FLIGHT BEHAVIOUR OF THE RED-BACKED HAWK (*BUTEO POLYOSOMA*) DURING SUMMER IN NEVADOS DE CHILLÁN, CHILE

VARIA A. DELLACASA M. [1], RICARDO A. FIGUEROA R. [2], SERGIO A. ALVARADO O. [3,4] AND ROBERTO P. SCHLATTER [5]

[1] *Imperial Street 092, Puerto Varas, Chile.*
[2] *Escuela de Graduados, Facultad de Ciencias Forestales, Universidad Austral de Chile. Valdivia, Chile. ra_figueroa_rojas@yahoo.com*
[3] *Laboratorio de Ecología de Vida Silvestre, Facultad de Ciencias Forestales y Conservación de la Naturaleza, Universidad de Chile. Santiago, Chile.*
[4] *Facultad de Ciencias de la Salud, Universidad de Tarapacá. Arica, Chile.*
[5] *Instituto de Ciencias Marinas y Limnológicas, Facultad de Ciencias, Universidad Austral de Chile. Valdivia, Chile.*

ABSTRACT.— We describe the flight behaviour of the Red-backed Hawk (*Buteo polyosoma*) during summer in Nevados de Chillán, Chile. Flight types most often used were gliding, wind-hovering and soaring (36.7%, 29.4% and 27.8% of the flying time, respectively). Spent time in gliding and wind-hovering peaked at mid-afternoon (17:00–19:00 h). Conversely, soaring was highest between mid-morning (10:00–11:00 h) and mid-day (13:00–14:00 h). Red-backed Hawk individuals appeared to use these flight types in an opportunistically manner using advantageous microclimatic and topographic conditions.

KEY WORDS: Buteo polyosoma, *gliding, hovering, Nevados de Chillán, Red-backed Hawk, soaring.*

RESUMEN. COMPORTAMIENTO DE VUELO DEL AGUILUCHO COMÚN (*BUTEO POLYOSOMA*) DURANTE EL VERANO EN NEVADOS DE CHILLÁN, CHILE.— Describimos los tipos de vuelo del Aguilucho Común (*Buteo polyosoma*) durante el verano en Nevados de Chillán, Chile. Los tipos de vuelo usados más a menudo fueron el vuelo planeado, el vuelo estacionario y el vuelo circular encumbrado (36.7%, 29.4% y 27.8% del tiempo de vuelo total, respectivamente). El tiempo invertido en el vuelo planeado y el vuelo estacionario fue máximo durante la media tarde (17:00–19:00 h). Por el contrario, la cantidad de tiempo invertido en el vuelo circular encumbrado fue mayor entre la media mañana (10:00–11:00 h) y el mediodía (13:00–14:00 h). Los aguiluchos parecieron usar estos tipos de vuelo de una manera oportunista, tomando provecho de las ventajas microclimáticas y las condiciones topográficas.

PALABRAS CLAVE: *Aguilucho Común,* Buteo polyosoma, *Nevados de Chillán, vuelo circular encumbrado, vuelo estacionario, vuelo planeado.*

Received 13 December 2010, corrected version received 5 August 2011, accepted 10 December 2011

Hunting modes of raptors have been dichotomized arbitrarily either as active (aerial-hunting) or passive ("sit-and-wait") searching (Bonney et al. 1981, Jaksic 1985, Jaksic and Carothers 1985). Active searchers may expend much energy in locating and capturing prey, but their chance of encountering prey is high; in contrast, "sit-and-wait" raptors expend minimal energy in pursuit, but they could have fewer opportunities to take suitable prey (Bonney et al. 1981, Greene 1986). Because most raptors have specialized in active searching, they have diversified their flight modes (Videler 2005), hunting with several techniques that vary both in rate of energy expenditure and return (Tarboton 1978, Wakeley 1978, Sarasola and Negro 2005). Understanding how raptors allocate their time in different hunting techniques is important information required to assess behavioural ecology of raptors (Jaksic 1985, Masman et al. 1988).

The Red-backed Hawk (*Buteo polyosoma*) is a South American species inhabiting diverse habitat types in open lands and mountainous terrain (Jiménez 1995). Although conspicuous and common (1–5 individuals can be detected

daily; Jaksic and Jiménez 1986), its basic behaviour is poorly known (Jiménez 1995). Here we describe flight types used by the Red-backed Hawk during summer in Nevados de Chillán, Chile, and discuss their use in relation to the amount of time expended and variations in the daily levels of activity.

We studied the flight types of the Red-backed Hawk in Los Huemules del Niblinto Nature Sanctuary (7000 ha; 36°45'S, 71°30'W; 50 km east of Chillán City). The landscape in the area is rugged, composed of fairly narrow valleys covered of second-growth *Nothofagus* mixed-deciduous forest remnants and high hills (800–2500 masl, 45° slopes) covered by steppe-shrublands. The climate is Mediterranean-temperate with dry, warm (20–30 °C) summers and cold (0–10 °C), wet (rainy and snowy) winters (mean annual precipitation 1000 mm).

Our specific study site (Campamento Base) covered an area of almost 9 km^2 and was characterized by being surrounded by three large hills (1700–2000 masl) permitting the convergence of either north-, south-, west-, and east-facing slopes. Observations were done during 17 non-rainy days from 29 January to 28 February 2004 (austral summer). We searched for hawks in the sky continuously from 08:00 to 21:00 h (except during two days when we only observed them from 08:00 to 14:00 h). Searching for hawks was made from a vantage point by unaided eye and with binoculars (10×50) or spotting scopes (60×) when necessary. Because the rugged topography and very slanted ridges, we placed our vantage point on a lowland site which enable wide visibility over all hill and ridge-slope faces (visibility radius approximately 1 km). At least 2–3 adult and 1–2 juvenile hawks were observed simultaneously. For each individual we measured the time spent in a particular flight type following birds focally (Altmann 1974, Lehner 1996).

We recognized the following flight types: (1) gliding, a flight at variable speed with extended wings and their tips relatively tucked, without wing-flapping and making use of horizontal wind and thermal updrafts, (2) cruising, a horizontal high-speed flapping flight, (3) soaring, a vertical flight in circles on thermal or wind updrafts (>30 m altitude) showing a pronounced forward sweep of the wings and with primary feathers opened, (4) diving, a straight high-speed flight with closed wings, (5) wind-hovering, a stationary flight wherein hawks face into wind updrafts and control their position with wing beats and tail movements, and (6) parachuting, a directed aerial descent at steep angles with upward wings similar to that observed in kites when they strike (for details see Warner 1931, Raspet 1960, Jaksic and Carothers 1985, Videler 2005, Dudley et al. 2007). We did not include perching activity because we were unable to clearly distinguish if hawks really perched on branches when they entered forests or landed on boulders when they disappeared on ridgetops.

For comparisons we divided the daily observation time into 13 one-hour intervals only including those days with complete observations (08:00–21:00 h). Because we observed non-marked hawks, it is probable that most of the time we had measured the same birds and observations could be not independent. Thus, we did not evaluate statistically differences in spent time for each flight type. In addition, since our observations were restricted to only one site and one season, total time we observed hawks flying was reduced (approximately 16 h), and that information represents sex and age classes combined (it was not always possible to distinguish between sexes and ages), the scope of our study could be limited. However, some interesting findings emerge from our observations that are worthy of documenting.

The time we observed hawks flying was 8% of the total effort time (995.91 out of 12180 min). During this time the flight types most often used were gliding (36.7%), soaring (29.4%) and wind-hovering (27.8%). Diving and parachuting accounted for only 1.8% and 1.0% of all the flying time, respectively. Time budgets of gliding, hovering, and soaring differed throughout the day (Fig. 1). Gliding was substantially highest during mid-afternoon (18:00–19:00 h), moderate during mid-morning (10:00–11:00 h) and mid-day (13:00–14:00 h), and markedly low during early-morning (08:00–09:00 h) and late-afternoon (19:00–21:00 h). Wind-hovering strongly peaked between 17:00–19:00 h and was markedly low during remaining intervals. In contrast, soaring was highest between mid-morning and mid-day (11:00–13:00 h) with a moderate peak during early-afternoon (15:00–16:00 h). Over-

all, hawks tended to fly markedly more during mid-afternoon (17:00–19:00 h) and during mid-morning to mid-day (10:00–13:00 h).

Since gliding, soaring, and wind-hovering are commonly used by buteonine hawks (e.g., Pennycuick 1972, Preston 1981, Soltz 1984, Hedenström 1993), is not surprising that these flight modes are also most often used by the Red-backed Hawk. However, we noted that the Red-backed Hawk in our study site soared less, but hovered markedly more than those studied by Jiménez and Jaksic (1991) during summer in Apoquindo, in the Andean foothills near Santiago, Chile. In Apoquindo, soaring flight accounted for >60 % of the activity time, with wind-hovering being negligibly used (<7 % of the activity time). We have not a clear explanation for such differences, but we explore some possible causes. In Niblinto, valleys are deeper and narrower, and hills and ridges are more angled than those from Apoquindo. This would have avoided a lesser loss of wind-currents and solar radiation resulting in a higher production of wind and thermal updrafts (Warner 1931, Finch and Trewartha 1954, Shamoun-Baranes et al. 2003), then resulting in a greater use of wind-hovering. Wind-hovering may require almost 7 times as much energy as perch-hunting and 12–13 times the standard metabolic rate, but it may become less expensive if birds have access to sufficient wind up-currents to sustain their flight (Tarboton 1978, Wakeley 1978). In fact, hawks in Niblinto hovered more during that time of the day when we recorded a higher occurrence of wind-currents (late-afternoon). Even when high level of hovering during late-afternoon could be a response to hunger and a high-cost last-minute attempt to secure prey before nightfall, favourable climate conditions could have maximized use of this flight type.

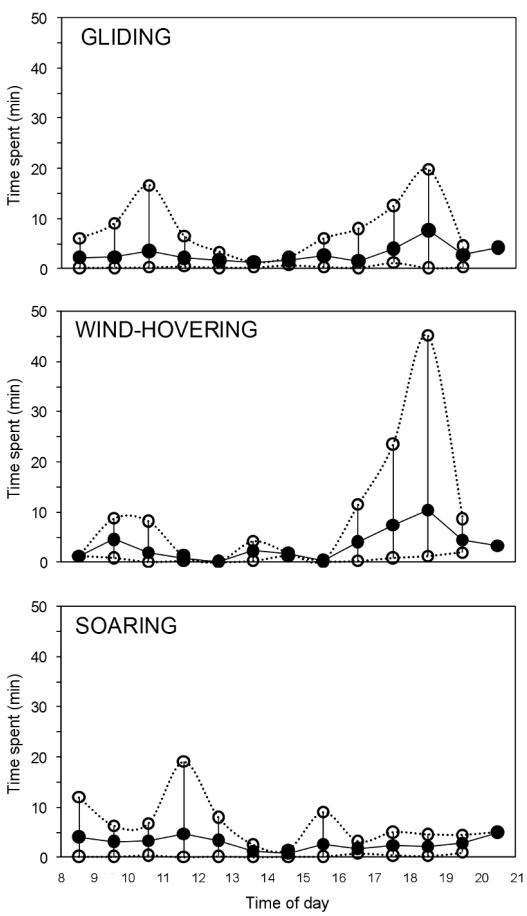

Figure 1. Time spent by the Red-backed Hawk in the three most often used flight modes (gliding, wind-hovering, and soaring) throughout the day in Los Huemules del Niblinto Nature Sanctuary, Nevados de Chillán, Chile. Black and white circles represent the mean and range (max and min values) of the time spent, respectively.

Apart from climate and topography, anatomical features of the Red-backed Hawk could have also facilitated the use of hovering flight. The linearized wing loading calculated for the Red-backed Hawk (0.201) is relatively nearest to those raptors tending to hover such as kites, harriers and eagles (Jaksic and Carothers 1985).The high use of soaring during mid-mornings and early-afternoon in Niblinto was consistent with those day times of higher solar radiation and more wind; i.e., when more vertical convections are produced (Warner 1931, Raspet 1960, Strahler and Strahler 1994). In fact, maximal temperatures in our study site were recorded between 16:00–18:00 h (taken from the Weather Station of the Universidad de Concepción in Chillán), one of the time intervals when hawks soared more.

In contrast to findings of Jiménez and Jaksic (1991), we found that the Red-backed Hawk showed clear peaks of flight activity among times of the day. Because patterns of daily activity associated with environmental conditions have been observed in a number of buteonine hawks (e.g., Bildstein 1987, Sarasola and Negro 2005), the absence of peak flight activity observed in Apoquindo remains puzzling. Jiménez and Jaksic (1991) reported

that the Red-backed Hawk shows seasonal variation in their activity levels, becoming most active in summer and least active during winter. Consistently, Baladrón et al. (2006) found that wintering Red-backed Hawk individuals in a coastal flatland area of Argentina devoted most of the time to perching and concluded that this species is primarily a "sit-and-wait" predator. In Niblinto, at least when hawks were visible, we always observed them searching for prey actively throughout the day. During summer, when hawks are reproductively active, males are not only constrained to provide prey to females and chicks, but also to defend territories (Newton 1979, Soltz 1984, Masman et al. 1988). Seemingly, Red-backed Hawk in Niblinto carried out both activities intensively as suggested by their alternate flight modes.

At present, we do not know if the virtually equitable use of gliding, soaring and hovering, instead of a prevalent use of soaring, had really ecological (e.g., higher hunting success rate) or behavioural (e.g., effective defense of reproductive territories) advantages. Circumstantial evidence suggests that all three types of flight can be used to search for prey (Alvarado and Figueroa 2005). In the particular case of wind-hovering, it is possible that it had conferred vantages for best detecting most desirable prey, such as large rodents (e.g., *Aconaemys fuscus*) or large lizards, which tend to concentrate in open flat areas and moderately inclined slopes on the mountains. Certainly, opportunistic raptors should take profit from all favourable environmental condition to minimize the daily energy expenditure in territory maintenance and exploitation (Rudolph 1982, Masman et al. 1988).

ACKNOWLEDGEMENTS

This paper is a product of the pregraduate veterinary faculty Seminar developed by V. Dellacasa and the Andean Raptor Project financed with private funds. The Frankfurt Zoological Society and the Comité Pro Defensa de la Fauna y la Flora (CODEFF) of Chile gave partial financing throughout the Huemul Deer Conservation Project. We thank Rodrigo López (CODEFF) who provided logistical support and E. Soraya Corales for their hospitality during our work in Chillán. Obtaining field data was made possible by the collaboration of Nuria Torés and Juan Carlos Deveras. We thank to three anonymous reviewers who helped to improve the quality of our manuscript.

LITERATURE CITED

ALTMANN J (1974) Observational study of behavior: sampling methods. *Behaviour* 49:227–267

ALVARADO S AND FIGUEROA RA (2005) Possible social foraging behavior in the Red-backed Hawk (*Buteo polyosoma*). *Ornitología Neotropical* 16:271–275

BALADRÓN AB, BÓ MS AND MALIZIA AI (2006) Winter diet and time-activity budgets of the Red-backed Hawk (*Buteo polyosoma*) in the coastal grasslands of Buenos Aires Province, Argentine. *Journal of Raptor Research* 40:65–70

BILDSTEIN KL (1987) Behavioral ecology of Red-tailed Hawks (*Buteo jamaicensis*), Rough-legged Hawks (*Buteo lagopus*), Northern Harriers (*Circus cyaneus*), and American Kestrels (*Falco sparverius*) in south central Ohio. *Ohio Biological Survey Biological Notes* 18:1–53

BONNEY RE, KELLEY JW, DECKER DJ AND HOWARD RA JR (1981) *Understanding predation and Northeastern birds of prey*. Cornell University, Ithaca

DUDLEY R, BYRNES G, YANOVIAK SP, BORRELL B, BROWN RM AND MCGUIRE JA (2007) Gliding and the functional origins of flight: biomechanical novelty or necessity? *Annual Review of Ecology, Evolution, and Systematics* 38:179–201

FINCH V AND TREWARTHA G (1954) *Geografía física*. Fondo de cultura económica, México DF

GREENE CH (1986) Patterns of prey selection: implications of predator foraging tactics. *American Naturalist* 128:824–839

HEDENSTRÖM A (1993) Migration by soaring or flapping flight in birds: the relative importance of energy cost and speed. *Philosophical Transactions of the Royal Society of London B* 342:353–361

JAKSIC FM (1985) Toward raptor community ecology: behavior bases of assemblage structure. *Raptor Research* 19:107–112

JAKSIC FM AND CAROTHERS JH (1985) Ecological, morphological, and bioenergetic correlates of hunting mode in hawks and owls. *Ornis Scandinavica* 16:165–172

JAKSIC FM AND JIMÉNEZ JE (1986) The conservation status of raptors in Chile. *Birds of Prey Bulletin* 3:95–104

JIMÉNEZ JE (1995) Historia natural del Aguilucho *Buteo polyosoma*: una revisión. *Hornero* 14:1–9

JIMÉNEZ JE AND JAKSIC FM (1991) Behavioral ecology of Red-backed Hawks in central Chile. *Wilson Bulletin* 103:132–137

LEHNER P (1996) *Handbook of ethological methods*. Second edition. Cambridge University Press, Cambridge

MASMAN D, DAAN S AND DIJKSTRA C (1988) Time allocation in the kestrel (*Falco tinnunculus*), and the principle of energy minimization. *Journal of Animal Ecology* 57:411–432

NEWTON I (1979) *Population ecology of raptors*. T & AD Poyser, London

PENNYCUICK CJ (1972) Soaring behaviour and performance of some east African birds, observed from a motor-glider. *Ibis* 114:178–218

PRESTON CR (1981) Environmental influence on soaring in wintering Red-tailed Hawks. *Wilson Bulletin* 93:350–356

RASPET A (1960) Biophysics of bird flight. *Science* 132:191–200

RUDOLPH SG (1982) Foraging strategies of American Kestrels during breeding. *Ecology* 63:1268–1276

SARASOLA JH AND NEGRO JJ (2005) Hunting success of wintering Swainson's hawks: environmental effects on timing and choice of foraging methods. *Canadian Journal of Zoology* 83:1353–1359

SHAMOUN-BARANES J, LESHEM J, YOM-TOV Y AND LIECHTI O (2003) Differential use of thermal convection by soaring birds over central Israel. *Condor* 105:208–218

SOLTZ RL (1984) Time and energy budgets of the Red-tailed Hawk in southern California. *Southwestern Naturalist* 29:149–156

STRAHLER AN AND STRAHLER AH (1994) *Geografía física*. Ediciones Omega, Barcelona

TARBOTON WR (1978) Hunting and the energy budget of the Black-shouldered Kite. *Condor* 80:88–91

VIDELER JJ (2005) *Avian flight*. Oxford University Press, Oxford

WAKELEY JS (1978) Hunting methods and factors affecting their use by Ferruginous Hawks. *Condor* 80:327–333

WARNER LH (1931) Fact and theories of bird flight. *Quarterly Review of Biology* 6:84–89