

Impact of human activity on foraging flocks and populations of the alpine chough *Pyrrhocorax graculus*

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Abstract - The Alpine Chough *Pyrrhocorax graculus* is a social corvid which uses food provided by tourist activities in mountain regions (e.g. at ski stations, refuse dumps, picnic areas). In order to determine the impact of the human food supply on the Alpine Chough, foraging flock size and distribution were studied in a tourist region in the Northern French Alps between 1988 and 1992. Alpine Chough attendance at tourist sites was closely related to human activities. Activity rhythm was influenced by human presence on picnic area in summer. Relations to human activities held at a seasonal scale (such as opening of a ski station) but not at a daily time scale (such as weekend). Long term trends of Alpine Chough populations since intense tourist development at altitude are discussed with regard of flock size counts recorded at a same site before and after intense tourist development.

Introduction

Availability of food is a factor which influences the distribution and abundance of species at a range of spatial and temporal scales. Many bird species forage in human related habitats (Murton and Wright 1968), and food supplied by man (e.g. in refuse dump or cultivated fields) forms a rich clumped food source that has been shown to influence not only bird distribution and flocking behaviour, but also population trends (Dunnet *et al.* 1969, Harris 1970, Feare 1984). In these cases, food supplied by man provides a good opportunity to test adaptation of flocking behaviour to fluctuations of food availability at different temporal scales.

Among birds that typically frequent human related habitats, corvids hold a major place (Feare *et al.* 1974, Dare 1986, Goodwin 1986, Birkhead 1991). The Alpine Chough *Pyrrhocorax graculus*, a gregarious montane corvid, forages naturally on alpine grassland where it feeds on berries and invertebrates (Lovari 1981, Dendaletche and Saint-Lebe 1988, Rolando and Patterson 1993), but uses also human refuse at altitude and frequent different types of man-related sites: i.e. ski stations and their restaurants, refuse dumps, picnic areas, huts (Holyoak 1972, Delestrade 1989, 1991), and towns in Switzerland (Strahm 1961, Voisin 1963). However, although exceptionally familiar to man, it is

a little studied species, and it is particularly uncertain whether Alpine Chough populations have increased since the intense development of tourist activities in mountains.

The aims of this study were (1) to determine whether the Alpine Chough adapted its foraging behaviour to temporal fluctuations of food sources provided by man, on daily and seasonally scales; (2) to assess whether recent tourist development in mountain areas are related to trends in Alpine Chough populations.

Study area and Methods

Alpine Choughs were studied in the Northern French Alps (in Haute-Savoie: massifs Mont Blanc, Aiguilles Rouges, Désert de Platé, Dents Blanches) and its surrounding massifs in the Valais Kanton (Switzerland: Dents du Midi) (ca. 400 Km²). This is a tourist region both in winter and summer, and the Mont Blanc massif is known to receive 400,000 visitors per year. The studied population in this area depends on human activity in winter (for details see Delestrade 1994).

I counted flock sizes at least three times each day. Census error was estimated at 10% by comparison with photographs. Daily activity rhythms of Alpine Choughs were recorded in two winter sites (Monthey (400 m): a town in Valais Kanton, and Flaine (1800

m): a refuse dump in Haute-Savoie depending of a ski station (for details see Delestrade 1993a) and two summer sites in Chamonix valley (Lac Blanc (1350 m): a picnic area, and Col de Balme (2000 m): an alpine grassland). The following variables were noted: time of arrival, number of birds present each hour and time of departure. In summer, at the Lac Blanc, humans (mostly picnickers) were counted, and the proportion of birds flying versus landed was also estimated each hour during a one minute count. In winter, flock sizes of Alpine Chough and human frequentation (number of people using the cable-car) were also daily recorded at Le Tour (ski station, 1500 m).

Lastly, the population of Alpine Choughs wintering at Monthey was Monitored from 1962 to 1965 and from 1990 to 1992 by R. Voisin (Voisin 1963 and unpubl. data). The counts in the same area provided the opportunity to estimate population fluctuations in a town before and after the intense tourist development at altitude, which took place in the Alps between 1965 and 1980.

The flock sizes distribution typically do not fit a normal distribution. The data will thus be presented as Median of flock size.

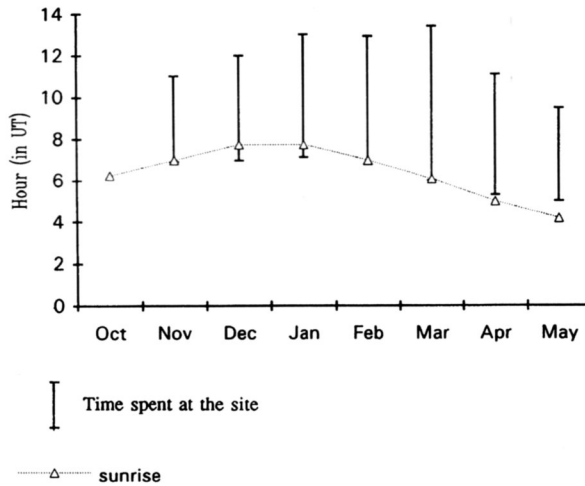
Results

Human effect on activity rhythm

Similar patterns of attendance were observed in winter (Flaine or Monthey, respectively refuse dump or town). Choughs arrived at sunrise time, i.e. immediately after leaving their roost, and stayed on these human-related sites until the beginning of the afternoon (Fig. 1). This pattern was in fact common to all human related sites in the study area (pers. obs.), and in winter Alpine Choughs foraged almost exclusively on human-related sites irrespective of their quality.

In summer, a different pattern occurred: at the Lac Blanc, Choughs and picnickers arrived at the area simultaneously at mid-day (Fig. 2a), but the birds spent little time of the day there. Moreover, when the number of people was at a maximum, Choughs were mainly flying, while when the number of people decreased the proportion of Alpine Choughs that landed increased (Fig. 2a). Thus, all Choughs did not feed on human foodscraps during all their time of presence. Alpine Choughs were in fact heavily disturbed by man, and up to 23% (n = 134) of the birds which landed took flight within 15 seconds without taking any food. Conversely, at the Col de Balme, a natural alpine grassland, foraging Alpine Choughs spent all day without being disturbed (Fig. 2b).

Flaine (a)



Monthey (b)

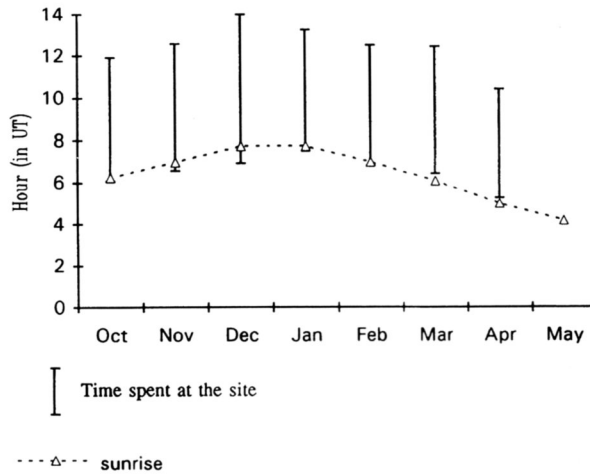


Figure 1 - Daily presence (monthly mean) in winter at Flaine (a) and Monthey (b). Time of sunrise (monthly mean) was also mentioned.

Daily variation in site attendance

Alpine Chough numbers did not change with daily variation of human frequentation (in number) at the ski station Le Tour ($r = -0.02$, $df = 169$, n.s.). Similarly, no difference appeared between flock sizes at the refuse dump (Flaine) on Sunday or Monday (i.e. when no refuse was brought into the site) and on days during the week (Wilcoxon signed rank test: $T = 1.3$, $n = 16$, n.s.). Thus, flock size was not affected by great fluctuations of food availability on a daily time scale.

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Alpine Chough frequented human related sites in winter and in summer, but patterns of attendance during the day were different between these two seasons. Foraging flocks spent more time at sites related to human activity in winter than in summer. Especially, Alpine Chough arrived at those sites immediately after leaving their roost, period during the day when birds search food intensively probably because of great heat loss during the night. In terms of time spend at each place, which could be correlated to quantity of food eaten, site related to human activity seems more interesting for Alpine Chough foraging flocks in winter when natural food was scarce than in summer. Foraging efficiency on human foodscraps seems to be reduced in summer because of human disturbance at picnic areas.

Alpine Choughs formerly stayed at low-altitude sites in winter (like towns, Voisin 1963), but since the development of ski stations in seventy years, this was found to be no longer true the case (Büchel 1983, Delestrade 1994). In the same way since tourist development, change in winter flock distributions induced by the opening of ski stations explained the differences between frequentation of the town before and after tourist season in altitude. Thus, relationships between temporal fluctuations of food availability depending on human activities and Alpine Chough attendance were observed at seasonal and decenny time scale.

But no relationship has been detected between daily attendance of Alpine Chough and daily food availability on human related site. At the contrary, Monaghan (1980) found that flock size of Gulls visiting refuse dumps diminished during weekends. Difference in social structure between these species could explained these different responses to great daily fluctuations of food availability. Social structure of Alpine Choughs seems based on stable flock composition (Delestrade 1993b) which is not the case for Gulls. And social bonds between flock members should limit regulation of the flock size. For example, in Alpine Chough pair bonds are maintained throughout the year (Büchel 1994). Thus, males and females visited sites simultaneously inducing stable sex-ratio in foraging flocks whatever the level of competition at the foraging site (Delestrade 1993a). Because of its social organization, foraging behaviour of the Alpine Chough seems better adapted to exploiting slowly depleting food source (like natural resources: berries or insects) than great temporal variations of food availability such as human-related sites. Counts at Monthey do not reveal long term trends of

Alpine Chough populations in tourist region, but showed that both before and after the development of tourist activities similar flock size were observed in autumn (season when the ski station have no influence because is not yet opened). Foraging efficiency seems reduced by human disturbance (particularly in summer). In the same way, Rolando & Patterson (1993) showed that in summer Alpine Choughs spent only 10% of their foraging time around human activities. These results may partly explain the lack of long term population increase, conversely to many other bird species exploiting food sources provided by man (Harris 1970, Spaans 1971, Kihlman & Larsson 1974, Verbeek 1977). Lastly, it should be noted that no refuse is available during two crucial periods in the annual cycle of the Alpine Chough: in autumn (during the 4 months after fledging) when the massive immature mortality occurs in corvids (Birkhead 1991, Bignal *et al.* 1987, Delestrade in press.), and in spring during the prebreeding period when the female presumably needs increased energy intake for egg formation.

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Résumé - Le chocard à bec jaune *Pyrrhocorax graculus* est un corvidé social qui utilise la nourriture produite par les activités touristiques en montagne (par exemple sur les décharges d'ordures ménagères liées aux stations de ski ou les aires de pique-nique). Afin de déterminer l'impact des ressources alimentaires apportées par l'homme sur le Chocard, la taille des groupes, la recherche de nourriture et la distribution de ces groupes ont été étudiés dans une région touristique des Alpes du Nord (France) au cours des années 1988 - 1992. La fréquentation des sites touristiques par le Chocard était étroitement liée la fréquentation humaine. Cependant, cette relation était vraie à l'échelle de la saison (comme par exemple en fonction de l'ouverture des stations de ski), mais n'existait pas l'échelle du jour (comme par exemple entre les jours de la semaine et le week-end). Le rythme d'activité dans la journée était lié à la présence humaine en été sur les aires de pique-nique, mais le dérangement du à l'homme ne permettait pas une exploitation intensive tout au long de la journée. L'évolution démographique des populations de Chocard depuis l'intense développement des activités touristiques en montagne est discutée au regard des recensements de la taille des groupes fréquentant la ville de Monthey (Suisse) effectués avant et après le fort développement touristique dans cette région.

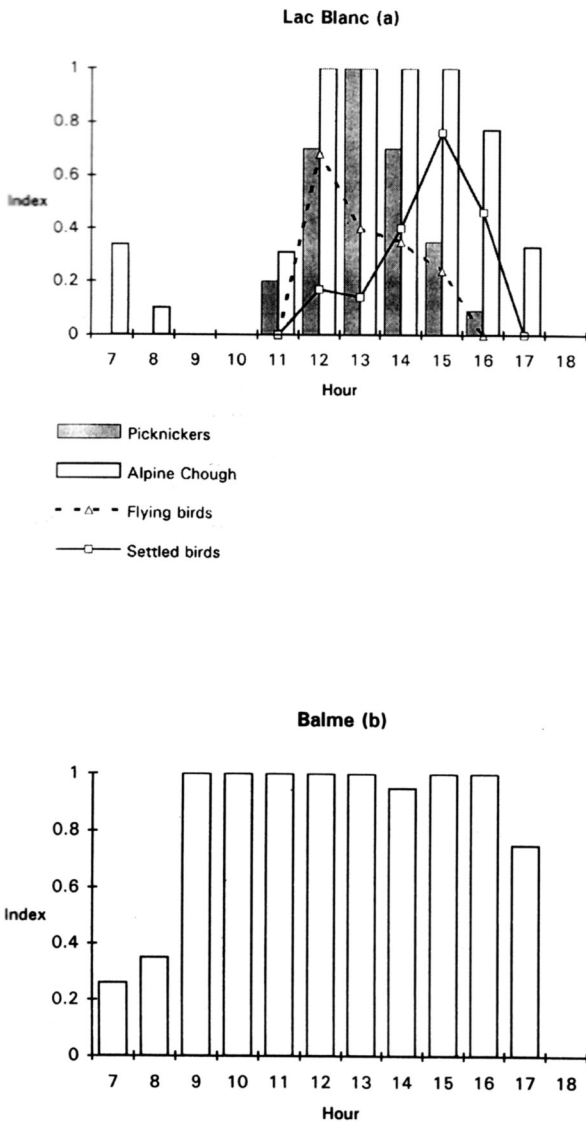


Figure 2 - Daily variations in the number (median value) of Alpine Choughs (total number, flying birds and settled birds) at Lac Blanc (a) (in July and August, n = 10 days) and at Col de Balme (b) (in June, n = 9 days) with reference to human frequentation (n = 14 days). The numbers are given as the ratio of the observed number to the highest number observed during the day.

Seasonal variation in site attendance

A decreasing frequentation at the town of Monthey in January coincided with increasing group size at the refuse dump of Flaine (ski station located 20 Km away): period when the ski station opened (Fig. 3a). Marked birds controlled at Monthey in autumn and resighted at Flaine during winter further confirmed that group displacement between the two site occurred.

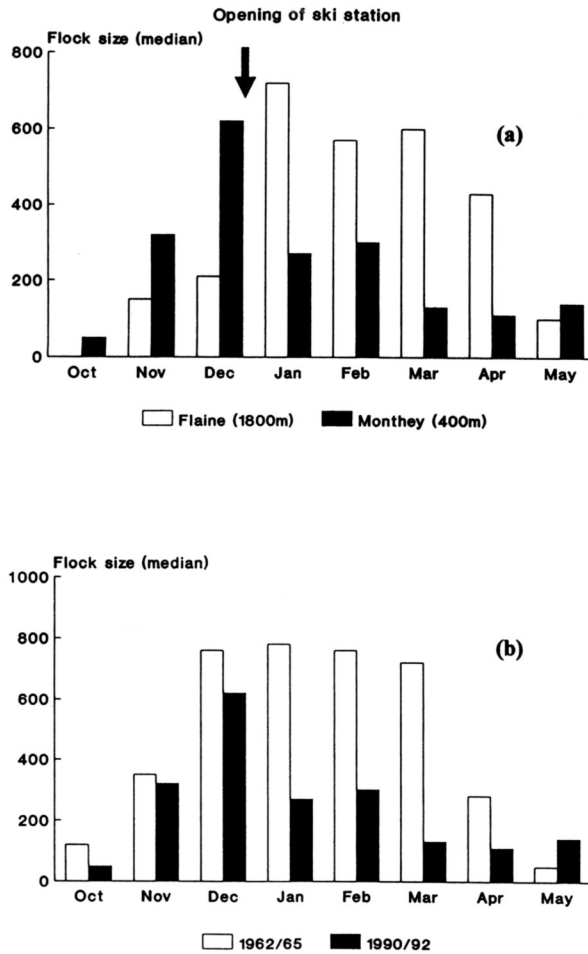


Figure 3 - Monthly flock size (N = median value) (a) at Monthey and Flaine in 1990-92 and (b) at Monthey between 1962-65 and 1990-92.

Long term trends

Monthly flock size at Monthey between 1962-65 and 1990-91 did not differ significantly in autumn (October to December) (T = 0.154, n = 26, n.s.). But in winter (from January to May), monthly flock size was significantly smaller in 1990-91 than 30 years ago (T = 0.553, n = 47, P < 0.01) (Fig. 3b). This presumably resulted from the building of Flaine ski station in 1967, 20 km away, and development of a refuse dump there (see above). Moreover, maximum flock sizes observed at Monthey have not changed appreciably between the two periods (1020 in 1962 and 900 in 1990).

Discussion

The results of this study suggest that tourist developments at altitude modified the spatiotemporal

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