NESTING OF THE RUFOUS-TAILED HAWK (*BUTEO VENTRALIS*) IN AN INTENSIVELY AGRICULTURAL AREA OF SOUTHERN CHILE

Un caso de nidificación del aguilucho de cola rojiza (*Buteo ventralis*) en un área intensivamente agrícola del sur de Chile

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RESUMEN.- Durante la primavera de 2016 encontramos de manera circunstancial un nido de aguilucho de cola rojiza (*Buteo ventralis*) al interior de un pequeño fragmento de bosque nativo (32 ha) de desarrollo secundario, localizado en un área con actividad agrícola intensiva en la provincia de Osorno, sur de Chile. El nido estaba ubicado a gran altura (27-28 m respecto del suelo) en la copa de un lingue (*Persea lingue*) de gran envergadura (29-31 m de altura). En el interior del nido había dos polluelos vivos de casi dos semanas de edad. El remanente de bosque donde encontramos el nido estaba distante entre 10 y 320 m del borde de otros remanentes circundantes. La matriz agrícola consistió de un mosaico extenso de distintos tipos de hábitat y uso de la tierra incluyendo cultivos de cereales, hortalizas forrajeras y pastizales con ganado vacuno. La significancia de nuestro hallazgo yace en que (i) demuestra la capacidad de algunas parejas de aguiluchos de cola rojiza de reproducirse en areas con bosque fuertemente fragmentado circundado por una matriz agrícola de uso intensivo, y (ii) apoya el argumento que los pequeños remanentes de bosque nativo son fundamentales para la conservación de especies endémicas en paisajes con una fuerte intervención humana.

Manuscrito recibido el 2 de mayo de 2019, aceptado el 27 de mayo de 2019.

The Rufous-tailed Hawk (*Buteo ventralis*) is a large-sized (body mass ≈ 1.000 g), forest-dependent species quasi-endemic to the southern temperate forest ecoregion (southern Chile and Argentina) and marginal to the sclerophyllous forest of central Chile (Rivas-Fuenzalida & Figueroa 2019). This hawk species typically reproduces within extensive old- or second-growth forests (150-3.000 ha) covering mountainous or rugged terrains (Trejo *et al.* 2006, Rivas-Fuenzalida *et al.* 2011, Rivas-Fuenzalida & Figueroa 2019). The primary nesting substrate of Rufous-tailed Hawks are large, old, native trees (Housse 1945, Behn 1947, Figueroa *et al.* 2000, Rivas-Fuenzalida *et al.* 2011, 2015, 2016, Medel *et al.* 2013), but some pairs can also nest on allochthonous mature pines or rock walls surrounded by native forest (Rivas-Fuenzalida *et al.* 2011, 2016, Norambuena *et al.* 2013, Rivas-Fuenzalida & Asciones-Contreras 2013). Moreover, many of its prey species also are forest dwellers (Figueroa *et al.* 2000, Rivas-Fuenzalida & Figueroa 2019).

The strong association of the Rufous-tailed Hawk to large forest remnants leads one to suppose that nesting of this species in highly fragmented forest landscapes with intensive land use is unlikely. Here, we report a recent observation of a Rufous-tailed Hawk pair nesting within a small forest patch in a highly agricultural area in the central valley of southern Chile. The significance of this finding lies in that it suggests an ability of some pairs to breed in areas with heavily fragmented forest habitat surrounded by an extensive apparently "inhospitable" matrix.

We recorded a Rufous-tailed Hawk nest circumstantially in the interior of a small forest remnant of approximately 32 ha while conducting a seasonal study on the forest small-mammal diversity in El Calabozo farm, 9 km northwest of Osorno (40°30'S, 70°10'W; Fig. 1). During the time we made observations that the landscape in the area was heterogeneous and composed mainly of native forest remnants and an extensive agricultural matrix (Fig. 1). These forest remnants varied in shape and extension (12-130 ha) and were composed of a mosaic of second-growth and sapling stands with a varying degree of degradation, and treeless spaces with shrub regrowth. Young

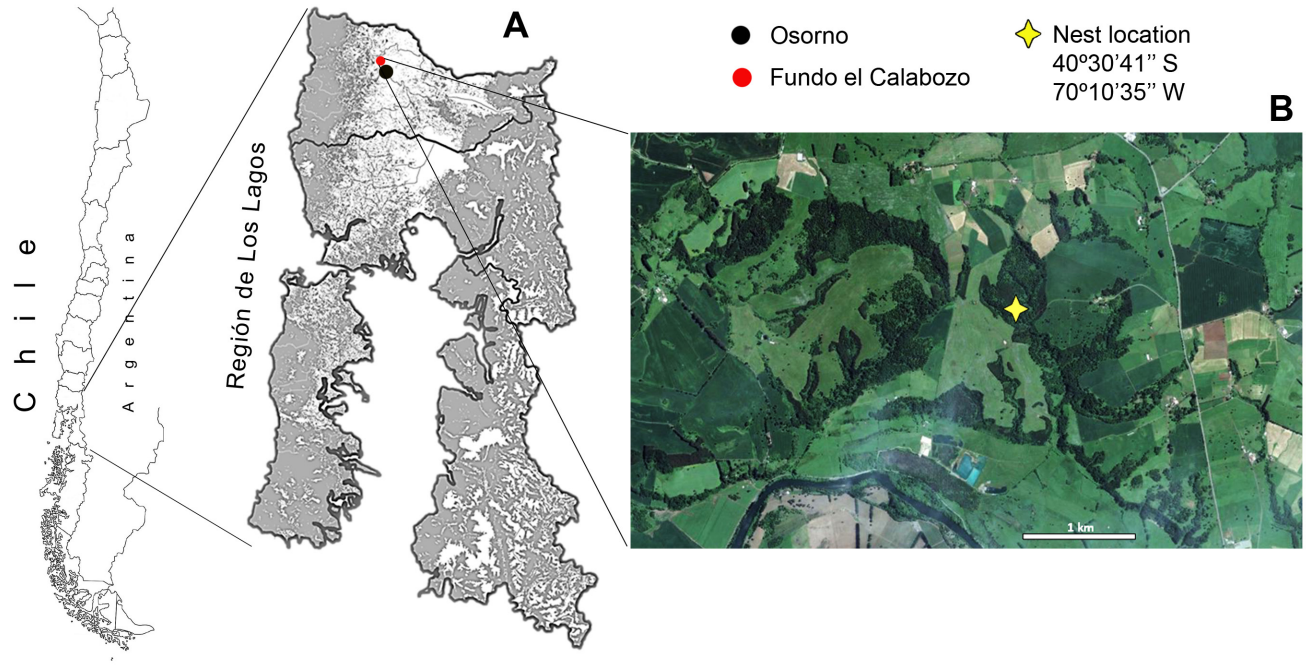

Figure 1. Location of a Rufous-tailed Hawk (*Buteo ventralis*) nest found during spring 2016 in a 32-ha forest remnant within the El Calabozo farm, Osorno province, southern Chile. A. Distribution of the native forest (shaded-grey area) at a regional scale and degree of forest fragmentation along the central valley. Source: National Forest Inventory, Instituto Forestal (INFOR), Chilean Government; B. Degree of forest fragmentation around the nesting site and the diverse land use in the surrounding agricultural matrix during the record date. Source: GoogleEarth®.

(5-6 years old) Monterrey pine (*Pinus radiata*) and eucalyptus (*Eucalyptus* spp.) plantations of different extension (0.1-4 ha) covered part of the edge and interior of some forest remnants. Thus, in terms of the original vegetation, the landscape exhibited a markedly fragmented layout (*sensu* McIntyre & Hobbs 1999). Forest remnants in the area represented the primitive semi-deciduous association of roble (*Lophozonia obliqua*), laurel (*Laurelia sempervirens*) and lingue (*Persea lingue*), which is typical of the central valley in southern Chile (San Martín *et al.* 1991). The agricultural matrix presented a fine-grained mosaic of distinct habitat patches and land use types (Fig. 1). Most distinctive habitat types were pasturelands, sedge-rush (*Carex-Juncus* spp.) marshes, herbaceous fallows, blackberry thickets, orchards, and non-native tree clumps. Moreover, several isolated native trees were distributed across agricultural habitats among forest patches. The main types of land use included wheat, oats, forage cabbage, clover, berry, and potato crops, extensive cattle grazing, Monterrey pine and eucalyptus plantations, and isolated human residences. The agricultural fields were crossed by a fence web separating the different land uses. Tree or shrub hedgerows and pasture strips bordered some fence lines. Topography was mostly flat with some gently rolling terrains (60-170 m s.n.m).

Our finding had the following chronology. On 20 May 2016, at 10:30 h, we heard alarm-calls from two adult hawks as they moved among the treetops. Although we could not see the hawks, the experience of one of us allowed us to identify the calls as belonging unequivocally to the Rufous-tailed Hawk. The hawks vocalized intermittently for at least 5 min, presumably in response to our presence. On 26 August 2016, at 14:51 h, we heard the alarm calls of Rufous-tailed Hawks in the same place. On this occasion, we saw a light morph adult hawk flying over the canopy and moving among the trees. These observations lasted almost 10 min. Finally, on 30 November 2016, between 14:40-15:30 h, while installing small mammal live-trapping lines, we recorded a nest with two Rufous-tailed Hawks nestling on a large old live lingue (*Persea lingue*, Fig. 2) located on the lower part of a small ravine slightly slanted (< 30°) at almost 70 m westward from where we sighted the adult hawks during the past visits.

The Rufous-tailed Hawk pair built its nest right on the bifurcation of a primary vertical branch in the tree crown at almost 27-28 m from the ground (Fig. 2). Other four thick lateral branches born from the same tree provided additional support to the nest. The nest tree reached 29-31 m in height (estimated visually) and 110 cm in diameter at breast height (measured by using a metric tape), and it was close to other native trees similar in size (2-5

Figure 2. A Rufous-tailed Hawk (*Buteo ventralis*) nest placed on the crown of large old live lingue (*Persea lingue*) found in the interior of a small forest remnant (32 ha) during spring 2016 in El Calabozo farm, Osorno province, southern Chile. A. Notice the head of a nestling hidden behind the bifurcated branch (yellow arrow). B. Partial view of one out two Rufous-tailed Hawk chicks. According to the plumage coloration pattern under the extended wing, nestlings were approximately 3-4 weeks old. Photos: Rodolfo Figueroa.

m among tree stems as estimated by the number of steps). Although we did not measure the nest, it had a bulk round-shaped appearance and was large compared to the body size of the nestlings (Fig. 2). The nest material consisted mainly of long dry branches, varying in length and width, firmly interlaced. As far as we could see, and according to its shape and color, all the branches that constituted the external nest structure were from native trees (Fig. 2). Although the tree top had a low cover, the foliage above the nest provided shade to nestlings (Fig. 2). According to the body size and plumage coloration, nestlings were approximately 3-4 weeks old (Fig. 2). At least on two occasions while we watched the nest, two light morph adult hawks soared low over the top of the nest tree uttering alarm calls.

The vegetation around the nest tree, as in much of the forest remnant, comprised tree clusters surrounded mostly by a dense and high (3-5 m tall) carpet of southern bamboo (*Chusquea* spp.) with interspersed native shrubs including maqui (*Aristotelia chilensis*), luma or myrtle (*Amomyrtus luma*), fuchsia (*Fuchsia magellanica*), Magellan's Mayten (*Maytenus magellanica*), firetree (*Embothrium coccineum*), and azara (*Azara* spp.). The tree clusters composed of mainly beech accompanied by laurel, lingue and/or firetree. Overall, the height of the trees reached 25-30 m. In the most open and sunny sites, the understory was also composed of saplings of beech and sparse clumps of the elm-leaf blackberry (*Rubus ulmifolius*), an invasive allochthonous plant. Near the nest tree, some young pines and eucalyptus were also present.

To our knowledge, this is the first Rufous-tailed Hawk pair found nesting in a strongly human-altered small forest patch (< 50 ha) surrounded by a strongly agricultural matrix in flatlands of Osorno province. Even though some pairs have established their breeding territories in the central valley of southern Chile, they located nests in the interior of extensive second-growth forests (190-1,200 ha) surrounded by open areas with low-intensity agriculture (Rivas-Fuenzalida *et al.* 2011). Interestingly, the structural characteristics of the nesting tree in our study site were very similar to those observed in less degraded extensive forest remnants (*e.g.*, tree height > 20 m; Rivas-Fuenzalida *et al.* 2011).

Our finding could be interpretable as an adaptation or high tolerance of the Rufous-tailed Hawk to the heavily fragmented forest landscape on the central valley of southern Chile. Some previous pieces of evidence partially support this idea. Figueroa *et al.* (2000) found that almost a third of the prey consumed by a Rufous-tailed Hawk pair nesting on the Ñielol hill consisted of native birds and allochthonous lagomorphs inhabiting open agricultural fields, raising the idea that the Rufous-tailed Hawk is not an obligate forest predator. Consistent with this conclusion, Jaksic & Jiménez (1986) advanced the idea that forest fragmentation and agricultural development could be increasing the availability of feeding habitat for the Rufous-tailed Hawk. Moreover, some pairs can nest unusually on large adult Monterrey pines (30-40 m tall) or standing dead trees entirely devoided of foliage within second-growth forests, demonstrating an ability to accept some degree of modification of their breeding habitat (Rivas-Fuenzalida *et al.* 2011, Rivas-Fuenzalida & Asciones-Contreras 2015). On the other hand, it is also possible that Rufous-tailed Hawks breed in the small human-altered forest patch because of the lack of primi-

tive forest remnants in the area, the pressure to reproduce or fidelity to an old nest site (Knick & Rotenberry 2000, Penteriani & Faivre 2001). Some habitat-specialist bird species may persist at a site to the extent that the altered habitat permits survival and reproduction ("the ghost of the past habitat"; Knick & Rotenberry 2000).

Alternatively or complementarily, a factor that may have contributed to the Rufous-tailed Hawk reproducing in the area is the existence of several second-growth forest remnants near the nesting patch (distance among forest remnants edges = 10-320 m; measured from GoogleEarth®). All these forest remnants are within a radius of 1.5 km from the nest tree, a distance that coincides with previous estimates of displacement lengths of the Rufous-tailed Hawk pairs within its reproductive territory (Rivas-Fuenzalida & Figueroa 2019). Thus, it is possible that the hawk pair had used surrounding forest remnants additionally (or as "nodal points") to meet their ecological requirements (*e.g.*, feeding, shelter, territory maintenance). For example, the Chilean Pigeon (*Patagioenas araucana*), a common prey of Rufous-tailed hawks (Rivas-Fuenzalida & Figueroa 2019), regularly moves in large flocks among forest patches and hawks possibly follow their movements. Moreover, all these patches hold large old trees that the hawk can use either as alternative hunting perches, courtship platform, or nesting substrate (Rivas-Fuenzalida & Figueroa 2019). Forest patches around the nesting site also may contribute to training for hunting and dispersal of juveniles. The isolated native trees within abandoned pastures and crop fields also may favor the displacements of Rufous-tailed Hawks among forest patches as these landscape elements constitute potential hunting perches, observation posts, resting platforms, shade and shelter for raptors (Dean *et al.* 1999). Previous studies show that isolated trees act as "stepping stones" facilitating animal connectivity among habitat patches (Manning *et al.* 2006).

Agricultural practices, depending on the adopted scheme, can have both negative and positive effects on raptors' life histories (Smallwood *et al.* 1996, Carrete *et al.* 2009, Grande *et al.* 2018). In the case of large-sized forest-dependent raptors, the removal of extensive tracts of native forest due to changes in land use leads to their local extinction (Stotz *et al.* 1996, Vargas *et al.* 2006, Gomes & Sanaiotti 2015). Nonetheless, there is evidence that when mosaics of native and agricultural habitats remain in the landscape, many raptor species with different ecological requirements are favoured by both maintaining their breeding habitats and increasing their prey resours (Estrada *et al.* 1997, Grande *et al.* 2018). Consistently, the habitat heterogeneity appears to explain well the presence and reproduction of Rufous-tailed Hawks in our study area. Because our record is only circumstantial and we did not know the fate of the nestlings, we do not know how well this hawk species does in the agricultural-forest mosaic we studied as other risks associated with agricultural activities such as human persecution (Rivas-Fuenzalida *et al.* 2011) or pesticides could negatively affect it and their prey. Beyond these limitations, our finding supports the argument that small patches of native vegetation are pivotal to the conservation of endemic species in heavily human-modified landscapes (Fischer & Lindenmayer 2002, Manning *et al.* 2006, Lindenmayer 2019, Wintle *et al.* 2019).

ACKNOWLEDGMENTS.- We thank Haydee Junge for permission to work on her lands, Tomás Rivas-Fuenzalida for corroborating the age of the Rufous-tailed Hawk' nestlings, and Diane Haughney who helped us with the English translation. We also appreciate the constructive and encouraging comments from three anonymous peer reviewers.

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