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Tourism, mountain huts and distribution of corvids in the Bavarian Alps, Germany

Ilse Storch & Christian Leidenberger

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Anthropogenic resources related to recreational activities and tourism infrastructure may greatly affect wildlife species in the Alps. In this paper, we explore the effects of mountain tourism in the Bavarian Alps, Germany, on the spatio-temporal distribution of corvids in the post-fledging period in summer and autumn. We contrast corvid point-counts in the surroundings of 28 popular mountain huts (hut areas) with those in 22 similar areas rarely visited by humans (control areas). Carrion crows *Corvus corone* and magpies *Pica pica* were exclusively observed at huts, and jays *Garrulus glandarius* occurred in more hut areas than in controls. Alpine choughs *Pyrrhocorax graculus*, jays and nutcrackers *Nucifraga caryocatactes* were more numerous at huts than in control areas. Ravens *Corvus corax* were equally common, but like Alpine choughs, they spent more time foraging in hut than in control areas. Multivariate analyses confirmed that corvid incidence was significantly related to tourist use. However, corvids visited huts regardless of the actual numbers of humans present. Our results suggest that corvids opportunistically adjust their range use to the availability of resources offered by tourism. Mountain huts and other places frequented by humans may thus contribute to an increased carrying capacity for corvids at higher elevations. This may have major ramifications for other species that corvids prey upon or compete with. Mountain tourism in the Alps may thus conflict with conservation efforts for threatened species such as grouse (Tetraonidae).

Key words: abundance, Bavarian Alps, corvids, distribution, tourism

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In the Bavarian Alps, Germany, centuries of pasturing around the tree line have greatly extended the open subalpine habitats, which are also highly attractive to humans. Day-trip visitors, weekenders and people on holiday frequent the region for hiking, skiing, mountain biking, hang-gliding and similar activities, and most aim for the higher elevations. Numerous mountain inns, cable car stations and Alpine Club (DAV) huts cater to these tourists. At elevations of ≥1,000 m a.s.l., about 140 publicly accessible huts with restaurant and accommodation for hikers account for a density of one tourist hut per 32 km^2. The 63 DAV huts alone account for a total of 150,000 overnight guests and > 400,000 daytime visitors per year (A. Herrlich, DAV, pers. comm.). In weekends, several hundred people may be counted simultaneously at the most popular huts.

Tourists, and the huts they use, offer attractive resources to some Alpine wildlife species. Marmots *Marmota marmota* and badgers *Meles meles* have dens underneath huts, cliff-nesting black redstarts *Phoenicurus ochruros* and Alpine choughs *Pyrrhocorax graculus* make use of buildings for their nests, and red foxes *Vulpes vulpes*

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search tourist stations for food remains (I. Storch, pers. obs.). Alpine choughs (Delestrade 1995b), and locally also ravens *Corvus corax* (I. Storch, pers. obs.), regularly visit popular hiker resting places and readily take picnic remains and handouts. Carrion crows *Corvus corone* and magpies *Pica pica*, species primarily inhabiting the open, rural landscape of the lowlands and valleys in the Bavarian Alps (Bezzel & Lechner 1978, Bezzel 1993), are increasingly observed around tourist stations (A. Zeitler, pers. comm.; I. Storch, pers. obs.).

Such observations suggest that tourist activities and infrastructure in the Alps may significantly influence the distribution and carrying capacity of mobile, generalist feeders, such as red foxes and corvids. If true, this may have major ramifications for the relationships between these and other species. In Scotland, human-induced increases in the density of carrion crows in alpine habitats in parallel to the development of tourist stations have been well documented (Watson 1979, 1996). Crow predation on ptarmigan eggs and chicks resulted in the extinction of the local ptarmigan *Lagopus mutus* populations near tourist stations, reduced ptarmigan breeding success several kilometres from a station, and dampened ptarmigan population cycles in the wider surroundings (Moss & Watson 2001; A. Watson & R. Moss, unpubl. data).

The objective of our study was to explore some of the effects of tourist stations on the spatio-temporal distribution of generalist feeders in the Bavarian Alps in summer and autumn. We chose corvids because they are easy to observe. We contrast two extremes, the immediate surroundings of popular mountain huts with numerous daytime and overnight visitors, and similar areas rarely visited by humans. We expected to find more corvids in hut than in control areas, and assessed the frequency, species composition, behaviour, circadian patterns and seasonal distribution of corvids in relation to hut locations and visitor numbers. Based on our findings, we discuss potential consequences of tourist stations for the conservation of threatened species such as grouse (Tetraonidae).

Material and methods

Study areas

The Bavarian Alps are the German, northernmost part of the Alps and spread over 5,000 km^2 along the Austrian border. The peaks reach elevations of 1,000-3,000 m a.s.l.; the valleys at 600-1,000 m elevation are densely populated and used for dairy farming. The climate in the Bavarian Alps is wet and temperate, with cool summers and snow-rich winters. Mean annual temperatures range between 5°C at 1,000 m and -5°C at 3,000 m elevation. Annual precipitation varies between 1,500 and 2,500 mm. Due to local differences with more precipitation in the northernmost ranges and the west, however, variation is not strictly altitudinal. Montane and subalpine mixed and coniferous forests cover major parts of the slopes. Above the tree line, i.e. between 1,300 and 1,800 m a.s.l., grasslands intermixed with patches of dwarf pine *Pinus mugo* and rocks and gravel prevail. Summer pastures for cattle are typical around the tree line. Most pastures have one or several huts traditionally used by cattle herders. Today, many of these huts are used as private holiday and weekend homes, and some have been developed into tourist restaurants or hostels. In addition, outdoor-oriented tourist organisations such as the German Alpine Club (DAV) and the Naturfreunde maintain huts that are frequented by daytime visitors and overnight guests, and numerous cable car stations operate mountain restaurants. We obtained information on tourist huts and their distribution from the DAV and the Naturfreunde, and from 1:50,000 hiking maps.

The corvid species in the Bavarian Alps are alpine chough, raven, carrion crow, jay *Garrulus glandarius*, nutcracker *Nucifraga caryocatactes*, and magpie. No hunting of corvids takes place in the Bavarian Alps.

Our study included 50 areas that are situated at elevations of 1,300-2,000 m a.s.l. and randomly distributed over the entire German part of the Alps from Oberallgäu in the west (10°24'E, 47°25'N) to Berchtesgaden National Park (13°02'E, 47°32'N) in the east. We selected 28 areas with Alpine Club huts, cable car stations, or other mountain inns that were intensively frequented by tourists ('hut areas'). All catered to day visitors, and most also offered overnight accommodation for hikers. All hut areas were in more or less open surroundings dominated by pastures or alpine grassland with moderate slopes. At all huts, anthropogenic food was accessible to wild animals, such as corvids and red foxes. Most regularly available was food dropped at outdoor restaurant terraces and picnic sites. Kitchen garbage and food remains from restaurants were generally kept in closed, inaccessible containers, which were transported into the valley for disposal. Compost heaps were accessible at eight of the 28 huts.

As controls, we selected 22 areas that were similar to the hut areas in orography and landscape features, but were ≥ 1 km from tourist huts, cable cars and frequented hiking trails. Most were in pastures and alpine grasslands. Many control areas had mountain huts, however, these were no longer in use or only sporadically used by cattle keepers or hunters. All control areas had

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trails nearby, however, these were used by few (< 1 per day) hikers only.

Data collection

We conducted field work between 27 June and 30 October 1999. By late June to early July, almost all juveniles of all corvid species occurring in the Bavarian Alps will have fledged (see Wüst 1986), and thus, the mobility of corvids during our study was not restricted by the location of nest sites. We alternated observations between hut and control areas as logistics allowed. In each study area, we selected an observation site that offered good overview. In hut areas, sites were selected within 100 m of a building. For each study area, we noted mean steepness of slope (°), aspect and elevation, and measured the size (in km^2) of the unforested area surrounding the observation site based on 1:50,000 topographical maps.

In nine hut areas and 19 control areas, we spent one observation day, and in 19 hut areas and three control areas, two observation days. Because all repeated observations were separated by at least six weeks, we treated them as independent. Each observation started at dusk and ended at dawn. In most cases, 'observation days' spread over two successive calendar days from noon to noon. Observation days were divided into 15-minute intervals (Central European Summer Time; 5:00, 5:15, 5:30.....). We documented the numbers, species and behaviours of all corvids seen per interval within a 100-m radius plot around the observation site, using 10 × 40 binoculars. Individuals that repeatedly entered the plot within an interval were registered once. We distinguished the behavioural categories flight (to fly over or circle) and foraging (any behaviour directly related to food intake), and all other behaviours (resting, comfort, social) were pooled into the category resting. Parallel to corvid observations, we documented the numbers of humans (excluding the observer), air temperature, cloud cover (%), and rainfall in the categories light, moderate and heavy.

Data analysis

We used the standard statistics t-test, Mann-Whitney U-test, Wilcoxon test, likelihood-ratio χ^2-test and Pearson's correlation coefficient to compare hut and control areas with regard to environmental variables, and to assess differences in the occurrence of corvids between hut and control areas and with regard to time of day, season and visitor numbers. Corvid counts did not show major autocorrelation effects (mean adjusted $r^2 < 0.16$ for all individual species and for species pooled) between consecutive 15-minute intervals. To assess circadian patterns in corvid presence, data were expressed per full hour, e.g. observations made between 09:00 and 09:59 were aggregated into hour 9. To correct for inflation of significance due to multiple testing, we used sequential Bonferroni-Holm adjustment of significance levels to reject null hypotheses (Holm 1979).

To assess multivariate influences on chough and raven incidence, respectively, we used logistic regression analysis. Dependent variable was the presence (1; ≥1 individual within the 100-m radius observation plot) or absence (0) of coughs or ravens, respectively, per 15-minute interval. Data from > 95% of the observation units (study site x date) showed no autocorrelation effects ($r^2 < 0.1$, $P > 0.05$). For choughs, incidence data from one ($r^2 = 0.39$) and for ravens, from two ($r^2 = 0.37, 0.34$) observation days showed significant ($P < 0.05$) autocorrelations exceeding $r^2 = 0.3$, and were therefore excluded from the analysis. Explanatory variables included elevation, size of unforested area (km^2), tourist use (hut vs control area), number of humans present (ln N), availability of compost heaps (yes vs no), cloud cover (%), time of day (hour; categorical), and month (categorical). Because all documented weather factors (temperature, cloud cover, precipitation) were closely correlated, we only used cloud cover in the analyses. For the variable month, we pooled the three observation days in late June with the July data. Because we found no indication that steepness of slope and aspect influenced the results, we excluded these variables from the logistic regression. Variables were selected by likelihood-ratio backward elimination using SPSS 10.0 (SPSS Inc. 1999).

Results

During a total of 3,957 15-minute intervals (2,658 in hut and 1,299 in control areas) on 89 observation days between 27 June and 30 October 1999, we counted 3,285 corvids and 46,742 human visitors (Table 1). We noted only three humans in control areas. Numbers at huts averaged 17.6 persons per 15-minute interval; the maximum number of people simultaneously counted were 500. Hut and control areas were similar in elevations (1,598 ± 161 m (SD) vs 1,637 ± 187 m; t-test, $P = 0.56$), and hut and control observations were made under similar weather conditions (cloud cover 62.5 ± 38.1% vs 60.5 ± 38.5%; t-test: $P = 0.50$), but hut areas tended to have larger unforested surroundings than controls (0.15-70 km^2, median 5 km^2 vs 0.08-30 km^2, median 1.5 km^2; U-test: $P = 0.10$).

The frequency of corvid observations was related to elevation. Alpine choughs (1,785 ± 166 m) and raven

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Table 1. Frequency of corvids and human visitors during 3,957 15-minute intervals on 89 days between 27 June and 30 October, 1999, in 28 study areas with (hut areas) and 22 without (control areas) tourist mountain huts in the Bavarian Alps, Germany.

Species	Corvid observations (N) 15-min intervals	Corvid observations (N) Individuals x 15-min	Group size (N) Range	Group size (N) Mean	Behaviour (%) Flight	Behaviour (%) Forage	Behaviour (%) Other	Observed in % study areas Huts N = 28	Observed in % study areas Controls N = 22	Individuals/15 minutes (mean) Huts N = 2568	Individuals/15 minutes (mean) Controls N = 1299
Alpine chough	201	2611	1-100	13.0	13	25	62	57	32	0.869[a]	0.232[a]
Raven	312	479	1-8	1.5	72	11	17	86	86	0.122	0.119
Carrion crow	33	48	1-3	1.5	73	6	21	25*	0*	0.018[a]	0[a]
Magpie	15	19	1-3	1.3	52	6	42	18*	0*	0.007[a]	0[a]
Jay	24	38	1-4	1.6	63	16	21	32*	5*	0.014[a]	0.001[a]
Nutcracker	41	90	1-6	2.2	48	40	12	21	9	0.031[a]	0.007[a]
Humans	2255	46742									

* species observed in significantly ($P < 0.05$) more hut than control areas (χ^2-test, Bonferroni-Holm correction for multiple testing).

[a] species significantly ($P < 0.05$) more numerous in hut than in control areas (Mann-Whitney U-tests, Bonferroni-Holm correction for multiple testing).

(1,630 ± 175 m) were observed at higher, and carrion crows (1,498 ± 165 m) magpie (1,557 ± 270 m), jay (1,448 ± 136 m), and nutcracker (1,536 ± 96 m) at lower than mean (1,605 m; all study areas) elevations (t-tests: all $P < 0.05$). Because hut areas and control areas did not differ significantly in elevation, species-specific elevational distributions, however, will not bias the study's results.

Hut and control areas

Carrion crows, magpies and jays were present in significantly more hut than control areas, and all corvid species, except ravens, were more numerous near huts (see Table 1). Carrion crows or magpies were seen in 32% of hut areas, but in no control areas. Ravens were present in most (86%) hut and control areas alike, and we also counted the same numbers of ravens (U-test, $P = 0.97$) per observation interval. Group sizes of choughs (13.4 ± 19.8 vs 10.8 ± 8.4; U-test: $P = 0.19$) and ravens (1.57 ± 0.85 vs 1.46 ± 0.6; $P = 0.36$) did not differ between hut and control areas.

Corvids visited huts regardless of actual visitor numbers. In hut areas, the number of corvids observed was not related to the number of humans present per 15-minute interval. This held for each single species and for all corvids pooled (Pearson's r: all $r < 0.1$). Also, corvids were no more numerous at the busier huts, as there was no correlation between the mean numbers of visitors and corvids per hut ($r = 0.22$; $P = 0.26$). Accessible compost heaps in the hut areas (N = 8 of 28 huts) did not increase the number of corvid individuals of any species counted per interval (U-tests: all $P > 0.7$), nor the number of corvid species present (U-test: $P = 0.94$).

Circadian patterns

In both control and hut areas, corvids were seen throughout the daylight period. Ravens and choughs were common enough to allow a closer inspection of circadian patterns (Fig. 1). Per observation interval, ravens were equally common in control and hut areas (Mann-Whitney U-test: $P = 0.68$), and there were no temporal differences in their presence (Wilcoxon: $P = 0.78$). In control areas, most choughs were present in the early morning before

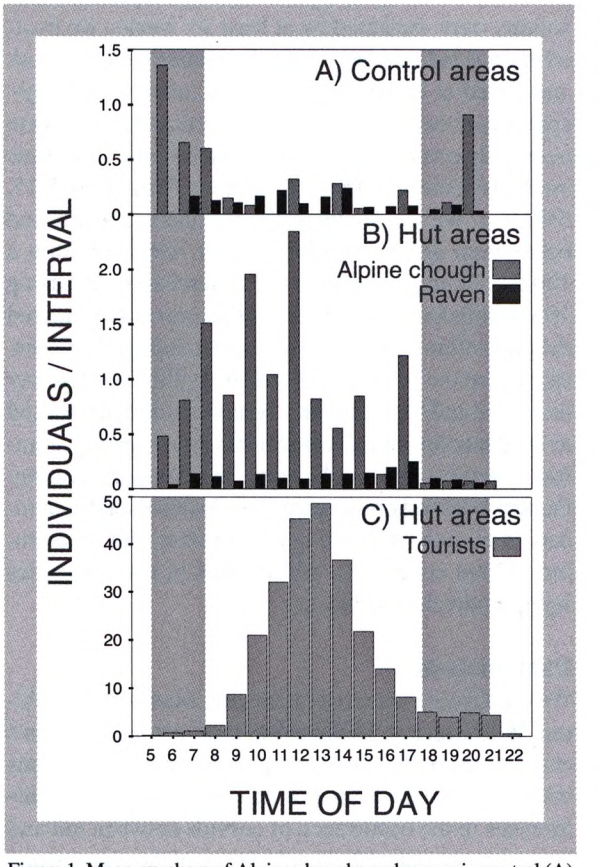


Figure 1. Mean numbers of Alpine choughs and ravens in control (A) and hut areas (B) and of humans in hut areas (C), per 15-minute interval during the daylight hours. Data were aggregated per full hour, e.g. 5 = 05:00-05:59 Central European Summer Time. Shading indicates the earliest and latest times of sunrise and sunset during the observation period 27 June - 30 October 1999.

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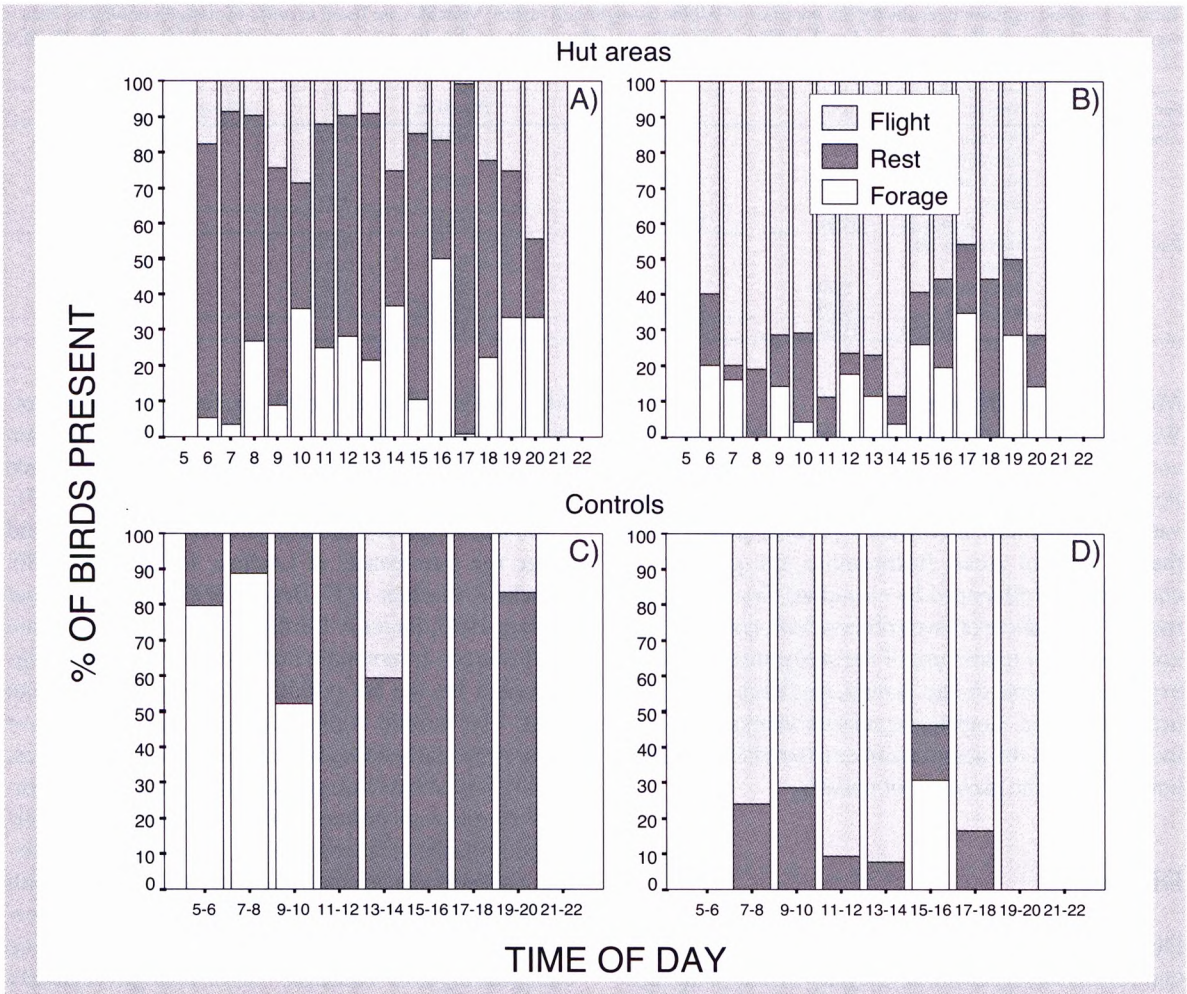


Figure 2. Frequencies of the behavioural categories flight, rest and forage among Alpine choughs (A, C) and ravens (B, D) observed in hut (A, B) and control (C, D) areas in relation to time of day. Data were aggregated per full hour, e.g. 5 = 05:00-05:59 Central European Summer Time for the observation period 27 June - 30 October 1999.

09:00, and in the evening around 20:00. In hut areas, choughs adjusted their circadian patterns towards prolonged morning presence. Significantly more choughs were present at huts than in control areas between 10:00 and 13:00 (Mann-Whitney U- tests: all $P < 0.0035$), and the daily peak in chough presence at midday coincided with the lunchtime of human visitors.

In hut areas, both ravens and choughs spread their foraging activities over much of the day, whereas in control areas, they fed during relatively narrow time periods in the afternoon (raven) and morning (chough; Fig. 2). Ravens that visited hut areas spent a larger proportion of their time foraging than birds that visited control areas (15 vs 3%; χ^2: df = 1, $P < 0.001$). Choughs in hut areas, however, spent less time feeding (22 vs 49%; $P < 0.001$) and more time resting (64 vs 46%; $P < 0.001$) than birds observed in control areas, and the birds regularly perched on and around buildings.

Seasonal patterns

Most corvids were seen in July, whereas most tourists were counted in September. Mean monthly observations of corvids and tourists at huts were not correlated. In both summer (June-August; U-test: $P = 0.028$) and autumn (September-October; U-test: $P < 0.001$), we saw more corvids per interval in hut than in control areas. The raven, however, was an exception among the species. In summer, ravens were less commonly seen in hut than in control areas (0.10 vs 0.15 birds per interval; U-test: $P = 0.017$), and only in autumn, were they more numerous around huts than in control areas (0.17 vs 0.09 birds; $P = 0.012$).

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Table 2. Logistic regression results for the presence of Alpine choughs and ravens. Variables are listed in order of strength of effects. Beta = regression coefficient, Deviance = -2 Log-Likelihood. Significance of resulting models for Alpine choughs (N = 3,919; $\chi^2 = 391.35$, df = 22, $P < 0.001$) and ravens (N = 3,906; $\chi^2 = 76.6$, df = 22, $P < 0.001$).

Species	Variable	Beta	SE	df	Exp (Beta)	P	Change in residual deviance
Alpine chough	Elevation (m)	0.008	0.001	1	1.008	0.000	264.1
	Time of day (hr)			17		0.002	49.2
	Hut vs control	1.460	0.295	1	4.305	0.000	29.4
	Month			4		0.000	23.8
	(constant)	-22.91	27.29		0.401		
Raven	Time of day (hr)			17		0.035	48.6
	Month			4		0.002	15.3
	Elevation (m)	0.001	0.000	1	1.001	0.000	14.3
	Area (km^2)	-0.008	0.003	1	0.992	0.016	6.3
	(constant)	-11.04	30.08		0.714		

Multivariate influences

We calculated logistic regression models for the two most common species, Alpine chough and raven (Table 2). For Alpine choughs, the analysis revealed that observation chances were more than four times greater in hut than in control areas; furthermore, the presence of choughs was influenced by elevation, time of day and month. The chances of raven observations, however, were not affected by tourist use of the study areas, but were explained by time of day, month, elevation and size of unforested area. Logistic regression analyses gave no indication that the actual number of tourists present at huts affected the presence of corvids.

Discussion

Distribution of corvids and mountain tourism

Our results clearly confirm the general notion that corvids in the Bavarian Alps concentrate around popular mountain huts. Alpine choughs, jays and nutcrackers were more numerous, and ravens spent more time foraging in hut than in control areas. Carrion crows and magpies, which are usually restricted to lower elevations in the Bavarian Alps (Bezzel & Lechner 1978), were observed exclusively in hut areas.

Around huts, we saw ravens, Alpine choughs, crows and magpies feeding on anthropogenic food sources. These were scraps at hikers' picnic sites, food dropped at outdoor restaurants, and lunch packs and snacks that people enjoyed sharing with the numerous food-begging Alpine choughs and a few daring ravens. At almost all huts, garbage from restaurant kitchens was inaccessible to animals, and huts that maintained compost heaps did not attract more corvids than others. Thus, the major cause of corvid concentrations was not, as one might think, the huts and garbage from their restaurant operation, but the many hut visitors eating their outdoor meals. Exploitation of food scraps left by mountain tourists is not at all unique to corvids in the Bavarian Alps, and is well documented, e.g. for crows in the Scottish highlands (Watson 1979, 1996, Moss & Watson 2001) and Alpine choughs in both the French (Delestrade 1995b) and Italian Alps (Rolando & Patterson 1993).

Related to species-specific differences in habitat and range use (see Bezzel & Lechner 1978, Wüst 1986, Nitsche & Plachter 1987, Bezzel 1993, Dvorak, Ranner & Berg 1993, Bauer & Berthold 1997), anthropogenic food sources at mountain huts may have different significance for the six corvid species of the Bavarian Alps. The mobile Alpine choughs and ravens have apparently learned that huts are reliable food sources, as they visited huts independent of present visitor numbers. People were present at 65% of all 15-minute intervals outside the huts we studied. Thus, to a corvid, a visit to a hut will almost always be rewarded. At places with greater fluctuations in human presence, however, correlations between the numbers of people and Alpine choughs might be expected. Alpine choughs regularly appear in expectation of food wherever hikers rest and lunch. Locally, individual ravens show similar behaviour (A. Zeitler, pers. comm.; I. Storch, pers. obs.). Observations suggest that the birds patrol extended areas sampling popular lunch places of hikers, and directly react to the presence of resting people. Jays and nutcrackers resident in the adjacent forest may opportunistically forage around huts at the tree line. Crows and magpies were present in one third of the hut areas, but in none of the control areas. The regularity of their presence indicates that the magpies and at least some of the crows at mountain huts are resident birds (A. Zeitler, pers. comm.; I. Storch, pers. obs.). Apparently, huts allow magpies and crows to colonise areas outside their normal range (see Wüst 1986, Dvorak et al. 1993, Bauer & Berthold 1997), as has also been documented in ski hill centres in Finland (J. Jokimäki, unpubl. data.).

Increased carrying capacity?

The concentration of corvids at mountain huts in the Bavarian Alps may not only represent a behavioural (spa-

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tio-temporal pattern of individuals), but also a numerical (population increase) response to anthropogenic resources. Although the distribution of foraging flocks of alpine choughs was significantly influenced by human presence, studies in the French Alps have not revealed any indication of population increases related to tourism (Delestrade 1994, 1995a, b). Nevertheless, numerous other studies have shown that corvid populations have benefited from anthropogenic resources (see Watson 1979, 1996, and references therein). In the Bavarian Alps, tourist stations apparently sustain carrion crows and magpies. Also for the other species, numerical population responses cannot be excluded.

Tourist huts clearly are great attractions for corvids (Rolando & Patterson 1993, Delestrade 1995b, Watson 1996, our study). Their effects, however, may not remain local. Due to the great density of tourist huts in the Bavarian Alps (1 hut/32 km^2, based on 140 publicly accessible huts with accommodation on an area of 4,450 km^2 at elevations of ≥1,000 m), the carrying capacity for corvids and other mobile generalist feeders, such as red foxes, may be increased also at a regional scale, i.e. throughout the Bavarian Alps. To mobile generalist feeders, tourist huts present a tight network of reliable food patches. Numerous lower-elevation inns and the many privately used subalpine and alpine huts further increase the density of this network. In the Scottish highlands, crows sustained by a tourist station reduced the breeding success of ptarmigan over distances of up to 4 km (Moss & Watson 2001; A. Watson & R. Moss, unpubl. data), equivalent to an area of 50 km^2 being affected by crow predation. Based on these figures, not a single part of the Bavarian Alps would remain unaffected by increased corvid densities sustained by anthropogenic resources at mountain huts.

Ecological consequences

Our results suggest that corvids opportunistically adapt their range use to the spatio-temporal availability of resources provided by tourism in the Bavarian Alps. Although intraspecific density-dependent regulation mechanisms may prevent a linear correlation between corvid population density and resource availability (Wüst 1986, Mäck & Jürgens 1999), it appears likely that both individual range use and increased population densities contribute to the observed concentrations of corvids around frequented tourist huts in the subalpine and alpine regions of the Bavarian Alps.

This may have major ramifications for other species. Corvids at mountain huts readily feed on food scraps provided by tourists; however, our observations and those of others (Rolando & Patterson 1993, Delestrade 1995b, Delestrade 1999, Watson 1996) suggest that natural foods still comprise a major part of the diet even in the surroundings of mountain huts. Thus, the concentrations of corvids may affect the populations of species that corvids prey upon or compete with. Negative consequences on rare and threatened species of the subalpine zone such as the black grouse *Tetrao tetrix* (nest and chick predation), the mountain hare *Lepus montanus* (predation on young), and the eagle owl *Bubo bubo* (nest site competition with ravens) appear likely. In Finland, for example, predation on artificial nests was much higher in ski hill centres than in surrounding undisturbed areas (J. Jokimäki, unpubl. data). On the other hand, one may speculate that concentrations of foraging corvids around huts may also lead to a relaxation of their predatory impacts in other parts of their ranges.

In this study, we have explored some aspects of the relationship between hiking tourism and the spatio-temporal distribution of corvids in summer and autumn in the Bavarian Alps. Our observations provided clear proof of corvid concentrations at popular mountain inns, Alpine Club huts, and cable car stations in the subalpine and lower alpine zone of the Bavarian Alps. However, numerous open questions remain that need to be answered before final inferences about ecological implications become possible, and conclusions for conservation can be drawn. Despite the preliminary nature of our research, we advise conservation managers to be aware of the potential effects of increased predation by mobile generalist feeders such as corvids and foxes in the surroundings of mountain huts and other places frequented by humans. As in Scotland (Moss & Watson 2001; A. Watson & R. Moss, unpubl. data; A. Watson, pers. comm.), conservation of unperturbed populations of grouse and other mountain species in the Bavarian Alps may depend on retaining big areas of habitat more than 5 km from any development that supports increased numbers of generalist predators.

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