically browsed. Consequently, browsing intensity per plant increases from spring to late summer, and then decreases (Graph 8).



Graph 8. Plant distribution by damage intensity
Grafikon 8. Distribucija biljaka po intenzintetu oštećenosti

Although over 50% of the plants in compartments 18 and 22b were damaged during winter and early spring, most (41 and 61%) were moderately damaged (from 1 to 30%). In compartment 3, of the 9% of damaged plants, the majority (48%) were in the critically damaged class.

DISCUSSION
RASPRAVA

The forests in the Mediterranean region have traditionally provided the local population with a multitude of functions, unlike those in the rest of Europe. In the first place, they provided timber and food, then shelter, medicinal herbs, cork, tannin, resin, etc (Fig. 3). Intensive forest exploitation not only by felling but also by uncontrolled browsing has resulted in various degraded forms. As a result, many activities are being undertaken at present to restore and preserve these forests.

Methods of forest management on the island of Rab are characterised by a specific feature: the treatment of *cleaning*. This is a silvicultural procedure which removes subordinate species from a stand, but also reduces the number of principal woody species (primarily holm oak, followed by manna ash). The local population is thus provided with small fuelwood or browse for cattle. This procedure, since it allows a lot of light to enter a stand, is followed by a "burst" of vegetation, not only stump sprouts of felled woody species, but also climbers and ground vegetation. The vegetation biomass increases significantly under a rarefied or broken stand crown canopy and so does the concentration of raw proteins, net energy and carbohydrates, or the degree of food digestibility (Adamič 1990, cit Blair *et al,* 1983, cit Regelic *et al.* 1974). Therefore, stand tending does not lead only to an increase in the productive function of the forest, but also in the production of its other functions (integral forest management - the conversion of plant biomass into meat, trophies, etc.). In the mentioned hunting ground, game makes very good use of the cleaning results. All the plots have been established precisely in the areas that were cleaned.

According to Graphs 2, 3, and 4, game showed weaker preference for the principal woody species in the stand - the holm oak and manna ash. The most preferred woody species in these sites were scorpion senna, laurustinus and phillyrea. Tree heath was highly preferred in early summer due to the fact that young shoots sprouted from the stumps (and the plants did not exceed 60 cm in height, that is, most of the damaged plants were in the height class from 1 to 30 cm - compartments 3 and 4). Clearly, plants only had one-year-old (young) shoots, which are more digestible than older shoots, so that game did not have to invest effort into selecting more nutritious, younger shoots. It is well known that tree heath has abundant and relatively small-sized shoots compared to other species in holm oak forests. When only shoots of several years are available, which have poorer nutritive properties, game is forced to find food that will feed them faster and better. Here, there are no typical signs of woody species being browsed by ruminants as is the case on the continent, where the place of bite from the bottom looks as if cut, while the top contains the remains of bark and bast fibre. (Fig. 4) It is clear from Figure 5 that animals did not bite off the shoots in the way described above but tore them with their lips instead. In such a case, the shoot breaks at an un-lignified point, enabling the game to consume less indigestible matter, such as, for example, lignin (Fig. 5), which shows that game makes full use of browsing.

Over the year the consumed - unconsumed species ratio changes. In the winter - spring period, game consumed 13 out of 16 species, in the spring - summer period it consumed 9 out of 16 species, and in the summer - autumn period 12 out of 14 species were consumed (common myrtle, mastic tree, sticky fleabane and the seedlings of maritime pine were not consumed). Although myrtle was only recorded in compartment 4 in the sample, it should be pointed out that by reviewing the damaged plants in the entire hunting ground no damage to myrtle was found anywhere. This classifies it into the category of non-preferable plants for these two game species.

The key to a good nutritive base in the eu-Mediterranean region at the beginning of the browsing period by big game lies precisely in the production of one-year shoots of woody species. This period begins in late June and early July, when pasture elements (various grasses

and herbaceous plants) are dry and do not provide good quality forage. In this period, game primarily searches for shoots that are preferably juicy (Krapinec *et al.* 2000). Contrary to the continental part of Croatia, where unfavourable life conditions for game occur in winter, in the Mediterranean region such conditions occur in summer. It is for this reason that game in the Mediterranean migrates, as shown in Figure 6. In assessing the capacity of a hunting ground, it would be advisable to do so by taking into account the quantity of the natural nutritive base at the disposal to the game over the most unfavourable period of the year.

Since a stump plant sprouts more main shoots than a seed plant, stump plants contain higher biomass per unit than seed plants. This is undoubtedly one of the reasons why plants from stumps participated in the damage from 91 to 100%. Namely, in browsing, animals move from a plant to a plant, trying to use as little energy as possible for feeding. This is why they fed mainly on the shoots from stumps, as they had to invest much less effort and much less movement. The verity of this is testified by Graph 5, which shows that game preferred to browse higher plants, that is, plants in higher height classes.

Game was less selective with respect to terminal or lateral shoots. In most cases, it damaged both terminal and lateral shoots. Krapinec *et al.* (2000) found that an increase in the shoot diameter was directly proportionate to the shoot length, as well as the length of the bitten part of the shoot. Thus, the longer the shoot, the longer the part that the animals bite off or consume.

Game damages a larger number of plants in winter and spring, but with lower intensity. It could be concluded that in under-capacitated sites, an increase in the number of damaged plants results in a decrease in the percentage of damaged plants and vice versa. A very important fact was noted during damage assessment: game did not damage the young growth of holm oak and manna ash. The reason why the young growth of holm oak was not consumed might lie in the fact that the leaves on the young growth are thornier and tougher than those on the shoots from stumps, while the second reason has already been explained - less quantity of used energy per plant.

Terrain recognisance revealed that mouflon stripped the bark of young aleppo pines of up to 70 cm tall, which led to their subsequent death due to having been girdled (Figure 8).

It was observed during the year that mouflon formed bigger herds than axis deer. Some lone axis deer were observed, as well as groups consisting of two males up to nine heads at most, made up of bucks and does with and without calves. The size of mouflon herds ranged from four heads (an older ram with three ewes) to 27 heads. Consequently, due to a larger number of heads in a herd, mouflon poses more threat to successful forest regeneration than axis deer. Effort will have to be put into further research concerning ways of reducing the number of heads in a herd and a more balanced distribution of individuals in a hunting ground.

It is important to monitor browsing and grazing of other ("non-commercial") species in a stand in order to detect other forms of forest damage. Namely, as a result of game browsing and grazing, a situation may arise in which a characteristic set of plant species in a site changes to such a degree that the site loses the characteristics of the original community (Medvedović, 1989). In the concrete case, game might endanger butcher's broom, which is already under protection. The analysis of browsing patterns should take account of the fact that game migration in the hunting ground is not possible in the sense of seasonal movement in search for food as

is the case in some other hunting grounds where mouflon is reared. On the other hand, it is interesting that mouflon has adapted well to habitat conditions in a relatively short period, since it was re-introducted in the Mediterranean from Central Europe in 1998. The same mouflon population in the Czech Republic and Slovakia originates from the Belvedere Park near Vienna, where Eugène de Savoie brought it from Corsica in 1730. This fact testifies to the plasticity of mouflon game, because the same population, despite not having lived in the Mediterranean for over 250 years, still managed to utilize the major part of the resource for food upon its return to the original habitat.

CONCLUSIONS
ZAKLJUČCI

The following can be concluded from the analyses:

1. No economic damage was recorded in the hunting ground at a density of 8 heads of big game (mouflon and axis deer together) per 100 ha. If the principle of compensation is applied from the "Specialist groundwork ...", stating that one head of axis deer can be compensated with 1.5 head of mouflon, then the hunting ground would contain either 52 heads of axis deer (6 heads per 100 ha) or 78 heads of mouflon (9 heads per 100 ha). This would mean that the carrying capacity was exceeded by 180% in the case of mouflon, and by 200% in the case of axis deer.
2. From the aspect of hunting management, forest cleaning is the most important silvicultural procedure in these stands, since it increases the browsing nutritive capacities for the game manifoldly. The cleaning treatment may yield up to 52,000 individuals of palatable plant species per hectare by the beginning of summer.
3. The preference of browsing species changes over the season.
4. In the w i n t e r - s p r i n g period, the five best preferred species were butcher's broom (*Ruscus aculeatus*), Spanish broom (*Spartium junceum*), wild madder (*Rubia peregrina*), green briar (*Smilax aspera*) and scorpion senna (*Coronilla emeroides*).
5. In the s p r i n g - s u m m e r period, the five best preferred plant species were tree heath (*Erica arborea*), sharp-leaved asparagus (*Asparagus acutifolius*), plume clematis (*Clematis flammula*), laurustinus (*Viburnum tinus*) and crack phillyrea (*Phillyrea latifolia*).
6. The five best preferred plant species in the s u m m e r - a u t u m n period were laurustinus (*Viburnum tinus*), black nightshade (*Solanum nigrum*), green briar (*Smilax aspera*), evergreen rose (*Rosa sempervirens*) and butcher's broom (*Ruscus aculeatus*).
7. Game prefers to browse plants from stumps than plants from seeds. Similarly, with an increase in the height of plants, the probability of their being damaged by game also rises.
8. The period in which forest stands are at most risk by game is summer - autumn. In this period, the number of damaged plants in sample plots was the highest, and so was the number of damaged plant species (86%).

9. Of woody species, game avoids common myrtle (*Myrtus communis*), mastic tree (*Pistacia lentiscus*) and young growth of all woody species.
10. The signs of biting the shoots of woody species in the eu-Mediterranean region differ from those on the continent. The place of a shoot bite is even, or in other words, game consumes non-woody shoots which are also the most digestible.
11. As a rule, in browsing, game bites both terminal and lateral shoots on one plant.
12. The reason why tree heath (*Erica arborea*) was highly preferred was that the shoots developed from winter to summer in the same year and the plants did not exceed 30 cm in height.

REFERENCES
LITERATURA

Adamič, M., 1990: Prehranske značilnosti kot element načrtovanja varstva, gojitve in lova parkljaste divjadi s odudarkom na jelenjadi (*Cervus elaphus* L.). Universa Edvarda Kardelja v Ljubljani – VDO Biotehniška fakulteta, Institut za gozdno in lesno gospodarstvo VTOZD za gozdarstvo, Strokovna in znanstvena dela 105, Doktorska disertacija na Univerzi v Beogradu, Ljubljana, 203 pp.

Alcock, J., 1998: Animal Behavior: An Evolutionary Approach. Sixt Edition, Sinauer Associates, Inc. Publishers Sunderland, Massachusetts, 718 pp.

Andrašić, D., 1982: Objekti tehničkog uređenja lovišta i uzgajališta divljači. Lovački savez Hrvatske, Zagreb, 106 pp.

Andrašić, D., 1984: Zoologija divljači i lovna tehnologija. Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 392 pp.

Bart, J., M. A. Fligner & W. I. Notz, 1998: Sampling and Statistical methods for Behavioral Ecologist. Cambridge University Press, Cambridge, 330 pp.

Blondel, J., & J. Aronson, 1999: Biology and Wildlife of the Mediterranean Region. Oxford University Press, New York, 328 pp.

Bouchner, M., 1990: Animal Tracks. Aventinum Nakladatelstvi, Prague, 264 pp.

Čeović, I., 1953: Lovstvo. Lovačka knjiga, Zagreb, 733 pp.

Danell, K., & R. Bergström, 1987: Studies on Interactions Between Moose and Two Species of Birch in Sweden. A Rewiew, Proceedings-Symposium on Plant – Herbivore Interactions, Snowbird, Utah, August 7–9, 1985, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Ogden, Utah, 48–57 pp.

Danon, J., Ž. Blaženčić & B. Bogović, 1966: Ispitivanje učešća samonikle šumske vegetacije u ishrani jelena. Jelen – bilten Lovno-šumskog gazdinstva – Beograd, Posebno izdanje Operativno-naučnog centra – Bilje, broj 4, Beograd, pp. 15–20.

Danon, J., Ž. Blaženčić & B. Bogović, 1969: Ispitivanje sadržaja hrane buraga jelenske divljači na osnovu morfološko-anatomskih karakteristika biljaka. Acta veterinaria, Vol. XIX, Fasc. 3, Beograd, pp. 195–200.

Darabuš, S., & I. Z. Jakelić, 1996: Osnove lovstva. Hrvatski lovački savez, Zagreb, 428 pp.

Denffer, D., & H. Ziegler, 1991: Udžbenik botanike za visoke škole, Morfologija i fiziologija. Školska knjiga, Zagreb, 595 pp.

Domac, R., 1994: Flora Hrvatske: priručnik za određivanje bilja. Školska knjiga, Zagreb, 503 pp.

Garms, H., & L. Borm, 1981: Fauna Europe. Mladinska knjiga, Ljubljana, 550 pp.

Grajdl, M., 1993: Analiza kvaliteta trofeja muflona u ograđenom uzgajalištu "Garjevica" Kutina. Diplomski rad, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 35 pp.

Grubešić, M., 1996: Utjecaj prirodnih i gospodarskih čimbenika na kvalitetu stojbine divljači. Disertacija, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 157 pp.

Grupa autora, 1967: Lovački priručnik. Lovačka knjiga, Zagreb, 704 pp.

Grupa autora, 1987: Velika ilustrovana enciklopedija lovstva. Građevinska knjiga, Beograd, 940 pp.

Havranek, D., 1998: Istraživanje palatabilnosti nekih vrsta trava ispašom ovaca. Disertacija, Sveučilište u Zagrebu, Zagreb, 97 pp.

Horvatić, S., 1938: Pregled vegetacije otoka Raba sa gledišta biljne sociologije. Znanstvene rasprave Botaničkog instituta Universe Kralja Aleksandra v Ljubljani, Ljubljana, 96 pp.

Jávorka, S., & V. Csapody, 1975: Iconographia florae partis austro-orientalis Europae centralis. Akadémiai Kiado, Budapest, 555. tab.

Knežević, M., 1989: Istraživanje selektivne ispaše četiri vrste trava. Disertacija, Sveučilište u Zagrebu, Zagreb, 66 pp.

Krapinec, K., J. Vukelić & Grubešić, M., 2000: Prilog poznavanju brštenja širokolisne zelenike (*Phillyrea latifolia* L.) divljih preživača na otoku Rabu. Šumarski list, CXXIV (5–6): 285–292.

Krebs, C. J., 1989: Ecological Metodology. Harper & Row, Publishers, New York, 654 pp.

Krejči, V., & V. Viličić, 1993: Obnova sastojina hrasta lužnjaka oštećenih od srneće divljači. Radovi, Šumarski institut Jastrebarsko, 28(1–2): 207–214.

Krejči, V., V. Viličić & T. Dubravac, 1997: Prilog obnovi lužnjakove sastojine koju oštećuje srneća divljač. Radovi, Šumarski institut Jastrebarsko, 32(2): 27–35.

Manning, A., & M. S. Dawkins, 1998: An Introduction to Animal Behavior. Cambridge university Press, Cambridge, 450 pp.

Medvedović, J., 1989: Metoda utvrđivanja prehrambenih potencijala za divljač. Radovi, Šumarski institut Jastrebarsko, 80: 29–36.

Medvedović, J., 1994: Prehrambeni potencijali za divljači u šumama hrasta lužnjaka i graba sjeverne Hrvatske. Radovi, Šumarski institut Jastrebarsko, 29(1): 123–136.

Medvedović, J., & J. Knepr, 1996: Prehrambeni potencijal za divljač u lovištima "Žabljački lug-Česma" i "Pisanička Bilogora". In: B. Mayer (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, Zagreb, pp. 209–216.

Pavlović, R., 1998: Utjecaj divljači na obnovu sastojina u GJ "Bolčansko-Žabljački lug". Diplomski rad, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 62 pp.

Piegert, H., 1999: Muffelwild – Von Korzika zum Oberhartz. Wild und hund Eksklusiv, Paul Parey Zeitscriftverlag GmbH & Co. KG, Singhofen, 14: 8–57.

Pranjić, A., 1990: Šumarska biometrika. Sveučilišna naklada Liber, Zagreb, 204 pp.

Pribičević, S., & B. Bogović, 1966: Prilog poznavanju ishrane beljskog jelena. Jelen –bilten Lovno-šumskog gazdinstva – Beograd, posebno izdanje Operativno-naučnog centra – Bilje, broj 4, Beograd, 7–14 pp.

Prpić, B., 1986: Odnos hrasta crnike i nekih njegovih pratilaca prema vodi i svjetlu. Glasnik za šumske pokuse, posebno izdanje, 2. dio, Zagreb, pp. 69–77.

Raguž, D., A. Alegro, A. Frković & M. Tompak, 1994: Stručna podloga za bonitiranje i utvrđivanje lovnoproduktivnih površina u lovištima Republike Hrvatske. Zagreb, 29 pp.

Raguž, D., & M. Grubešić, 1996: Istraživanja mogućnosti gospodarenja na prostoru Mediterana. In: B. Mayer (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, Zagreb, pp. 187–193.

Raguž, D., & M. Grubešić, 1997: Revizija lovnogospodarske osnove za Državno lovište VIII/6 "Kalifront" za razdoblje 1997–2005. Zagreb, 90 pp.

Rauš, Đ., & S. Matić, 1986: Prevođenje makija i panjača hrasta crnike u sastojine višeg uzgojnog oblika. Glasnik za šumske pokuse, posebno izdanje, 2. dio, Zagreb, pp. 79–86.

Risehoover, K. L., 1987: Intraspecific Variation in Moose Preference for Willows. Proceedings-Symposium on Plant – Herbivore Interactions, Snowbird, Utah, August 7–9, 1985, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Ogden, Utah, pp. 48–57.

Sajfert, R., 2000: Rezultati analize načina odgrizanja runjikastog jagušca (*Picris hieracioides* L.) od strane divljači u lovištu "Kalifront" na otoku Rabu. Rukopis, Zagreb, 28 pp.

Scalet, C. G., L. D. Flake & D. W. Willis, 1996: Introduction to Wildlife and Fisheries: An Integrated Approach. W. H. Freeman and Company, New York, 512 pp.

Španjol, Ž., 1995: Prirodna obilježja otoka Raba. Rab–Zagreb, 440 pp.

Trinajstić, I., 1986: Fitogeografsko raščlanjenje šumske vegetacije istočnojadranskog sredozemnog područja – polazna osnovica. Glasnik za šumske pokuse, posebno izdanje, 2. dio, Zagreb, 53–65 pp.

Vančina, N., 1994: Razvoj populacije muflona u lovištu "Petehovac" Delnice od unašanja do danas. Diplomski rad, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 55 pp.

Viličić, V., 1992: Metoda istraživanja utjecaja divljači na prirodnu obnovu šuma. Radovi, Šumarski institut Jastrebarsko, 27(2): 167–174.

Viličić, V., V. Krejči & T. Dubravac, 1996: Razvoj lužnjakovih sastojina nakon oplodne sječe dostupnih krupnoj divljači. In: B. Mayer (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, Zagreb, pp. 195–208.

Viličić, V., V. Krejči & T. Dubravac, 1997: Stanje lužnjakovih sastojina dostupnoj krupnoj divljači dvije godine nakon oplodne sječe. Radovi, Šumarski institut Jastrebarsko, 32(1): 107–114.

Viličić, V., V. Krejči, M. Grubešić & T. Dubravac, 1998: Razvoj pomlatka hrasta crnike (*Quercus ilex* L.) izvrgnutog utjecaju krupne divljači. Radovi, Šumarski institut Jastrebarsko, 33(2): 103–116.

Vukelić, J., & Đ. Rauš, 1998: Šumarska fitocenologija i Šumske zajednice u Hrvatskoj. Zagreb, 310 pp.

PREFERABILNOST BILJNIH VRSTA ZAJEDNICE HRASTA CRNIKE I CRNOGA JASENA *(FRAXINO ORNI-QUERCETUM ILICIS H-IĆ /1956/ 1958)* U MUFLONA *(OVIS AMMON MUSIMON PAL.)* I JELENA AKSISA *(AXIS AXIS ERX.)*

SAŽETAK

Vegetacija u lovnom gospodarenju ima veliko značenje. Ona služi i za prehranu biljojedima i kao zaklon. Svaka pojedina životinjska vrsta ima specifične zahtjeve s obzirom na način života, stanište i hranu. Zbog toga je nužno lučiti različite tipove vegetacije odnosno kulture glede pogodnosti za uzgoj pojedine vrste divljači. Jedan od glavnih problema vrednovanja staništa za divljač je i dobar odnos oranica, livada, pašnjaka i šuma u lovnogospodarskom smislu. Što se tiče prvih triju kategorija s lovnogospodarskoga se gledišta do sada pokušala istražiti samo kakvoća umjetno proizvedene hrane u obliku koncentrata, silaže ili sijena za divljač tako da su prirodni hranidbeni potencijali još uvijek slabo istraženi.

U prirodnom uzgoju divljač na raspolaganju ima mnogo više hrane nego što je njezina ukupna potreba. To se u prvom redu odnosi na zeljaste biljke, i to samo tijekom vegetacije (iako pašne vrste divljači tijekom razdoblja bez vegetacije posežu i za suhim biljkama), dok izvan vegetacijskoga razdoblja određene vrste divljači hranu pronalaze uglavnom u šumi. S tom interakcijom divljač – stanište u nas, a i u svijetu uglavnom su se bavili šumari. Iako mnogi zaštitari prirode okrivljuju šumare za degradaciju staništa pojedinih životinskih vrsta, ovdje je bitno napomenuti da je već odavno dokazano kako suvremeno šumarstvo ide u prilog poboljšanju staništa za određene životinjske vrste. Naime, progresivnom sukcesijom vegetacije prostorno se i kakvoćno povećava gospodarski kapacitet divljih biljojeda, i to ne samo s prehrambenoga gledišta nego i u smislu zaklona.

U usporedbi s prašumom u gospodarskim se šumama količina i raznovrsnost dostupne biomase i zaklona povećavaju u skladu s nastajanjem inicijalne faze (branjevina). U posljednje se vrijeme u zapadnoeuropskim zemljama, pogotovo u Njemačkoj, nameće problem prekomjernoga broja divljači. Stoga se obavlja redukcijski odstrel prekobrojnih grla. Štetne učinke divljači na obnovu šuma neki autori navode kao glavni problem srednjoeuropskoga šumarstva, međutim, štete od divljači nisu isključivo u svezi s njhovom prekobrojnošću, a isto tako nisu nov pojam jer je analizom izvrtaka donjega dijela odraslih jela (*Abies alba* Mill.) iz Kočevskoga roga dobiven podatak da su u razdoblju od sredine 17. stoljeća do sredine 19. stoljeća na izraslim jelama terminalni pupovi 75 % analiziranih stabala u mladosti bili odgrizeni, i to od jednom do 35 puta. Dakle "štete" su u šumama i u prošlosti bile prisutne i pri niskom brojnom stanju divljači.

U istraživanjima prehrane divljači danas su vidljiva dva potpuno različita pristupa: europski (s izuzetkom Skandinavije i Velike Britanije), koji je usmjeren na prilagođavanje i ublažavanje šteta od divljači te proučavanje važnosti i racionalizacije zimske prehrane divljači, te sjevernoameričko-skandinavski, koji je u prvom redu usmjeren na upoznavanje prehrambene ekologije biljojeda, kompeticije među simpatičkim vrstama te kompeticije među divljim i

domaćim vrstama životinja na velikim površinama. Ovaj je pristup lovnomu gospodarstvu usmjeren na oblikovanje strategije upravljanja populacijama divljači u prirodi uz poštivanje biotskoga kapaciteta staništa.

Istraživanja interakcije divlji biljojed – stanište u sredozemnom području Hrvatske započela su u ograđenom dijelu Državnoga lovišta VIII/6 "Kalifront" površine 1351,22 ha. Navedeno lovište smješteno je na otoku Rabu. Od krupne divljači u lovištu obitavaju muflon (*Ovis ammon musimon* Pall.) i jelen aksis (*Axis axis* Erx.). S obzirom na to da se radi o lovištu koje je u biti u cijelosti smješteno na poluotoku, pregrađeno je u središnjem dijelu na duljini 3,4 km. Time je sjeverozapadni dio lovišta (840 ha) s divljači ostao izoliran od domaće stoke koja je do tada na čitavoj površini lovišta "Kalifront" nekontrolirano brstila u šumi. Učinak takve pregrade jednak je učinku potpunoga ograđivanja ovoga dijela lovišta jer su ostale tri strane okružene morem. Zbog toga će se u daljem tekstu više koristiti naziv ograđeni dio lovišta. Dakle, u potpunosti su stečeni preduvjeti za istraživanja prirodnoga uzgoja divljači.

U ograđenom dijelu lovišta tijekom uzimanja podataka za ovaj rad bilo je 45 grla muflonske divljači i 22 grla jelena aksisa. Ukupno gledano to čini gustoću populacije sve krupne divljači od 8 grla na 100 ha lovišta. Iz tablice 1 je vidljivo da je u godini izmjere populacija divljači bila u skladu s kapacitetima staništa. Razlika u lovnoproduktivnoj površini nastala je pregrađivanjem lovišta ogradom na dva dijela. Pregrađeni dio u kojem su obavljena istraživanja ima površinu od 840 ha, a stvarni se broj grla odnosi na prebrojavanje u tome dijelu lovišta.

Na temelju podataka iz akta o osnivanju lovišta ukupna površina lovišta iznosi 1475 ha. Raspored površina po kulturama i zemljovlasnički razmjer dan je u tablici 2.

Sredozemne su šume tradicionalno pružale mnogo više koristi lokalnomu pučanstvu za razliku od šuma ostaloga dijela Europe. U prvom redu služile su za drvo i hranu, a zatim za zaklon, uporabu ljekovitoga bilja, pluta, tanina, smola itd. (slika 3). Posljedica intenzivnoga iskorištavanja šuma ne samo sječom nego i nekontroliranom ispašom jesu različiti degradacijski oblici. Zbog toga se danas dosta poduzima kako bi se te šume očuvale.

Promatrajući način gospodarenja šumama na otoku Rabu, uočava se njihovo čišćenje. To je gospodarski zahvat u sastojini kojim se iz nje uklanjaju sporedne vrste, ali i smanjuje broj glavnih drvenastih vrsta (u prvom redu crnike, a manje crnoga jasena). Lokalno pučanstvo tako dobiva sitan ogrjev ili pak brst za stoku. Nakon takva zahvata u sastojini, budući da je u nju ušlo dosta svjetla, doslovce "bukne" vegetacija, ne samo izbojci iz panja posječenih drvenastih vrsta nego i penjačice te prizemno raslinje. Pri rijetkom do nepotpunom sklopu krošanja u sastojini se značajno povećava biomasa raslinja, a time raste koncentracija sirovih bjelančevina, te neto energija i ugljikohidrati, odnosno stupanj probavljivosti hrane (Adamič 1990, cit. Blair i dr. 1983, cit. Regelic i dr. 1974). Dakle, njega sastojina ne pridonosi samo povećanju proizvodne funkcije šume, nego i povećanju proizvodnosti ostalih njezinih funkcija (integralno gospodarenje šumama – konverzija biomase biljaka u meso, trofej i sl.). U navedenom lovištu divljač se jako dobro koristi posljedicama čišćenja. Sve navedene plohe smještne su upravo na površine u kojima je obavljeno čišćenje.

Promatrajući grafikone 2, 3. i 4, vidljivo je da divljač daje slabiju prednost glavnim drvenastim vrstama u sastojini, odnosno hrastu crniki i crnomu jasenu. Najpreferabilnije drvenaste vrste u ovim staništima su krunica, lemprika i zelenika. Veliki vrijes je početkom ljeta

imao veliku preferabilnost upravo zbog toga što su iz panja potjerali mladi izbojci, a biljke nisu prelazile visinu od 60 cm, odnosno veći dio oštećenih biljaka bio je u visinskom razredu od 1 do 30 cm (odjel 3 i 4). Dakle, biljke su imale samo ovogodišnje (mlade) izbojke koji imaju višu probavljivost od starijih te divljač nije morala ulagati veći napor u prebiranje hranjivijih, mladih izbojaka. Naime, poznato je da vrijes ima prilično sitne i mnogobrojne izbojke u usporedbi s ostalim vrstama crnikovih šuma te u slučaju dostupnosti isključivo višegodišnjih izbojaka, koji su slabih prehrambenih svojstava, divljač je prisiljena nalaziti hranu kojom će se brže i bolje nahraniti. Ovdje nije izraženo tipično odgrizanje drvenastih vrsta kao u kontinentnim krajevima, gdje preživači odgrizaju tako da mjesto odgriza s donje strane izgleda kao odrezano, a s gornje je ostatak kore i lika (slika 4). Na slici 11 jasno je uočljivo kako izbojci nisu odgrizani na gore opisani način, nego ih divljač kida usnama. Izbojak u tom slučaju puca na neodrvenjelom dijelu te divljač tako konzumira manje neprobavljivih tvari, npr. lignin (slika 5). To pokazuje kako divljač dobro iskorištava brst.

Tijekom godine mijenja se i odnos konzumiranih i nekonzumiranih vrsta. Tako je divljač u razdoblju zima-proljeće od 16 vrsta konzumirala njih 13, u razdoblju proljeće-ljeto od 16 vrsta konzumirala je njih 9, a u razdoblju ljeto-jesen od 14 vrsta konzumirala je 12 (nije jela mirtu, tršlju, ljepljivi oman te ponik primorskoga bora). Iako je mirta bila u uzorku snimljena samo u odjelu 4, treba reći da detaljnim pregledom oštećenih biljaka u cijelom lovištu nigdje nije ustanovljeno oštećenje biljaka mirte. To je također uvrštava u kategoriju nepreferabilnih biljnih vrsta za ove dvije vrste divljači.

Ključ dobre hranidbene podloge u eumediteranskom području na početku brsnoga razdoblja krupne divljači leži upravo u proizvodnji jednogodišnjih izbojaka drvenastih vrsta. To razdoblje nastupa krajem lipnja i početkom srpnja kada su različite trave i zeljanice suhe te su stoga loša krma. Divljač tada u prvom redu traži još neodrvenjele izbojke koji su, po mogućnosti, što sočniji (Krapinec i dr. 2000). Za razliku od kontinentalnoga dijela Hrvatske, gdje za život divljači nepovoljni uvjeti vladaju tijekom zime, u sredozemnom području takvi uvjeti vladaju tijekom ljeta. Upravo stoga divljač u Sredozemlju poduzima migracije prikazane na slici 6. Bilo bi dobro određivati kapacitet lovišta prema količini prirodne prehrambene baze divljači koja joj stoji na raspolaganju tijekom za život najnepovoljnijega dijela godine.

Budući da biljka iz panja tjera više glavnih izbojaka od biljke iz sjemena, ona ima veću biomasu nego biljka iz sjemena. Jedan od razloga zašto su biljke iz panja u udjelu oštećenosti bile zastupljene od 91 do 100 % nedvojbeno leži u toj činjenici. Naime, životinje pri brstu prelaze od biljke do biljke, a poznato je da se nastoje hraniti uz što manje trošenja energije. Zbog toga su se i hranile ponajprije izbojcima s panjača, jer su morale uložiti mnogo manje napore, odnosno što manje se kretati od biljke do biljke. Da je to točno, pokazuje i grafikon 6, iz kojega je vidljivo da je divljač radije brstila više biljke, odnosno biljke u višim visinskim razredima.

Pri izboru vršnoga ili postranoga izbojka divljač pokazuje manju selektivnost. U većini slučajeva je oštećivala i vršne i postrane izbojke. Krapinec i dr. (2000) utvrdili su da s povećanjem promjera izbojaka raste i duljina izbojka, te duljina odgrizenoga dijela izbojka. Znači, što je izbojak dulji, to je i dulji dio divljač odgrizla.

Tijekom zime i proljeća divljač ošteti veći broj biljaka, ali s manjim intenzitetom. Iz toga bi se moglo zaključiti da se u nenapučenim staništima s porastom broja oštećenih biljaka smanjuje

postotak oštećenosti biljaka, i obratno. Bitna činjenica uočena pri snimanju oštećenosti jest da divljač nije dirala ponik hrasta crnike i crnoga jasena. Razlog u nekonzumiranju ponika hrasta crnike mogao bi biti i taj što su listovi na poniku bodljikaviji i žilaviji nego na izbojcima iz panja, dok je drugi već objašnjen – manja količina potrošene energije po biljci.

Pri rekognosciranju terena utvrđeno je da je muflonska divljač gulila koru s mladih alepskih borova visine do 70 cm koji su se poslije, budući da su bili prstenovani, osušili (slika 8).

Promatranjem divljači tijekom godine moglo se uočiti da muflonska divljač formira veća krda od jelena aksisa. Kod aksisa je bilo zamijećenih samotnjaka, zatim grupe od dva mužjaka do najviše devet grla koje su činili jeleni i košute s teladi i bez teladi. Veličina krda kod muflonske divljači kretala se od četiri grla (stariji ovan s tri ovce) do 27 grla. Iz toga izlazi da je za uspješnu obnovu šuma opasnija muflonska divljač od jelenske jer ima veći broj grla u krdu. Zbog toga će trebati uložiti napore u daljnja istraživanja na koji način smanjiti broj grla u krdu te kako jedinke ravnomjerno rasporediti u lovištu.

Potreba praćenja brsta i paše na ostalim ("nekomercijalnim") vrsta-ma u sastojini bitna je zbog toga jer se šumskom štetom može smatrati i situacija u kojoj se, zbog paše i brsta divljači, promijenio karakterističan skup biljnih vrsta, i to tako da stanište prestaje biti karakteristično za prvotnu asocijaciju (Medvedović 1989). U konkretnom slučaju divljač bi mogla ugroziti bodljikavu veprinu koja je ionako već zaštićena. Pri analizi brsta treba uzeti u obzir i to da u lovištu nije moguća migracija divljači u smislu sezonskoga premještanja za hranom kao što je to slučaj u nekim drugim lovištima u kojima se gospodari muflonom. S druge je strane zanimljivo da se muflonska divljač dobro prilagodila u relativno kratkom vremenu na stanišne uvjete jer je iz srednje Europe 1998. godine dopremljena ponovo na Sredozemlje. Ista populacija muflona u Češkoj i Slovačkoj porijeklom je iz parka Belvedere kod Beča, gdje ju je Eugen Savojski dopremio s Korzike 1730. godine. Dakle, o plastičnosti muflonske divljači taj podatak puno govori jer ista populacija nije bila na Sredozemlju otprilike preko 250 godina, a ipak je uspjela pri povratku na prvobitno stanište u relativno kratkom vremenu za prehranu iskoristiti dobar dio resursa.

Ključne riječi: muflon (*Ovis ammon musimon* Pall.) i jelen aksis (*Axis axis* Erx.), šuma hrasta crnike i crnoga jasena (*Fraxino orni-Quercetum ilicis* H-ić /1956/ 1958)