

## NEST SITE DESCRIPTIONS FOR CHILEAN HAWKS (*Accipiter chilensis*) IN THE VALDIVIAN COASTAL RANGE, SOUTHERN CHILE

### Descripción de los sitios de nidificación del peuquito (*Accipiter chilensis*) en la Cordillera de la Costa de Valdivia, sur de Chile

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**ABSTRACT.**- During breeding season 2011–2012 we studied nesting habits of two Chilean Hawks (*Accipiter chilensis*) pairs in the Valdivian Coastal Range, Chile. One nest site was located within a commercial mature Monterey pine (*Pinus radiata*) plantation and the other within an extensive remnant of second-growth evergreen forest. Both sites were located in rugged terrain with variable elevations (80–520 m s.n.m.), slopes of 20–30°, presence of small ravines, and near roads (linear distance, LD = 18–245 m), open areas (LD = 127–250 m), and water courses (LD = 46–30 m). Nesting sites were close to rural residences (LD = 127–500 m), but they were relatively far from urban areas (LD = 6–13 km). Nests were built inside the crown of live trees (>15 m tall, 21–46 cm in diameter at breast height), 11–19 m above-ground and close to the main trunk (20–30 cm in distance). The two nests were round-shaped platforms (length × width = 40 × 40 cm, and 45 × 34 cm) composed of strongly interlaced dry twigs and sticks (10–50 cm length, 1–2 cm width.). Platforms were firmly placed on forked branches (five to six) and were relatively hidden from the ground. Although preliminary, we think our results will contribute to better conservation planning for the Chilean Hawk in the coastal mountain range of southern Chile. **KEY WORDS.**- *Accipiter chilensis*, Chilean Hawk, hawk nest, pine plantation, *Pinus radiata*, Valdivian forest.

**RESUMEN.**- Durante la temporada reproductiva 2011–2012 estudiamos los hábitos de nidificación de dos parejas de pequitos (*Accipiter chilensis*) en la cordillera de la Costa de Valdivia, sur de Chile. Un sitio de nidificación fue ubicado en una plantación comercial madura de pino insigne (*Pinus radiata*) y el otro en un remanente extenso de bosque siempreverde de desarrollo secundario. Ambos sitios fueron localizados en terrenos accidentados de elevación variable (80–520 m s.n.m.), con pendientes de 20–30°, con presencia de pequeñas quebradas, y cerca de caminos (distancia lineal, DL = 18–245 m), áreas abiertas (DL = 127–250 m) y cursos de agua (DL = 46–30 m). Los sitios de nidificación estuvieron cerca de residencias rurales (DL = 127–500 m), pero distantes de áreas urbanas (DL = 6–13 km). Los nidos fueron construidos dentro de la corona de árboles adultos vivos (> 15 m de altura, 21–46 cm de diámetro a la altura del pecho), a 11–19 m sobre el nivel del suelo y cerca del tronco principal (20–30 cm de distancia). Las plataformas fueron redondeadas (largo × ancho = 40 × 40 cm, and 45 × 34 cm) y consistieron de ramas y ramillas secas (10–50 cm de largo, 1–2 cm de ancho) fuertemente entrelazadas. Las plataformas fueron construidas firmemente sobre ramas horquilladas (cinco a seis) y fueron poco visibles desde el suelo. Aunque preliminar, nuestros resultados pueden contribuir a planificar mejor estrategias de conservación del pequito en la cordillera de la Costa del sur de Chile. **PALABRAS CLAVE.**- *Accipiter chilensis*, bosque valdiviano, nido de gavilán, pequito, *Pinus radiata*, plantación de pino.

## INTRODUCTION

Knowing the breeding biology of forest-specialist raptors is pivotal to better guide their conservation (Bierregaard 1998, Mougeot *et al.* 2011). However, their secretive behavior, low population densities, extensive movements and the complexity of their habitat and associated low visibility make forest raptors difficult to study and, consequently, most of them are poorly known (Thiollay 1996, Penteriani 2011).

The Chilean Hawk (*Accipiter chilensis*, Thiollay 1994) is one of the least known forest-specialist raptors in the southern temperate rainforest region comprising Argentina and Chile (Trejo *et al.* 2006). This hawk species has been listed as rare along its entire geographic range, and its population size has supposedly been declining because of the increasing forest loss by extensive fires and logging (Jaksic & Jiménez 1986, Rottmann & López-Calleja 1992, Jaksic *et al.* 2001). To our knowledge, little is known about the breeding biology of the Chilean Hawk (Pavez & González 1998, Ojeda *et al.* 2004, Figueroa *et al.* 2007, Minoletti *et al.* 2011, 2015, Rivas-Fuenzalida *et al.* 2015). Here, we report a preliminary description of the nesting site characteristics of the Chilean Hawk in the Valdivian coastal mountain range, southern Chile.

## MATERIAL & METHODS

Our study area is located in the vicinity of the city of Valdivia (39°49' S, 73°13' W). Topography is characterized by presence of relatively low hills (< 1600 m a.s.l.) with moderate slopes (Mardones 2005). Vegetation is dominated by relatively continuous remnants of old-growth and secondary growth evergreen forests with presence of some secondary growth remnants of deciduous *Lophozonia* [*Nothofagus*] forest at lower elevations on the eastern side. The evergreen forest is composed mainly of olivillo (*Aextoxicum punctatum*), canelo (*Drimys winteri*), ulmo (*Eucryphia cordifolia*), laurel (*Laurelia sempervirens*), tepa (*Laureliopsis philippiana*) and several species of Myrtaceae. The deciduous forest is mainly composed of southern beech (*Lophozonia obliqua*) accompanied by a high diversity of other tree species (tepa, laurel, ulmo, olivillo, lingue [*Persea lingue*], avellano [*Gevuina avellana*], maqui [*Aristotelia chilensis*]). Commercial Monterey Pine (*Pinus radiata*) plantations cover some areas at lower and mid elevations on the eastern side in dispersed patches.

During two breeding seasons (2010–2012) we searched for nesting of Chilean Hawks in different localities of the Coastal range. Localities were arbitrarily selected according to forest conditions that appeared to fit the habitat characteristics described in the literature (e.g., Ojeda *et al.* 2004, Figueroa *et al.* 2007). For clarity, we de-

fined a nest site as the exact place where a pair established their nest platform (Reynolds *et al.* 1982, Reynolds 1983). Detection of potential nesting sites of Chilean Hawks was based on either opportunist direct observations of adult hawk during foot searches, vocal responses to playbacks, indirect signs such feathers or droppings (Thorstrom & Quixchán 2000, Seipke & Cabanne 2002, Figueroa *et al.* 2007) and on information provided by local villagers familiar with the species. Once a nest site was identified, we exhaustively searched for confirmatory evidence of breeding activity including presence of nest platforms, fledged young, adult hawks transporting food, pieces of eggshell, abundant droppings, and accumulation of pellets or prey remains under trees (Figueroa *et al.* 2007).

Because we could not estimate the real extension of the nest sites, we described the nest site characteristics based on a radial distance of approximately 100 m taking as central point the nest tree. We characterized nest sites, nest trees and platforms according to previous studies (Trejo *et al.* 2004, Figueroa *et al.* 2007, Rivas-Fuenzalida *et al.* 2011, 2013). Nest sites were characterized according to the following variables: (i) elevation at the point of the nest tree, (ii) cardinal orientation of the platform, (iii) topographic location of nest trees, i.e., if ravine, flatland or hilltop, (iv) size in area of the forest patch where the nest was located, (v) habitat types of the forest patch, (vi) successional stage of the forest patch, (vii) minimum linear distance from the nest tree to the nearest stream or body of water, (viii) minimum linear distance from the nest tree to the nearest open area, and (ix) minimum linear distance from the nest tree to the nearest human activity site (Rivas-Fuenzalida *et al.* 2011, 2013). Elevations, compass orientation, size of forest patches and distances were all derived from scaled satellite images ([www.earth.google.es](http://www.earth.google.es)) and expressed in conventional metric units. Topographic locations, habitat types and successional stages were directly measured in the field. Each nest tree was described according to species, height (in m) and trunk diameter at the breast height (dbh; in cm). Logistical limitations meant that we could not climb to the nest platform in Punucapa. However, nests not climbed was visible from a point near the nest tree where it was possible to visually estimate the height above the ground (i.e., distance between the tree base and the lower edge of the platform), their location inside the crown, and their shape and composition (i.e., building material). Tree and nest height were derived from triangulation by using a home-made clinometer based on recreational geometry (Perelman 2003). Nest platforms were measured based on the external diameter of platform, depth of the platform, diameter and depth of nest cup (in cm). All measurements were taken at the final of the breeding season (early March 2012). Behavior of the Chilean Hawk

**Table 1.** Characteristics of Chilean Hawk (*Accipiter chilensis*) nest trees found during breeding season 2011–2012 in the Valdivian coastal mountain range, southern Chile.

Characteristic	Nest		
	Oncol (occupied)	Oncol (abandoned)	Punucapa (occupied)
Tree species	<i>Laureliopsis philippiana</i>	<i>Laureliopsis philippiana</i>	<i>Pinus radiata</i>
Tree height (m)	20	17	20–22
Tree diameter at the breast height (m)	40	36	24
Height of nest above ground (m)	19	11.3	15
Distance to nearest tree (m)	2	0.6	1.3
Distance to nearest nest-tree (m)	30	30	–
Distance of nest to main trunk (cm)	20	30	0
Diameter of main trunk at height of nest (cm)	12	19	nm
Diameter of main branch supporting nest (cm)	13	12	nm

nm = not measured.

pair in the interior of the nest sites was observed from different points depending on visibility of hawks. Observations were conducted using binoculars (8 × 42).

## RESULTS

We documented two nest sites. The first site was found during spring 2011 (October) within a small commercial mature Monterey pine plantation (80 ha, 25 years old) in Punucapa (39°45' S, 73°18' W), 14 km northwestern of Valdivia city. Some Valdivian shrub species (e.g., maqui, melí [*Amomyrtus meli*], arrayán [*Luma apiculata*], arrayán macho [*Raphithamnus spinosus*], murta [*Ugni molinae*]) interspersed with nonnative shrub species (e.g., blackberries [*Rubus ulmifolius*, *R. constrictus*]) constituted the ‘midstorey’ of the interior of the pine stands. During the summer 2012 (January) a second nesting site was identified in an extensive secondary growth evergreen forest (13,000–14,000 ha, 100–200 years old) near the border of Oncol Park (39°41' S, 73°20' W), 6.5 km northwest Valdivia. The overstorey was mainly composed of ulmo, tepa, olivillo and melí. Common species in the subcanopy were canelo, melí, tiaca (*Caldcluvia paniculata*), mañío de hoja larga (*Podocarpus saligna*), mañío macho (*Podocarpus nubigenus*), peumo (*Cryptocarya alba*), and luma (*Amomyrtus luma*). Saplings of these species accompanied by ferns (*Blechnum* spp., *Hymenophyllum* spp., *Lophosoria* spp.) and austral bamboo (*Chusquea* spp.) interspersed

composed the understory. Some standing dead trees were also present in both nest sites. Both sites were located within small ravines on rugged terrain with hills variable in altitude (Punucapa = 80–100 m a.s.l., Oncol = 480–520 m a.s.l. and gentle slopes (20–30°). The two sites were near roads, open areas (e.g., pastures), and water courses. In Punucapa, the linear distance to the nearest road, open area and stream was 18 m, 127 m, and 46 m, respectively. In Oncol, the linear distance to the nearest road, open area and stream was 245 m, 250 m, and 30–60 m, respectively. The nest sites were near rural residences (linear distance: Punucapa = 127 m, Oncol = 500 m), but they were far from urban areas (Punucapa = 6 km, Oncol = 12.5 km).

One occupied nest was found in each nesting site, and an abandoned nest was also found in Oncol. All three nests were built inside the crown of mature live trees (>15 m tall, 21–46 cm d.b.h.) 11–19 m above ground and close to the main trunk (Table 1). The nest trees were relatively close to other trees at Punucapa, but in Oncol, nest trees were relatively distant from each other (Table 1). All three nests were oriented to the south of nest site. Nests were platforms firmly placed on forked branches (five to six) and were relatively hidden from the ground. The two nests measured in Oncol were round shaped and similar in size (Table 2). Although the nest in Punucapa was not measured, it was somewhat oval shaped (Fig. 1) and relatively similar in size to those located in Oncol. Material used for

**Table 2.** Characteristics of two Chilean Hawk (*Accipiter chilensis*) nests found during breeding season 2011–2012 in Oncol, Valdivian coastal mountain range, southern Chile.

Nest	Nest Diameter (cm)	Cup Diameter (cm)	Depth of Nest (cm)	Depth of Cup (cm)
Occupied	45 × 34	13 × 16	22	6
Abandoned	40 × 40	20 × 20	20	8.5



**Figure 1.** Nest platform of the Chilean Hawk (*Accipiter chilensis*) found during spring 2011 in a commercial mature Monterey pine (*Pinus radiata*) plantation in Punucapa, Valdivian coastal mountain range, southern Chile.



**Figure 2.** Female Chilean Hawk (*Accipiter chilensis*) observed during spring 2011 eating a bird prey in a commercial mature Monterey pine (*Pinus radiata*) plantation in Punucapa, Valdivian coastal mountain range, southern Chile

nest building consisted of dry twigs and sticks, and were strongly interlaced. In Oncol, twigs and sticks belonged to tepa, and in Punucapa mostly of Monterey pine. Sticks were relatively thin and long (1–2 cm width, 10–50 cm length). The inner cup of nests were covered with fresh or dry leaves, prey remains (e.g., feathers, bones), and down

of Chilean Hawk chicks. In Punucapa, abundant pine needles also covered the inner cup. Under the two occupied nests, we found pieces of eggshells belonging to Chilean Hawks. The outer surface of the eggshell was light bluish white or dull white, unspotted and not glossy. The inner surface of some fragments was bluish tinged.

In each nesting site, we observed only one breeding pair. During the nestling period, three young were detected Oncol, respectively. During the incubation and nestling period, males delivered prey to females and young on the nest platform or branches of several trees located near the nest tree. Prey were plucked and consumed on the same platform or branches where they were delivered, or were transported to other branches (Fig. 2). In Oncol, prey also were plucked and consumed on the abandoned nest platform.

We observed males delivering prey at different times of the day from 09:15 to 20:30 H and with an interval of 36–277 min (mean  $\pm$  SD = 98.1  $\pm$  76.6; N = 9) between prey deliveries. During prey deliveries both adult females and males issued strong vocalizations similar to a “tetetetetetete” and adult females also issued a hoarse “euu euu” when males were present. Fledged young issued a repetitive soft whistle similar to a “suiiiiiiu...siiiiiiiiiu” when moving within the forest or when they were far apart. When young received prey or disputed it, they issued a soft “suiiisisisu” and “psiiisisisu”.

On occasion, adult hawks used standing dead or tallest trees as roosts and platforms for mating or vigilance of nest sites. During early-morning and late-afternoon we observed adult hawks displaying rapid straight or diving flights over the forest canopy and open areas. In Oncol, we also observed on most occasions adult and young hawks roosting on the forest ground.

## DISCUSSION

Overall, the nest site characteristics located within forest in Valdivia were similar to those previously found in Bariloche, southern Argentina, and Nevados de Chillán, central Chile (Ojeda *et al.* 2004, Figueroa *et al.* 2007). In these latter two localities, Chilean hawks established their nest sites within old-growth or secondary growth multilayered forests with values of canopy coverage > 50%. In Nevados de Chillán, a nest site was also located near open areas and water courses, and distant from urban areas. In addition, nest site characteristics in Oncol were similar to those of Bicolored Hawks (*Accipiter bicolor*) in Guatemala (Thorstrom & Quixchán 2000).

Finding of Chilean hawks nesting within a pine plantation indicates that some pairs can tolerate a certain degree of native forest cover loss and degradation within their territories. In fact, a number of nesting records have



**Figure 3.** Commercial mature Monterey pine (*Pinus radiata*) plantation occupied by a breeding Chilean Hawk (*Accipiter chilensis*) pair in Punucapa, Valdivian coastal mountain range, southern Chile. The orange arrow indicates direction to the nest location (almost 6 m from the road edge).

been made within commercial pine plantations in coastal areas located at north of Valdivia (Rivas-Fuenzalida *et al.* 2015, Uribe *et al.* 2015). In addition, similar cases have also been described for three other Chilean forest-specialist raptors, the Rufous-legged Owl (*Strix rufipes*; Estades 1998, Vukasovic *et al.* 2006, Rivas-Fuenzalida *et al.* 2014), Rufous-tailed Hawk (*Buteo ventralis*; Rivas-Fuenzalida *et al.* 2011), and White-throated Hawk (*B. albogularis*; Rivas-Fuenzalida *et al.* 2013). The occupancy of pine plantations by Chilean forest-specialist raptors could be interpreted as an adaptation to the substitution of native forest by monospecific nonnative tree plantations. However, it is also possible that hawks had occupied the pine plantation because of the extensive loss of native forest in the area or fidelity to a nesting site (Knick & Rotenberry 2000, Penteriani & Faivre 2001). Some habitat specialist species may persist at a site to the extent that the changed habitat permits survival and reproduction, even at below replacement rates ("the ghost of past habitat"; Knick & Rotenberry 2000, Figueroa *et al.* 2012). In the case of Punucapa, occupancy of a pine stand by a Chilean Hawk pair for nesting could have been promoted by a high availability of native prey as consequence of the dense native vegetation in the understory and nearby ravines (Fig. 3). Several authors have determined that other *Accipiter* species in temperate zones can nest within commercial pine plantations as habitat conditions and prey availability permit (e.g., Reynolds 1983, Wiggers & Kritz 1991, Rosenfield *et al.* 1998, 2000,

Garner 1999). However, as was mentioned above, the nest in Punucapa failed while female was incubating. Although we do not know the causes of the failure, it is possible that close proximity to a road, homogeneous structure of the vegetation and open canopy (Fig. 3) could have increased exposure to wind and rainfall, access to aerial predators or human disturbances. Although less probable, dropping of pine cones by natural causes (e.g., gravity, wind) could also have disturbed the female during incubation or destroyed the eggs. Even though no harvest activity was observed during the nesting in Punucapa, tree harvesting represents the major threat for nesting hawks in pine plantations (Rivas-Fuenzalida *et al.* 2015). In fact, the pine stand where the Chilean Hawks nested was harvested four months later, although the nest tree was not felled.

In general, the native nest trees in Valdivia had similar characteristics to those previously described. However, tree species used as nest substrate in Valdivia differ from those previously reported. The majority of Chilean Hawk nests documented were found in southern beeches (coigüe [*Nothofagus dombeyi*], roble [*Lophozonia obliqua*], roble blanco [*Lophozonia macrocarpa*]; Housse 1937, Ojeda *et al.* 2004, Figueroa *et al.* 2007, Minoletti *et al.* 2015), although one nest was also located in peumo (Minoletti 2011, Minoletti *et al.* 2015). It should be noted, however, that all these tree species have a crown with relatively dense foliage, which would provide adequate shade for the chicks and hides them from aerial predators (Figue-

roa *et al.* 2007). The measured nest platforms in Valdivia were similar in shape to one platform located in Bariloche, but they were smaller than all those previously documented (Capitán Pastene: external diameter  $\approx$  60 cm [Housse 1937]; Bariloche: external diameter = 56 x 49 cm, depth = 59 cm, N = 1 [Ojeda *et al.* 2004]; Nevados de Chillán: mean external diameter = 74.2 x 53.1 cm, mean depth = 25.5 cm, N = 3 [Figueroa *et al.* 2007]). These discrepancies may be the result of differences in building material, structure of the nest tree or age of the platform (Thorstrom & Quixchán 2000, Figueroa *et al.* 2007). The observation of the abandoned nest in Oncol indicates that Chilean Hawks may build a new nest for each breeding season, a fact previously noted by Figueroa *et al.* (2007), Minoletti *et al.* (2015), and Rivas-Fuenzalida *et al.* (2015). Number of young per nesting pair in this study was consistent with results from other studies (Ojeda *et al.* 2004, Minoletti *et al.* 2015, Rivas-Fuenzalida *et al.* 2015). Egg color observed from shell fragments found below the nests was similar to that reported for the Chilean Hawk in Nevados de Chillán (Figueroa *et al.* 2007) and in Nahuelbuta mountain range (Rivas-Fuenzalida *et al.* 2015), and for Bicolored Hawk in Guatemala (Thorstrom & Kiff 1999).

Overall, behavior of breeding Chilean Hawks in Valdivia was similar to that observed in other localities (Pavez & González 1998, Ojeda *et al.* 2004, Figueroa *et al.* 2004b). Observation of Chilean Hawks roosting on the forest ground agrees with observations made by other authors and is consistent with high predation on terrestrial prey (Figueroa *et al.* 2004a, 2004b).

Whether in forests or plantations, Chilean Hawks in the Valdivian coastal range placed their nests in relatively well protected sites with dense vegetative cover in the understory, and near small open areas, and thus assuring refuge against predators and a presumed higher availability of potential prey (Figueroa *et al.* 2004a, 2004b, 2007). Our results in combination with other studies confirm that the Chilean Hawk is a habitat-specialist and breeds within protected forest patches. Although preliminary, we think that these results will contribute to better conservation planning for the Chilean Hawk in the coastal mountain range of southern Chile.

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