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Long-term trends of hunting bags and wildlife populations in Central Europe

Schlagworte/key words: Hunting bag statistics, wildlife habitats, long-term population trends, Central Europe, Jagdstrecken, Jagdstatistik, Wildlebensraum, langfristige Populationstrends, Mitteleuropa

1. Introduction

Time series analyses play an important role in the detection of mechanisms that drive fluctuations and trends of populations (IMPERIO et al. 2010). However, long time series are rare. In this study, we compare the trends of long-term hunting bag numbers (since 1970) of nine Central European countries to estimate large-area population trends of 19 wildlife species or groups of species, typical for different habitat types (Fig. 1). Habitat changes are discussed as potential causes for the trends in Central Europe.

2. Method

The hunting bag statistics were taken, as far as possible, from the official statistical information of the countries. Not generally accessible data and further information were researched by competent people from the countries (see acknowledgements). With the total yearly hunting-bag numbers (not differentiated between sexes and age classes) only long-term and country-wide population trends were compared, not changes of local population densities.

3. Countries investigated

The nine countries within the study area (Fig. 1, Table 1) differ in topography, in hunting system (licence; district/hunting ground), and in history of wildlife management. The total area covers 1.04 million square kilometres with altitudes up to 4600 m. Central Europe has very different landscapes: from the alpine mountains in the southwestern part with Switzerland, Austria and South Tyrol to the lowlands of Poland and northern Germany, and the plains in Hungary. The former barrier “iron curtain” dividing Europe into communist and non-communist countries with different wildlife management practices has disappeared through the political change in 1990. Vegetation cover and forest share differ markedly between the countries. The forest share ranges between 22 % in Hungary to 58 % in Slovenia (Table 1).

The most common ungulate game in Central Europe is roe deer. The yearly hunting bag in 2014 was 1.9 million head (9 countries). Further abundant ungulate species are wild boar and red deer. The other ungulates, fallow deer, chamois, mouflon, moose, ibex, bison, sika deer and white-tailed deer are restricted to smaller areas. Fallow deer, mouflon, sika and white-tailed

deer are alien species in Central Europe. Large predators are not widespread in Central Europe, but increasing. Their regularly settled habitat covers about 10 % of land area. They are now under protection in most countries.

Wildlife management is usually regulated by hunting laws. Official aims are similar in the countries, such as high diversity of game species, protection of game populations, protection of habitats (only in few countries), avoidance of game damage to vegetation, and sustainable use of game animals. Hunters and game wardens are responsible for wildlife management.

The dominating hunting system in Central Europe is district hunting (hunting grounds). License hunting (no subdivision of hunting area into hunting grounds) exists only in some cantons of Switzerland. In five of the nine countries the hunting rights are connected to the land owner. Only in Switzerland, Slovenia, South Tyrol and Poland game belongs to the public.

The minimum size of hunting districts differs between 75 ha in Germany and 3000 ha in Poland and Hungary. In all 9 countries the hunters must take special courses and pass an exam before they are allowed to hunt. Game damage compensation in forests is provided for in those countries where hunting rights belong to the land owners, whereas compensation in agriculture is common in all countries.

Supplemental feeding is done often for cervids in winter, only seldom for bovids, and luring very frequently for wild boar. There are great regional differences.

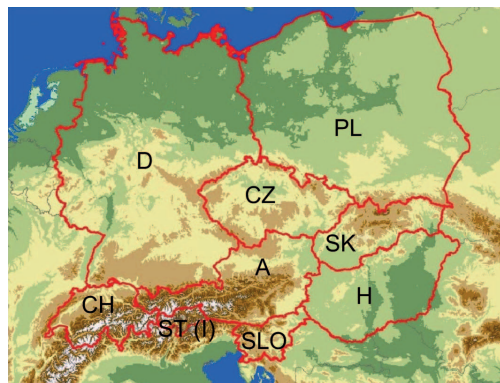


Fig. 1 Topography of the nine Central European countries investigated

The hunting statistics for the nine countries partly show very different figures (Table 1):

- the percentage of hunters per inhabitants varies between 0.3 in Poland and 1.4 in Austria
- the hunting bag density in Germany with 5.4 culled ungulates per square kilometre is 3 times higher than in Switzerland with 1.9
- the hunters density in Austria and Czech Republic with 1.4 hunters per square kilometre is 4 times higher than in Poland with 0.35
- In Poland a hunter on average culled 2.6 times more ungulates per year (5.4) than in Slovakia (2.1); hunting guests not included.
- On average over all nine countries 0.5 % of the population are hunters, which results in 0.9 hunters per km².
- On average 37 wild ungulates were culled per 1000 ha hunting area in the year 2014 (not including sika deer, fallow deer and white-tailed deer). By comparison in 1970 only 12 ungulates per 1000 ha hunting area were culled.
- On average 4.0 ungulates were culled per hunter (in 2003 on average 3.2).

The number of hunters is stable or slowly increasing. In 2003 812,500 hunters were registered in the nine investigated countries, in 2014 their number reached about 858,500.

Game damage in agriculture is increasing in most of the countries due to the increasing number of rooting wild boar. From the viewpoint of the land owners and hunters this is now one of the most significant problems in ungulate management in Central Europe. Hunters mostly do not know how to stop the increasing wild boar populations.

The situation of game damage to forest (twig browsing, bark stripping), is more or less an old and constant problem.

4. Hunting bags and population trends

The total hunting bags of Central Europe (9 countries together) are summarized for the 19 wildlife species in Table 2 (period 1970–2014), and the detailed hunting bag numbers for each of the nine countries are presented in Table 3a–3c. Figure 2 shows the culling trends of 7 main species in each country (period 1970–2010).

Table 1 Characters of the nine compared countries

	SLO	ST (I)	CH	A	D	PL	CZ	SK	H	Total
Country area (km ²)	20273	7400	41284	83858	357025	312683	78866	49036	93030	1043455
Huntable area (km ²)	19057	6233	37156	82181	325583	286100	68313	44426	82437	951486
Huntable area (%)	94	84	90	98	91	91	87	91	89	91
Huntable area of Central Europe (%)	2	1	4	9	34	30	7	5	9	100
Inhabitants x 1000 2002/2003	1964	461	7261	8100	82159	38632	10206	5330	10200	164692
Inhabitants x 1000 2014/2015	2063	512	8212	8663	81459	38484	10553	5416	9856	164956
Population density (inhabitants/km ²)	97	62	176	97	230	124	129	109	110	158
Hunters (n x 1000) 2003	21.3	5.7	30.0	115.0	338.6	100.3	97.0	54.0	50.6	812.7
Hunters (n x 1000) 2014	22.0	6.2	30.0	123.3	351.0	106.0	110.0	55.0	55.0	858.3
Hunters/hunting area	1.1	0.9	0.8	1.4	1.1	0.4	1.4	1.2	0.6	0.9
Hunters/inhabitants (%)	1.1	1.2	0.4	1.4	0.4	0.3	1.0	1.0	0.6	0.5
Ungul. cull./hunter (2014)	2.3	2.5	2.4	3.0	5.0	5.4	2.7	2.1	5.3	4.0
Ungul. cull./1000 ha hunting area (2014)	27.1	24.2	19.0	45.6	53.7	19.9	44.2	25.6	35.4	36.5
Altitude max (m)	2864	3905	4618	3797	2963	2499	1602	2654	1010	4618
Forest area (%) 2014	58	45	31	48	32	29	34	40	22	33
Broadleaved trees (%)	52	3	33	28	43	22	27	60	85	37
Conifers (%)	48	97	67	72	57	78	73	40	15	63

If a culling number of a certain year was far outside the trend, the culling number was substituted with a mean including the two years before. This was the case in Poland for grey partridge in the years 1970 and 1980 with prior exceptionally harsh winter and cold weather conditions in spring which led to outliers in the culling numbers (PANEK 2006, KAMIENIARZ and PANEK 2008b). For Austrian culling numbers of capercaillie the mean of the given year and the year before was used in the calculations because in some provinces hunting was permitted only every second year (REIMOSER and REIMOSER 2016).

Comments to ungulates (Table 3a, Fig. 2):

Red deer shows an increase in all Central European countries, their culling rates tripled since 1970. While the Alpine countries Switzerland, Austria and South Tyrol show a constant increase from 1970 to 2010, the other countries show a more or less decline in the year 2000 before increasing again. All countries with exception of South Tyrol and Austria currently have their maximum in 2014.

Roe deer shows also a clear increase in the yearly culling rates, in total about doubled since 1970, more so in the eastern countries than in the western part. Switzerland has its maximum

Table 2 Total hunting bags of Central Europe (9 countries) in the years 1970, 1980, 1990, 2000, 2010 and 2014 for 19 wildlife species, and bag differences 2014–1970 (trends)

Species	Hunting bag per year (number of animals)						Difference
	1970	1980	1990	2000	2010	2014	2014–1970
Red deer (<i>Cervus elaphus</i>)	106,429	153,220	241,912	201,129	263,868	324,317	217,888
Roe deer (<i>Capreolus capreolus</i>)	907,066	1,217,972	1,528,596	1,709,543	1,842,035	1,879,313	972,247
Chamois (<i>Rupicapra rupicapra</i>)	26,377	42,074	50,098	45,293	38,216	36,655	10,278
Ibex (<i>Capra ibex</i>)	0	549	1,283	1,358	1,471	1,629	1,629
Mouflon (<i>Ovis orientalis</i>)	4,091	8,097	20,701	19,954	26,678	28,807	24,716
Wild boar (<i>Sus scrofa</i>)	105,244	254,197	565,133	625,009	1,146,365	1,199,380	1,094,136
Brown hare (<i>Lepus europaeus</i>)	3,155,274	1,551,461	1,388,048	915,112	649,649	507,954	-2,647,320
Partridge (<i>Perdix perdix</i>)	979,871	242,629	264,676	44,716	18,398	14,746	-965,125
Pheasant (<i>Phasianus colchicus</i>)	2,992,075	2,274,026	2,093,670	1,704,942	1,315,510	1,270,824	-1,721,251
Wild pigeons (<i>Columbidae</i>)	582,486	627,332	818,232	813,229	869,666	604,913	22,427
Wild Ducks (<i>Anatidae</i>)	653,924	929,808	1,326,943	1,338,709	1,024,041	938,863	284,939
Capercaillie (<i>Tetrao urogallus</i>)	1,309	411	607	420	383	316	-993
Black grouse (<i>Tetrao tetrix</i>)	4,558	3,121	4,004	2,567	1,901	2071	-2,487
Red Fox (<i>Vulpes vulpes</i>)	287,434	350,744	556,041	921,676	900,760	861,658	574,224
Badger (<i>Meles meles</i>)	14,172	12,114	23,401	51,468	85,758	93,019	78,847
Raccoon dog (<i>Nyctereutes procyonoides</i>)	18	289	548	7,365	27,924	41,689	41,671
Raccoon (<i>Procyon lotor</i>)	0	0	1,936	9,075	68,141	117,297	117,297
Brown bear (<i>Ursus arctos</i>)	15	21	53	31	47	20	5
Wolf (<i>Canis lupus</i>)	56	87	225	118	150	56	0
Moose (<i>Alces alces</i>)	350	600	1,490	300	200	0	-350

Table 3a Number of ungulates culled in the years 1970, 1980, 1990, 2000, 2010 and 2014 in the 9 countries

	Year	SLO	ST (I)	CH	A	D	PL	CZ	SK	H
Red deer	1970	976	303	1611	33187	36885	10500	7535	7650	9061
	1980	3098	585	4097	40187	47869	18800	10881	11769	19617
	1990	4713	1039	6241	42365	63550	54300	20849	19367	35240
	2000	3686	2252	7036	43498	53241	41000	17796	9646	28912
	2010	4743	3626	9078	53536	67969	54000	20706	19418	39161
	2014	5816	2950	10740	51677	74359	83000	23361	29349	51831
Roe deer	1970	11522	4754	26111	143883	632217	18600	57192	9419	19613
	1980	27661	6708	43958	211105	757466	53800	84846	15654	51143
	1990	42736	9950	37239	255371	925595	166600	86757	15540	41494
	2000	31080	9866	42615	256672	1071236	158000	112795	15471	52754
	2010	31172	8776	39958	263279	1147219	161000	119838	22453	88288
	2014	33219	8605	40599	268054	1139536	195000	100348	24556	111220
Chamois	1970	1098	1104	10821	13831	1718	0	3	4	0
	1980	2458	3007	14818	24709	2463	0	83	1	0
	1990	1974	3034	17976	27278	4704	0	136	4	0
	2000	1983	4052	16625	24523	4097	0	41	7	0
	2010	2239	4202	13427	20290	4473	0	19	7	0
	2014	2223	3533	12231	19690	4703	0	19	12	0
Ibex	1970	0	0	0	0	0	0	0	0	0
	1980	5	0	471	78	0	0	0	0	0
	1990	9	4	1068	215	0	0	0	0	0
	2000	7	49	962	396	0	0	0	0	0
	2010	8	29	1097	374	0	0	0	0	0
	2014	10	0	1099	530	0	0	0	0	0
Mouflon	1970	21	0	0	511	1881	0	1310	223	166
	1980	377	0	0	1274	2387	0	2759	717	960
	1990	549	0	0	2019	6259	60	7580	1807	2976
	2000	623	0	0	1822	5869	400	7719	1812	2332
	2010	659	0	0	2209	7269	600	9050	4564	2986
	2014	579	0	0	2637	8007	518	9059	5149	3437
Wild boar	1970	472	0	60	2993	60484	24400	4803	3548	8992
	1980	1300	0	543	3634	129119	80400	11773	8487	20241
	1990	5043	3	1536	13205	305740	121600	55812	20568	46672
	2000	5068	3	4160	24822	350976	93000	67858	16448	67745
	2010	8742	13	7647	37115	585244	233000	143378	39045	100936
	2014	9703	1	6067	32559	520623	291000	168974	54541	125616

Table 3b Number of small game culled in the years 1970, 1980, 1990, 2000, 2010 and 2014 in the 9 countries

	Year	SLO	ST (I)	CH	A	D	PL	CZ	SK	H
European hare	1970	29833	6006	20097	342870	1264587	284000	808299	246309	189112
	1980	9072	5259	14651	265520	740925	178000	225023	76565	50777
	1990	9388	3069	5681	180067	607834	217000	189785	63836	123845
	2000	2135	2718	2584	194019	442127	65000	94108	32051	85223
	2010	2452	2802	2409	106101	367321	18000	62483	14525	78810
	2014	2156	2797	1755	116135	236106	15000	39591	14890	84477
Partridge	1970	7971	58	1485	105203	445564	270000	32919	49694	75006
	1980	1361	9	299	37640	46403	158000	37	10	240
	1990	1585	0	0	8265	29328	223000	38	0	4045
	2000	2479	0	0	9109	11092	23000	0	269	1246
	2010	1507	0	0	7132	5543	3100	0	419	2204
	2014	1445	0	0	4098	2322	2500	0	2624	3202
Pheasant	1970	69669	2166	6268	409767	983375	56000	1019370	93133	424162
	1980	29013	1936	2903	353051	369378	233000	486112	87318	742264
	1990	37820	1916	2292	206283	367154	118000	527537	60165	812239
	2000	39658	101	155	190601	336908	95000	561637	90257	430384
	2010	20890	13	23	82138	204541	104000	526545	91811	306452
	2014	13925	5	31	70444	113914	129000	478808	79275	399352
Pigeons	1970	14037	2695	13909	36619	421727	<i>no data</i>	104921	5310	<i>no data</i>
	1980	4448	1081	6522	23677	559225	3000	33331	1577	<i>no data</i>
	1990	4748	748	2948	20942	773296	6000	15154	892	<i>no data</i>
	2000	0	608	9121	20180	749729	11000	21393	1806	<i>no data</i>
	2010	0	200	6092	17915	812028	11100	20925	1606	<i>no data</i>
	2014	0	125	4854	14650	552340	12100	18374	2595	<i>no data</i>
Ducks	1970	6680	<i>no data</i>	19520	41123	386907	<i>no data</i>	102233	26613	77528
	1980	8207	552	23346	70418	424424	128000	115967	25254	142399
	1990	11196	780	15348	77674	571240	123000	273973	22498	243210
	2000	6164	790	8109	85000	516868	130000	336013	18385	244334
	2010	3775	1044	6364	80497	418331	105000	272267	18276	123306
	2014	2820	781	6588	57663	394842	105900	262345	16529	95037
Capercaillie	1970	89	206	11	1036	145	<i>no data</i>	23	94	0
	1980	42	0	0	365	0	10	0	36	0
	1990	0	0	0	599	0	9	0	0	0
	2000	0	0	0	420	0	0	0	0	0
	2010	0	0	0	383	0	0	0	0	0
	2014	0	0	0	316	0	0	0	0	0

Extension of Table 3b

	Year	SLO	ST (I)	CH	A	D	PL	CZ	SK	H
Black grouse	1970	148	506	1397	2026	465	<i>no data</i>	632	38	0
	1980	119	0	532	2094	0	405	72	18	0
	1990	138	0	1294	2555	0	144	11	0	0
	2000	0	274	508	2059	0	0	0	0	0
	2010	0	300	390	1511	0	0	0	0	0
	2014	0	351	542	1529	0	0	0	0	0

in 1980, South Tyrol and Slovenia in 1990, all other countries in 2010 or 2014.

Chamois culling, common only in the alpine countries, was also doubled between 1970 and 2000 (maximum), then the culling rates declined to about 73 % of the maximum in 2010.

Wild boar culling shows a dramatic increase in all countries up to 2014, with culling rates 10 times higher than 44 years ago. All countries have their maximum in either 2010 or 2014.

The introduced mouflon shows a strong increase in culling numbers.

The reintroduction of the almost exterminated Alpine Ibex in the Alps was a success story.

In the 19th century only a small population of some dozen animals lived in one small region in northwest of Italy. Today we have widespread ibex populations in the Alps with about 40 thousand animals. In 1970 there was still no culling of ibex. Now we have a sustainable use in Switzerland, Austria and South Tyrol of about 1,600 animals per year in total.

Moose was regularly culled only in Poland, the culling rates increased from about 350 head in 1970 to 1060 head in 1980 and 1490 head in 1990. Through overhunting the population number was reduced by over 70 % (RACZYNSKI and RATKIEWICZ 2011) and as a consequence culling numbers declined to about 300 animals in 2000, and roughly 200 (cull only for research) in 2010. 2014 no moose were culled. Regular moose hunting was stopped since 2001 to increase the population.

Total culling rate of the investigated ruminant ungulate species more than doubled from 1970 to 2014, whereas wild boar culling multiplied 11 times. Altogether the total ungulate culling tripled from about 1.1 million to 3.5 million.

Comments to small game (Table 3b, Fig. 2):

Brown hare, grey partridge and pheasant showed a continuing negative trend in hunting bags and populations. For partridge the decrease is very dramatic since decades. The culling numbers of wild ducks increased from 1970 to 1990/2000 and are now more or less declining. This trend is apparent in most countries. Capercaillie is still huntable only in Austria, but the culled number in 2014 is only 26 % of the amount in 1970. Germany, Switzerland, South Tyrol and Czech Republic culled few capercaillies in the 1970s, Slovakia and Slovenia until the 1980s, and Poland until the 1990s, after which the species was protected in these countries. Black grouse is still hunted in Austria, Switzerland and South Tyrol. In Austria the culling rate increased from 1970 to 1990 and then declined again. In 2014 the culling rate was 75 % of the rate in 1970. Slovenia, Germany, Poland, Czech Republic and Slovakia have stopped hunting black grouse.

Comments to predators (Table 3c, Fig. 2):

While the culling numbers for red fox increased in Austria, Poland, Czech Republic, Slovakia and Hungary until now, the maximum number of foxes culled in Slovenia, South Tyrol, Switzerland and Germany was in the year 2000. The culling numbers of badgers increased, with exception of Slovenia and South Tyrol. Culling numbers of the alien predator species raccoon dog and raccoon are increasing in Austria, Czech Republic, Slovakia and very dramatically in Germany. Brown bear is only culled in Slovenia, here with increasing population trend, and in Slovakia. Wolves are also culled in Slovenia and Slovakia. In Poland higher numbers of wolves were culled until 1990, later they

Table 3c Number of predators culled in the years 1970, 1980, 1990, 2000, 2010 and 2014 in the 9 countries

	Year	SLO	ST (I)	CH	A	D	PL	CZ	SK	H
Red fox	1970	9120	2181	19650	37197	171547	<i>no data</i>	21425	9259	28356
	1980	10168	1842	13881	27356	216368	23000	27830	13331	28978
	1990	4857	1943	33191	36874	373822	26000	39655	14129	32370
	2000	13555	4907	42221	57929	606456	101000	38697	15557	59816
	2010	11066	3837	31044	60309	518768	142000	74644	17644	56351
	2014	9995	1772	26366	64107	457815	147000	73678	19359	73333
Badger	1970	1157	286	1563	5077	5946	<i>no data</i>	1106	480	0
	1980	736	210	950	4988	5167	200	554	255	0
	1990	782	39	1812	5199	15241	300	312	537	0
	2000	778	108	2693	7872	38419	1300	346	838	0
	2010	611	13	3463	8617	59696	4500	2758	925	5799
	2014	748	0	3272	7422	63554	6000	3003	983	8785
Raccoon dog	1970	0	0	0	0	0	<i>no data</i>	10	8	0
	1980	0	0	0	0	0	200	70	19	0
	1990	0	0	0	0	0	600	11	37	0
	2000	0	0	0	18	7161	0	165	16	5
	2010	0	0	0	29	14674	12000	1148	70	3
	2014	0	0	0	36	23880	16000	1671	95	7
Raccoon	1970		0	0	0	0	0		0	0
	1980		0	0	0	0	0	-	0	0
	1990		0	0	0	1936	0	-	0	0
	2000		0	1	4	9064	0	-	0	6
	2010		0	0	18	67707	100	314	0	2
	2014		0	0	7	116068	700	513	3	6
Brown bear	1970	47			0	0	0		15	0
	1980	47			0	0	0	0	21	0
	1990	41			0	0	0	0	53	0
	2000	45		0	0	0	0	0	31	0
	2010	98		0	0	0	0	0	47	0
	2014	120		0	0	0	0	0	20	0
Wolf	1970	10				0	16		40	0
	1980	3				0	50	1	36	0
	1990	3				0	110	0	115	0
	2000	2				0	0	0	118	0
	2010	9		1		0	0	0	149	0
	2014	7		0		0	0	0	56	0

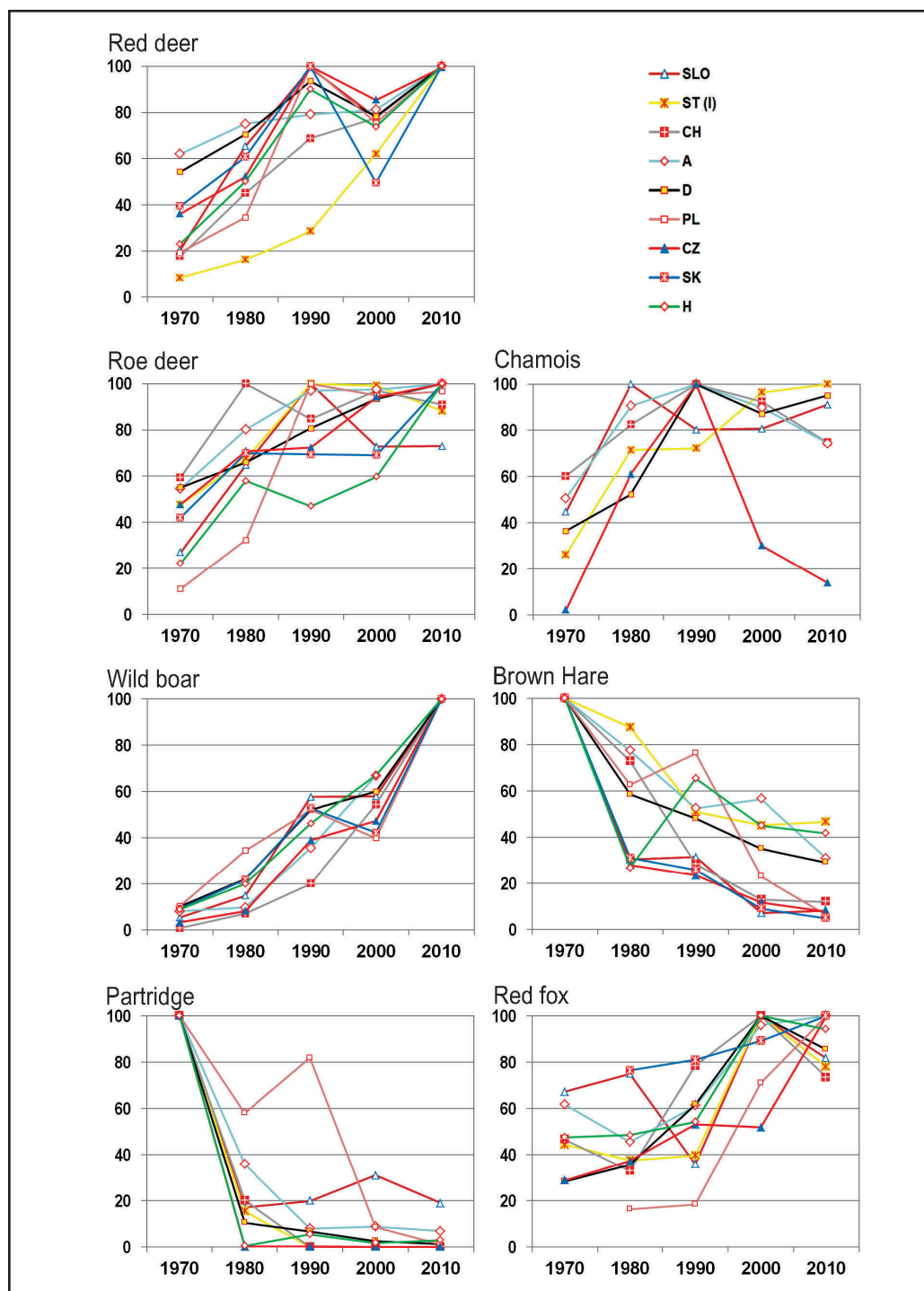


Fig. 2 Trends in culling rates (%) for 9 Central European countries 1970–2010 (7 species); bag maximum = 100 %

were protected. The wolf population in Central Europe is increasing, but in most countries this species is protected (no culling allowed).

In total for all 9 countries (Fig. 3) the main species culled in 1970 were hares (33 %), followed by pheasants (31 %), partridges (10 %), roe deer (9 %), ducks (6 %), pigeons (6 %), foxes (3 %), red deer (1 %) and boars (1 %). In 2014 the main species culled were roe deer (24 %), followed by pheasants (16 %), boars (15 %), ducks (12 %), foxes (11 %), pigeons (8 %), hares (6 %), red deer (4 %), raccoon dogs (2 %) and badgers (1 %). All other investigated species were below 1 %.

Between the 9 countries (Fig. 3) the culling bag composition was quite different. In Slovenia the hunting bag in 2014 consisted in 40 % roe deer, 17 % pheasants, 12 % foxes and 12 % boars. In South Tyrol: 42 % roe deer, 17 % chamois, 14 % red deer and 14 % hares. Switzerland: 36 % roe deer, 23 % foxes and 11 % chamois. Austria: 38 % roe deer, 16 % hares, 10 % pheasants. Germany: 31 % roe deer, 15 % pigeons, 14 % boars, 12 % foxes and 11 % ducks. Poland: 29 % boars, 19 % roe deer, 15 % foxes, 13 % pheasants, 11 % ducks. Czech Republic: 41 % pheasants, 22 % ducks and 14 % boars. Slovakia: 33 % pheasants, 22 % boars and 12 % red deer. Hungary: 42 % pheasants, 13 % boars, 12 % roe deer and 10 % ducks.

Hunting number of all investigated species decreased from 9.8 million in 1970 to 7.9 million in 2014 (Fig. 4). Ruminants culled increased from 1.0×10^6 to 2.3×10^6 . Culled wild boar increased from 0.1×10^6 to 1.2×10^6 . Hare culls

decreased considerably from 3.2×10^6 to 0.5×10^6 and the investigated game birds dropped from 5.2×10^6 to 2.8×10^6 . Hunting bags of the investigated predators, however, increased from 0.3×10^6 to 1.1×10^6 .

Biomass of the hunting bags was calculated by multiplying the hunting bag numbers with an average weight of the given species. The substantial increase of culled biomass from 56,000 tons in 1970 to 156,000 tons in 2014 is shown in Fig. 5. This increase is due to the increment in ruminants (from 30,000 tons to 72,000 tons) and wild boar (from 6,000 tons to 72,000 tons). Biomass of hare bags dropped from 13,000 tons in 1970 to 2,000 tons in 2014. Game birds and predators play only a minor role in the biomass changes.

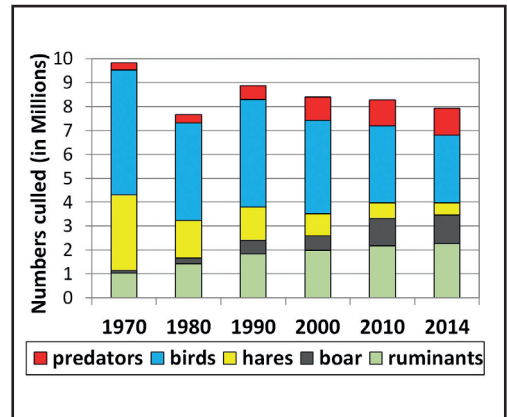


Fig. 4 Composition of hunting bag numbers (total of all 9 countries) in millions

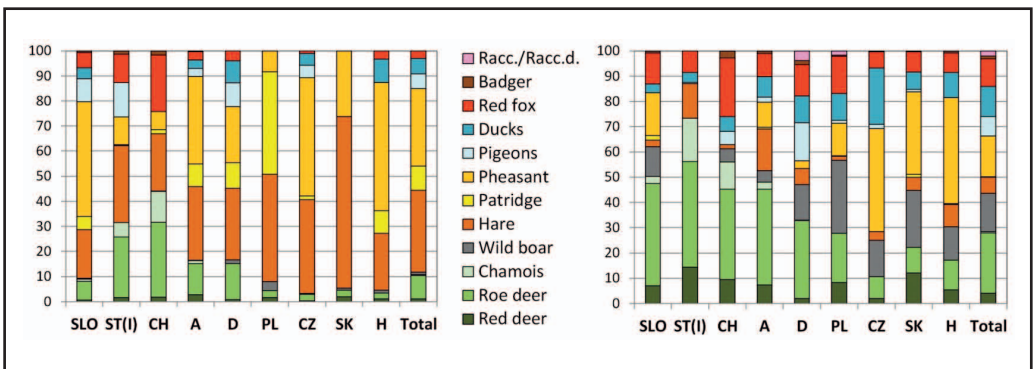


Fig. 3 Country related composition of hunting bag numbers (in %) in the year 1970 (left) and 2014 (right)

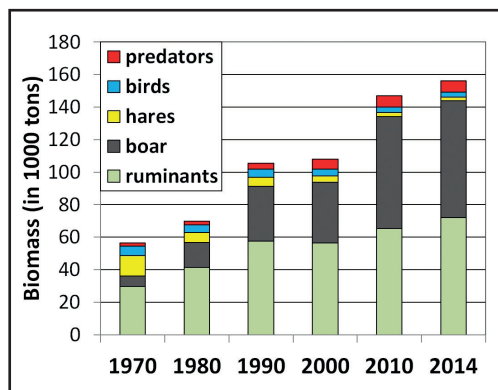


Fig. 5 Composition of culled biomass (total of all 9 countries) in 1000 tons

Synopsis of population trends

All ungulate species increased after 1970 in all investigated countries. Roe deer increases particularly in the eastern countries. Wild boar shows dramatic increase in all countries independent of the differing habitat and management practice. Chamois populations increased in the Alpine countries until 1990, but then began to decrease in some countries, particularly in the main chamois countries Austria and Switzerland. The moose population in Poland is increasing, yet cull numbers decreased due to protection.

Large predators are mostly stable or increasing. Only in Slovakia and Slovenia wolf and brown bear are regularly hunted at present. In the other countries the small numbers of wolf, bear and lynx are non-hunted and protected. However, poaching can be a problem. Medium sized predators such as red fox, badger, raccoon dog and raccoon are increasing. Similar to the ungulates they are the winners in the man-made landscape of Central Europe. Probably this will also remain so in the future, particularly if they live increasingly in urban areas where hunting is forbidden.

The small-game species partridge, pheasant, brown hare are the main losers depending on habitat changes in agriculture and increasing populations of predators (mammals and birds). Small-game species such as pigeons and ducks are more or less stable. Populations of other bird species are increasing in many regions (e.g. geese, crows).

5. Discussion

Do hunting bag trends reflect population trends?

The interpretation of culling data regarding population trends and the productivity of the species is uncertain. Hunting bags do not always reflect population trends correctly. Hunting bag numbers are often self-reported, by hunters, which may make them subject to potential biases. One problem is the potential for over-reporting to fulfil official shooting plans (e.g. for ungulate species, particularly females without trophies), another one is the fact that self-reporting may be used for management and regulation of hunters behaviour. This can cause them to provide untruthful strategic answers for many different reasons. Depending on design of regulation, this can complicate the use of bag rates for population estimates considerably. When dealing with abundant game species, the reporting is quite high, but when the game species is declining, hunters may be afraid of imparting their hunting bag numbers just because they don't want to give clues to restrict their hunting activities. And if there were e.g. a tax on hunting bag, they would systematically underreport even if mandatory (cf. Research-Gate discussion: https://www.researchgate.net/post/Do_you_think_that_catch_hunting_bag_reflects_population_numbers_correctly2).

Most likely hunting bag numbers can be a good basis for the assessment of development trends of wildlife populations, if a systematic, centrally organized documentation of culling data is available in long time series and uniform for large, population-based spaces. A precondition is that the accuracy of the data documentation and the rules and interest for the hunting of the species concerned did not significantly change during the period of the comparison.

Through the large-scale aggregation and long-term comparison of the available data at least basic trends of game population densities in Central Europe should be noticeable from their culling rates, since sustainable culling requires a minimum population size and accordingly minimum growth rate. This applies mainly for increasing culling rates. However if a game species becomes unattractive for hunters or is under protection population size trends are

not necessarily conform with declining culling rates (REIMOSER et al. 2014).

Small game species such as hare, pheasant and partridge are rarely subject to governmental shooting plans and are generally not hunted selectively. The culling rate normally complies with the annual increment of population growth in autumn. Therefore culling rates of these species show population trends directly, in contrast to ungulate species that underlie a required shooting plan. Typical for small game species are strong annual fluctuations in population size and culling rates during autumn hunts since weather conditions in spring have a crucial impact on upbringing of offspring. However, in some countries also annual releases of raised animals have deciding influence on hunting bags.

The hunting behaviour towards the wildlife species as well as the documentation mode should be constant, so that no bias for the development trend arises; changes have to be considered when interpreting the hunting bag trends. The authors can assess this largely for Austria, for the other countries only partly.

Do population trends reflect habitat changes?

This contribution should be understood as a synoptic approach to assess the whole effect of environment changes on wildlife. Not the single habitat factors, but the end result of all factors in their balance is in the foreground (REIMOSER 1987, REIMOSER et al. 2006).

Excluding misinterpretations of trends, wildlife species can indicate habitat changes in a holistic way. Kamieniarz and Panek (2008) described the complexity of interactions for instance as follows: *“An increase in numbers was observed in the case of large mammals. It was connected with the continued introduction and development of newly-established populations (fallow deer, mouflon), stopping the cull aimed at reduction in their numbers which was periodically carried out in the past (moose, red deer), or in general with the moderate intensity of hunting exploitation (roe deer, wild boar). Another important factor was an advantageous environmental situation, caused, among others,*

by the modification of crop structure in the agricultural land which resulted in an increased abundance of food and periodical availability of hiding places in the crop fields”.

Changes in the species – individuals – relation

In the long-term in many regions of Central Europe increasing population growths in single game species and simultaneously a loss of diversity of species able to be hunted is observable (e.g. REIMOSER 1987). This can be seen as an indicator for a progressively more unstable ecosystem “landscape”, with many environmental changes, but also as a change in the human society with an increasing influence of anti-hunting interest groups. Fact is that more and more species are turning into “problem species”, on the one hand through regionally becoming extinct, on the other hand by partially causing serious damage both for humans and habitats.

In this context it should be mentioned that multi-causal problems such as the issue forestry versus ungulates arising from the increasing damage to forest trees, cannot alone be explained by excessive gamekeeping (supplementary feeding, etc.) of the concerned species. The problem also has its roots in measures of forestry, agriculture, tourism and the whole ecological field (REIMOSER 2003).

Main problems in wildlife management and management needs

Typical for Central Europe is an intensive multiple use of landscapes by settlements, traffic infrastructure, agriculture, forestry, hunting, nature conservation and tourism. A sustainable integration of wildlife animals without serious problems for land-users or/and the species concerned is difficult in such habitats (APOLLONIO et al. 2010, FORSTNER et al. 2006, REIMOSER et al. 2013). Following problems were mentioned by experts of the countries (examples).

Related to ungulates: game damage to forest and agriculture; shy game, caused by high hunting pressure, recreation activists and tourism; culling goal not fulfilled; monitoring of populations and impact on vegetation; traffic

kills, barriers by roads; diseases as tuberculosis and epidemic swine fever (some countries); economical marketing of venison; small hunting districts (some countries); hostilities between interests (hunting-forest-tourism-conservation).

Related to small game: intensification of agriculture crop protection and pest control, loss of plant biodiversity; silage production, meadows mown 4–6 times yearly; more rapeseed, maize, wheat crops, less potatoes, root crops; fertilizer; mechanization of agriculture, small mosaics changed into large homogenous plots; land consolidation, removal of structures such as hedges, rock piles, lynchets; loss of fallow lands; road traffic; predators; diseases.

Related to predators: wolf, brown bear, lynx (problem is increasing as well as decreasing populations – various by region and viewpoint of interest groups); invasive species; diseases.

Following research and management needs were mentioned by experts of the countries (particularly related to ungulates): research on interaction plants-herbivores-predators; research on population dynamics; research on developing „game-friendly“ forests with less predisposition to game damage; evaluation of hunting as a factor of national economy; better marketing of venison; socio-cultural integration of hunting; cultivation of hunting customs; standardized statistics of hunting bags on European level; more flexible and adaptive hunting strategies; ungulate culling on basis of browsing and peeling intensity instead of only animal counts.

A main consequence is species protection and game damage avoidance by large-scale habitat management. That means particularly: (i) areas with little disturbance of game, (i) connections of habitat, corridors, (iii) better cooperation agriculture-forestry-hunting-conservation, and (iv) better cooperation with recreation activists/tourists.

An instrument to coordinate and co-operate the different interests in the intensely multiple-used landscape of Central Europe on large-scales is the so-called WESP which means “Wildlife Ecological Spatial Planning”. Up to now WESP is used successfully in a few countries (for instance parts of Austria and Switzerland). WESP is developed interactively with the local inter-

est groups and focuses on population areas as seen from the wildlife species of interest, often across national borders (REIMOSER 1999).

Altogether ungulate management consists of three main sections: the habitat, the game population, and the tolerance level to game damage. These three sections are strongly interconnected and have to be balanced in a holistic view. Habitat management is done primarily by land owners, foresters, farmers, tourists and hunters too. The direct regulation of game populations is in many countries matter of the hunters. And the tolerance limits are defined above all by land owners and the public administration (REIMOSER 2003).

Summary

Long-term hunting bag trends of 19 wildlife species (species groups) since 1970 in 9 Central European countries were compared. Several species increased significantly, others decreased despite protection measures. Species diversity and the number of yearly culled wildlife were less in 2014 compared to 1970; in contrast the biomass culled increased in the same period.

For the investigated ruminant ungulate species the total culling rates (9 countries) more than doubled from 1 million in 1970 to 2.3 million in 2014, whereas wild boar culling multiplied 11 times from 0.1 to 1.2 million. Altogether the total ungulate culling tripled from about 1.1 to 3.5 million. Culling rates of hares decreased markedly from 3.2 million in 1970 to 0.5 million in 2014. Also culling numbers of game birds decreased from 5.2 to 2.8 million. Culling numbers of predators increased in the same period from 0.3 to 1.1 million.

Related to all investigated wildlife species the total hunting bag of the Central European study area decreased from 9.8 million (1970) to 7.9 million animals (2014). The biomass of the total hunting bag, however, increased from about 56.000 tons (1970) to 156.000 tons (2014). Biomass of culled ruminants increased from 30,000 tons in 1970 to 72,000 tons in 2014. Biomass of culled wild boar increased dramatically from 6,000 to 72,000 tons. Biomass of culled hares decreased from 13,000 to 2,000 tons, and of game birds from 6,000 to 3,000 tons. In the

same period the biomass of culled predators increased from 2,000 to 7,000 tons.

Causes of hunting bag changes and management requirements are discussed. Wildlife Ecological Spatial Planning (WESP) is an instrument that can be applied successfully to integrate wildlife into comprehensive land management, both nationally as well as across national borders.

Zusammenfassung

Langfristige Trends von Jagdstrecken und Wildtierpopulationen in Mitteleuropa

Veränderungen der Jagdstrecke von 19 Wildarten (-gruppen) seit 1970 in neun mitteleuropäischen Ländern wurden verglichen. Mehrere Arten zeigten eine starke Zunahme, während andere Arten trotz jagdlicher Schonung und Hege rückläufig sind. Insgesamt waren Artenvielfalt und Anzahl des jährlich erlegten Wildes 2014 geringer als 1970, die jährlich entnommene Biomasse des erlegten Wildes stieg hingegen bis 2014 stark an.

Die Strecke der untersuchten wiederkauenden Huftierarten hat sich in Mitteleuropa (9 Länder) von 1970 bis 2014 mehr als verdoppelt (von 1 auf 2,3 Millionen Stück). Bei Wildschweinen stieg die Jagdstrecke im selben Zeitraum um das 11-fache an (von 0,1 auf 1,2 Mio.). Insgesamt (alle untersuchten Huftierarten) verdreifachte sich die Strecke von 1,1 Millionen (1970) auf 3,5 Millionen Stück (2014). Die Jagdstrecke von Hasen nahm im selben Zeitraum von 3,2 auf 0,5 Mio. Stück ab, jene von Federwild von 5,2 auf 2,8 Mio. Die Raubwildstrecke stieg im gleichen Zeitraum von 0,3 auf 1,1 Mio. Stück an.

Bezogen auf alle untersuchten Wildtierarten verminderte sich die Gesamtstrecke im mitteleuropäischen Untersuchungsgebiet von 9,8 Mio. Stück (1970) auf 7,9 Mio. Stück (2014). Die Biomasse der Gesamtstrecke stieg hingegen von rund 56.000 Tonnen (1970) auf 156.000 Tonnen (2014) an. Die Biomasse des erlegten wiederkäuenden Schalenwildes nahm von 30.000 auf 72.000 Tonnen zu, jene der Wildschweine von 6.000 auf 72.000 Tonnen. Die Biomasse von Hasen nahm hingegen von 13.000 auf 2.000 Tonnen ab, und jene des Federwildes von 6.000 auf 3.000 Tonnen. In der-

selben Periode nahm die Biomasse von erlegtem Raubwild von 2.000 auf 7.000 Tonnen zu. Ursachen der Jagdstreckenveränderungen und Konsequenzen für das Wildtiermanagement werden diskutiert. Das Management von Wildtieren könnte durch das Instrument der Wildökologische Raumplanung (WESP) besser in ein umfassendes Landnutzungsmanagement integriert werden, um dadurch Schäden an Wildtieren und durch Wildtiere zu vermeiden, sowohl national als auch über nationale Grenzen.

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