Tinamous in Mexico

Erick H. Baur, Patricia L. R. Brennan, and Daniel M. Brooks

Mexico is the northern distributional limit of tinamous (order Tinamiformes, family Tinamidae), which are terrestrial Neotropical birds related to flightless ratites, although tinamous are capable of flight. Tinamous reach their greatest diversity in South America and may be subdivided based on ecological and phylogenetic affiliations between open-habitat (Nothurinae or Eudromiinae) and forest (Tinaminae) tinamous (Bertelli and Porzecanski 2004, Bertelli and Chiappe 2005, Remsen et al. 2011). Four species from two genera are native to Mexico, all of which belong to the forest clade: great tinamou (Tinamus major), thicket tinamou (Crypturellus cinnamomeus), slaty-breasted tinamou (C. boucardi), and little tinamou (C. soui). The distributions of all four species overlap in southern Mexico, where multiple species are often sympatric (Zimmerman 1957, Estrada et al. 1997), and in some areas, all four tinamous occur sympatrically (André 1967, Puebla-Olivares et al. 2002).

In Mexico as elsewhere, people hunt tinamous for subsistence and sport (Leopold 1959, Cabot 1992, Jorgenson 1995). Many tinamous are highly suitable for management and sustainable use. The reproductive features of most species contribute to high fecundity, which is likely to improve resilience to properly managed harvest pressure. The most commonly hunted Mexican species, the thicket tinamou, thrives in natural and second-growth scrub and can likely be managed compatibly with a broad spectrum of land uses. Several tinamous species can be attracted to imitated or playback calls, which could facilitate selective harvest efforts and offers an appealing element to sport hunting (Sutton 1951, Lancaster 1964a). The great tinamou in particular is renowned for its palatability (Van Tyne 1935, Leopold 1959). Leopold (1959) promoted greater utilization of tinamous, which could be an appropriate means of increasing public interest in and financial support for research and conservation.

Evolution and Taxonomy

Tinamous and flightless ratites belong to the superorder Palaeognathae, a primitive group that is phylogenetically distinct from all other living birds (Prager et al. 1976, Olsen 1985, Cabot 1992, Gill 2007, Harshman et al. 2008). Genome research found that extinct moas (order Dinornithiformes) and tinamous are more closely related to one another than to other palaeognaths, implying that tinamous are embedded among the ratites rather than being a sister group (Phillips et al. 2010, Baker et al. 2014). The oldest palaeognath fossils from the Paleocene and Early Eocene of the western US and England are of volant birds that were morphologically more similar to tinamous than to other modern ratites (Olsen 1985). The earliest known tinamous fossils are from the Middle Miocene in Argentina (Bertelli and Chiappe 2005). Currently, 47 tinamous species are recognized among nine genera (AOU 1998, Remsen et al. 2011).

Multiple subspecies have been described from the entire geographical ranges of all four native Mexican tinamous. Two races of the great tinamou occur in Mexico: robustus throughout most of the range of the species, and persecutus on the Yucatán Peninsula (Cabot et al. 2014). Because of the allopatric distribution of the thicket tinamou, as well as its calling and morphological variability, some researchers have suggested that multiple species are present in Mexico. Six subspecies have been described: mexicanus in the north, sallei from Veracruz to Chiapas, soconusicensis in the western lowlands of Oaxaca and Chiapas, vicinior in the Atlantic lowlands of Chiapas, goldmani on the Yucatán Peninsula, and occidentalis in the separate Pacific coastal range (Conover 1933, del
Table 4.1. Tinamou species with English and Spanish common names, and subspecies (in parentheses) occurring in Mexico.

<table>
<thead>
<tr>
<th>Species</th>
<th>English name</th>
<th>Spanish name*</th>
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<tbody>
<tr>
<td><em>Tinamus major</em></td>
<td>Great tinamou</td>
<td>Tinamú mayor</td>
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<td>(robustus, percautus)</td>
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<tr>
<td><em>Crypturellus cinnamomeus</em></td>
<td>Thicket tinamou</td>
<td>Tinamú canelo</td>
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<tr>
<td>(mexicanus, salaei, soconuscoensis, vicinior, goldmani, occidentalis)</td>
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<tr>
<td><em>C. boucardi</em></td>
<td>Slaty-breasted tinamou</td>
<td>Tinamú jamuey</td>
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<tr>
<td>(boucardi)</td>
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<tr>
<td><em>C. soui</em></td>
<td>Little tinamou</td>
<td>Tinamú menor</td>
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<td>(meserythus)</td>
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*Spanish common names are based on Escalante et al. (2014).


**Description**

Mexican tinamous share general anatomical features such as cryptic plumage; a stout, tailless appearance; a long, thin neck; and a dove-like head with a slender bill. Although females are slightly larger than males in many species, this difference is not noticeable under most field conditions (Leopold 1959, Lancaster 1964a, Davies 2002). One is more likely to hear tinamous than to see them, and they can be identified by their distinctive whistle-like calls, examples of which are available on various Internet websites.

**Great tinamou**

This is the largest Mexican tinamou; adults are at least twice the size of other species, ranging from 795 g to 1,400 g (1.75 to 3 lb) (Leopold 1959, Davies 2002, Brennan 2009). The legs are gray and the plumage on both sexes is grayish brown with slight barring and spots over most of the body, a pale abdomen and throat, a dark crown, and white eye rings. Great tinamou calls have a haunting, trilled quality and are often heard in single or paired phrases that rise and fall in pitch.

**Thicket tinamou**

This is also referred to as the rufescent tinamou; adults weigh 350 g to 500 g (0.77 to 1.1 lb) (Leopold 1959). This species has red legs and more noticeably barred plumage than other Mexican tinamous. Body plumage is more heavily barred on females. Both sexes have gray plumage on the head and neck, a paler throat, and cinnamon-brown plumage on the underparts (Leopold 1959). There are plumage variations attributed to each subspecies, but the most divergent is the allopatriic Pacific race (*occidentalis*), which lacks rufous coloration and is paler than other subspecies (see Conover [1933] and Brodkorb [1939] for subspecies descriptions). Leopold (1959) reported that specimens from northern Mexico are larger than those from the south. The mournful, slightly quavering reproductive calls of this species typically have three syllables in the north but may have only one or two syllables in the south (Sutton 1951, Leopold 1959).

**Slaty-breasted tinamou**

Also known as the Boucard tinamou, this species is similar in size to the thicket tinamou, with adults weighing 432 g to 485 g (0.95 to 1.06 lb) (Leopold 1959). The legs are red. Males have dark gray plumage on the head, neck, and breast; body plumage is grayish brown with faint barring that is more noticeable on females. Plumage is paler on the throat and undersides in both sexes. Calls are often extended single or paired phrases with a haunting, airy, whistle-like quality.

**Little tinamou**

Formerly referred to as the pileated tinamou, this is the smallest Mexican tinamou, with adults ranging from 165 g to 268 g (0.36 to 0.59 lb) (Davies 2002). The legs are olive gray and the plumage on the head, neck, and back is dark gray, with a pale throat and rufous undersides in both sexes. Females have a greater amount of rufous plumage than males. Common calls include an alternating duet contact call and an ascending series of five to ten high-pitched, tremulous two-syllable whistles (D. M. Brooks, Houston Museum of Natural Science, personal observation).

**Distribution**

**Great tinamou**

The distribution of this species includes humid and semihumid lowlands (less than 1,000 m [3,280 ft] in elevation) from southern Mexico to northern South America (AOU 1998). In Mexico (fig. 4.1),...
it occurs in parts of Veracruz, Oaxaca, Chiapas, Tabasco, Campeche, and Quintana Roo (Howell and Webb 1995). It requires broadleaf forest and has been locally extirpated where forest cover has been lost (Leopold 1959, Cabot 1992).

**Thicket tinamou**

This species has the northernmost range of any tinamou and the broadest distribution in Mexico. Its allopatric distribution includes most of the Gulf-Caribbean slope of Mexico, northern Guatemala and Belize, across to the Pacific slope of the Isthmus of Tehuantepec southward through Central America to northwestern Costa Rica, and separately along Mexico’s central Pacific coast (AOU 1998). Its distribution in Mexico (fig. 4.2) includes parts of Tamaulipas, Nuevo León, San Luis Potosí, Hidalgo, Puebla, Veracruz, Tabasco, Campeche, Yucatán, Quintana Roo, Oaxaca, and Chiapas, and coastal areas of Sinaloa, Nayarit, Jalisco, Colima, Michoacán, and northern Guerrero (Leopold 1959, Howell and Webb 1995). According to Leopold (1959), the species distribution was formerly continuous along the remaining Pacific coast between Guerrero and Oaxaca. It occurs from sea level to 1,850 m (6,000 ft) (AOU 1998).

**Slaty-breasted tinamou**

The distribution of this species includes humid and semihumid areas from southern Mexico to northern Costa Rica (AOU 1998). In Mexico (fig. 4.2) it occurs in parts of Veracruz, Oaxaca, Chiapas, Tabasco, Campeche, and Quintana Roo (Howell and Webb 1995). It requires broadleaf forest and has been extirpated from deforested areas. It is generally considered a lowland species (AOU 1998) but may occur at elevations up to 1,800 m (5,900 ft) (Cabot 1992).

**Little tinamou**

This species is distributed throughout humid and semihumid lowlands from southern Mexico through much of South America (AOU 1998). In Mexico (fig. 4.1) it occupies parts of Veracruz, Oaxaca, Chiapas, Tabasco, Campeche, and Quintana Roo (Howell and Webb 1995). It occurs from sea level to 1,500 m (4,900 ft) (AOU 1998).

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**Legend**

- **Tinamus major** & *Crypturellus soui*

Figure 4.1. Approximate distributions of the great tinamou (*T. major*) and little tinamou (*C. soui*) in Mexico, which are sympatric.
Habitat requirements
Great tinamou
This species is associated with tall broadleaf forests with open understories (Leopold 1959, Skutch 1963, Davies 2002). It occupies primary and secondary forests, fallow plantations and woodlots, riparian forests, and wooded savannas (Zimmerman 1957, Lancaster 1964a, AOU 1998). In northern Guatemala, it was as abundant in low-canopy scrub forests as it was in taller forest types (Baur 2008).

Thicket tinamou
Thick ground cover is a key habitat requirement for this species (fig. 4.3) (Dickey and Van Rossem 1938, Leopold 1959), which occurs from humid to semiarid areas and uses primary and secondary forest or scrub (Leopold 1959, Lancaster 1964a, Cabot 1992). In the north it occupies habitats ranging from thorny scrub dominated by terrestrial bromeliads (Bromelia pinguin) to mixed oak-sweetgum (Quercus-Liquidambar) forests (Sutton 1951, Leopold 1959). In the south it is often associated with fallow agricul-
Slaty-breasted tinamou
This species is associated with tall forests with open understories (Leopold 1959, Lancaster 1964a). In adjacent areas, it may also use scrub forests, fallow plantations, and secondary forests with moderate undergrowth (Lancaster 1964a). Paynter (1957) reported it was common in low, dense, transitional vegetation between pine and broadleaf forests in Chiapas.

Little tinamou
This species inhabits numerous habitat types with thick ground cover. It occupies forest edges, natural scrub, secondary forests and scrub, and various agricultural habitats (Leopold 1959, Skutch 1963, Davies 2002). Skutch (1963) found it to be common in sugarcane, coffee, and banana plantations; maize and cassava fields; and overgrown pastures (fig. 4.4).

Natural History
Diet
Mexican tinamous have similar generalist diets that are dominated by seeds and fruits but also include invertebrates and occasional small vertebrates (Leopold 1959, Lancaster 1964a, Baur 2008). Tinamous do not scratch when foraging, relying on their bills to search through leaf litter. Some species have been observed foraging among mixed flocks at ant swarms (Leopold 1959, Lancaster 1964a).

Great tinamou
Van Tyne (1935) reported Brosimum alicastrum and Pseudolmedia spuria fruit as dominant food items in northern Guatemala. Leopold (1959) reported Guatteria sp. fruit as a dominant food item in Chiapas. Diet composition in northern Guatemala, based on year-round samples (n = 55), was dominated by seeds (88%) from 67 plant species, followed by fruit pulp (7%), invertebrates (2%), mineral grit (2%), and minor amounts (1%) of leaves and other plant material (Baur 2008). Seeds and fruits of B. alicastrum, Pseudolmedia spuria, and Probini copal dominated the diet in mass and frequency of occurrence in that study (E. H. Baur, unpublished data). Other important diet items included the fruits and seeds of trees such as Calophyllum brasiliense, Dendropanax arboreus, Drypetes sp., Manilkara zapota, and Masticodendron foetidissimum, as well as Chrysophyllum mexicanum and Sabal mauritiiformis.

Figure 4.4. The little tinamou (Crypturellus soul) inhabits a variety of habitat types. Photo by Jorge Dangel/Macaulay Library at the Cornell Laboratory of Ornithology.
palms. Invertebrates in the diet included beetles, ants, snails, wasps, spiders, grasshoppers, flies, and moths (E. H. Baur, unpublished data).

**Thicket tinamou**

Sutton and Pettingill (1942) reported *Bromelia* sp. seeds in all birds collected in Tamaulipas. Dickey and Van Rossem (1938) described a diet of seeds, mineral grit, dung beetles, and other insects in El Salvador. Leopold (1959) reported a variety of seeds and fruits in the diet in Campeche, including a prominent small red fig.

**Slaty-breasted tinamou**

The spring diet of this species in northern Belize was dominated by fruits and seeds of *Brosimum alicastrum*, *Protium copal*, and *Pseudomedia spuria*. The diet also included fruits or seeds of tree species such as *Acacia* spp., *Aspidosperma megalocarpon*, *Drypetes brownii*, *Forchhammeria trifoliata*, *Pouteria durlandii*, *Spondias* sp., *Swietenia macrophylla*, and *Tropis racemosa*; shrubs (*Rinorea guatemalensis*); palms (*Chrysophyllum* sp. and *Sabal* sp.); and an agave (*Dracaena americana*). Other diet items included leafcutter (*Attta* sp.) and army ants, termites, moths, beetles, frogs, and lizards (Lancaster 1964a).

**Little tinamou**

Specimens from Panama consumed insects, a small frog, and vegetative matter and seeds from species of *Amaranthus*, *Oxalis*, *Panicum*, *Paspalum*, *Solarum*, *Scleria*, *Styrax*, *Malvaceae*, and *Euphorbiaceae* (Wetmore 1965). The diet also includes tubers, seeds of *Cyperaceae* spp., ants, termites, millipedes, grasshoppers, weevils, and larval butterflies and moths (Cabot 1992). Lancaster (1964a) observed a pair consuming an unidentified frog.

**Reproduction**

Mating systems among tinamous vary widely, often including traits of polyandry or promiscuity, and exclusive male incubation and parenting (Handford and Mares 1985, Brennan 2004). Tinamous are ground nesters with precocial young that hatch synchronously (Leopold 1959, Lancaster 1964b, Brennan 2004, Brooks 2015). They lay relatively large, often colorful eggs that have a glossy appearance because of the extreme uniformity of the cuticle on the shell surface (Igic et al. 2015).

Incubating tinamous are extremely reluctant to flush from the nest and will often tolerate being approached closely or even being touched or prodded with a stick or instrument before flushing (Skutch 1963, Cabot 1992, Brennan 2004, 2009). Some species, including the slaty-breasted (Lancaster 1964b) and little tinamous (D. M. Brooks, unpublished data), cover clutches with debris during incubation recesses (Cabot 1992). Incubating thicket tinamous (Sutton 1951) and little tinamous (Skutch 1963) have been observed performing a distraction display after being flushed from the nest that involves walking near the intruder with trembling, lowered wings. Incubating great tinamous (P. L. R. Brennan, personal observation) and slaty-breasted tinamous (Lancaster 1964b) have been observed tossing leaves erratically in the immediate vicinity of the nest after rising for recesses, which may deter nest predators by disturbing chemical cues in the leaf litter.

**Great tinamou**

This species is promiscuous, pair bonds are temporary, and there are no apparent associations among females (Brennan 2005). In Costa Rica, birds reproduce at approximately one year of age (P. R. L. Brennan, unpublished data). Leopold (1959) reported most nesting in Mexico from April to June, with limited activity later in the year. In northern Guatemala, active nests were found from February through September, with a peak from mid-May to mid-July (Baur 2008). In Costa Rica, most nesting occurs between February and May but continues as late as October (Brennan 2005, 2010). Large (63 × 56 mm, 2.4 × 2.2 in), spheroid, turquoise-blue eggs are laid in scrapes between buttress tree roots (Leopold 1959, Davies 2002, Brennan 2004, 2009). Females lay eggs every other day in the early morning or late afternoon. Clutches produced by a single female have as few as three eggs, whereas clutches formed by multiple females have up to 12 eggs (Cabot 1992, Brennan 2005). In Guatemala (Baur 2008), clutches ranged from three to seven eggs (mode = 4). A 17-day incubation period begins five to nine days after the first egg is laid, and nest attendance is high throughout incubation. Males do not cover clutches during incubation recesses, will continue to incubate partially predated clutches, and aggressively defend clutches and chicks (fig. 4.5) (Brennan 2009, 2010).
Thicket tinamou

In Mexico, males are territorial during the breeding season from late March until early August (Sutton and Pettingill 1942, Sutton 1951, Paynter 1955, Leopold 1959). In Tamaulipas, Sutton (1951) reported reproductive calling beginning in early March and nesting in April and early May. In Costa Rica, breeding occurs from March to August (Davies 2002). Vegetation usually shelters nests (Sutton 1951, Leopold 1959, Cabot 1992). Eggs are described as various shades of purple (Dickey and Van Rossem 1938, Sutton and Burleigh 1940, Sutton 1951, Cabot 1992). Clutches range from three to seven eggs (mean = 5) that measure approximately 45 × 35 mm (1.77 × 1.37 in) (Leopold 1959). Thicket tinamou young become independent and solitary when they reach half the size of adults (Dickey and Van Rossem 1938).

Slaty-breasted tinamou

The mating system of this species has been described as harem polyandry and alternatively as harem polygyny in conjunction with serial polyandry (Emlen and Oring 1977, Handford and Mares 1985). Van Tyne (1935) and Lancaster (1964b) collected specimens with immature plumage that were in breeding condition, implying that maturity is reached at an early age. In northern Belize, males begin calling and establishing breeding territories in late January, and females begin calling later in the season (Lancaster 1964b). Males typically defend territories from other males via calling duels or occasionally through direct physical aggression. Territoriality declines after mating and ceases entirely once nesting begins (Lancaster 1964b). Breeding males accumulate females one at a time into temporary harems consisting of two to four females. Harems roost with the nesting male, separate during foraging in the morning, and assemble again in the afternoon in response to calls from the nesting male. Following courtship, both sexes cease calling (presumably while laying) until incubation commences, after which females disperse to repeat the process with other males (Lancaster 1964b). Lancaster (1964b) identified a pair of females that transferred together to consecutive harems and speculated that social bonds among females may facilitate communal laying. In that study, some males attending harems exhibited a defensive display in response to intruders that involved repeated vigorous flapping a few feet into the air until the females had left the scene.

Nest placement is not related to territories or home ranges (Lancaster 1964b). Males that lose nests to predators during incubation resume courtship and renest. Clutches of up to 10 purplish-pink eggs averaging 46 × 40 mm (1.81 × 1.57 in) are formed within a 4-day period by multiple females. Nests are located primarily among buttress tree roots and less frequently under fallen trees or vines. Nest attendance is high during a 16-day incubation period, when males do not call. Males use the same routes for approaching and leaving nests (Lancaster 1964b). Brooding males in the presence of chicks are aggressive toward other males. Males attend chicks for
approximately two weeks (Lancaster 1964b). Young are nearly adult size at 15 days of age. Some males repeat the entire process of territorial calling, harem acquisition, and cessation of calling up to three times during a single season, leading Lancaster (1964b) to suggest that successful males could raise up to three broods annually.

**Little tinamou**

This species is considered monogamous; however, no systematic study has been done on its mating behavior in the wild (Skutch 1963). In captivity, pairs breed successfully, and pair mates engage in contact calling and pace restlessly when separated (Brooks 2015). Although breeding pairs (Brooks 2015) and multiple birds (D. Richardson, Dallas World Aquarium, personal communication) may be maintained compatibly in captivity, when unfamiliar birds are introduced into occupied aviaries, residents attack them aggressively, as if in territorial defense (Brooks 2015). Captive females are capable of laying at one year of age. Females perform a precopulatory courtship display that involves walking slowly in circles 0.3 to 0.5 m (0.98 to 1.64 ft) in diameter with the tail oriented upward, and slowly swaying back and forth while the anterior portion of the body is held stationary (Brooks 2015).

Skutch (1963) reported breeding during most of the year in Costa Rica, with nesting peaks in February and September. Most nests were in agricultural habitats (Skutch 1963). Nests can occur under bushes or at the base of trees (Cabot 1992). Captive birds laid eggs more frequently during periods of abundant rainfall (D. M. Brooks, unpublished data) and repeatedly used the same nest sites, which consisted of slight depressions 10–11 cm (3.9–4.3 in) in diameter that were lined with leaf mulch and surrounded by low (10–18 cm, 3.9–7.0 in) vegetation (Brooks 2015). Nest abandonment and false abandonment occurred in response to extreme weather events (floods and heat waves), flushing by humans, or the placement of nests in vulnerable locations.

Eggs are a drab purplish color (Skutch 1963). More than 80% of nests in Costa Rica had two eggs, averaging 43 × 32 mm (1.7 × 1.3 in); the remainder had only one egg (Skutch 1963), although clutches of up to four eggs have been reported (Cabot 1992). Brooks (2015) reported a single clutch of three eggs in captivity that was later abandoned.

The nesting male was unable to cover all three eggs simultaneously, and consequently only one developed normally, suggesting a physical constraint favoring the typical clutch size of two eggs. Males exhibit high nest attendance during incubation, taking only 60- to 90-minute recesses each evening during the first 14 days and remaining on the nest for the duration of a 17-day incubation period in captivity (Brooks 2015). In Costa Rica, incubating birds were observed taking recesses in the morning, and incubation lasted 16 days (Skutch 1963). Brooding males exhibit a defensive display that involves ruffling the feathers and extending wings to the ground. The postnatal molt begins on day 5, and by day 25, chicks are fully feathered except for the midsagittal tracts on the head and ventrum, at which stage plumage on both sexes resembles the rich rufous plumage of adult females. Chicks are able to flutter approximately 25 cm (10 in) over distances of 2–3 m (6.5 to 9.8 ft) at 15 days of age and attain full flight at 25 days (Brooks 2015).

**Behavior**

Where several tinamou species co-occur, they may separate ecologically via different periods of activity or habitat use (Brooks et al. 2001, 2004, Schelsky 2004), although Mexican tinamous exhibit some habitat overlap (Leopold 1959, Lancaster 1964a). Some species, including the great tinamou, appear to be active at night on occasion; however, nocturnal behavior among tinamous is poorly understood (Brooks et al. 2004). Tinamous are generally solitary except when breeding (Leopold 1959, Lancaster 1964a). The great tinamous roost in trees; the other Mexican species roost on the ground (Skutch 1960, 1963; Brennan 2004).

Mexican tinamou share similar evasive and concealment behavior (Leopold 1959, Skutch 1963, Lancaster 1964a, Brennan 2004). When encountered at a distance, individuals walk away quietly and conceal themselves. When approached, they may cease movement and often alter their profile by lowering their head and raising their tail slightly. Tinamous are reluctant to fly and flush only when approached closely, usually over short distances (Leopold 1959, Lancaster 1964a, Brennan 2004).

**Communication**

Tinamou calls are an iconic element of the Neotropical experience. All four Mexican species call primarily
during crepuscular periods, to a limited extent during the day, and occasionally at night (Zimmerman 1957; Leopold 1959; Skutch 1960, 1963; Lancaster 1964a). The great tinamous (Brennan 2005), slaty-breasted tinamou (Lancaster 1964a), and little tinamou (D. M. Brooks, unpublished data) have sexually distinct calls. Slaty-breasted tinamou males call for prolonged periods from prominent landscape features or fallen trees during the breeding season, but they do not call consistently from the same sites (Lancaster 1964a). Skutch (1963) observed incubating little tinamou males calling from the nest until dark in response to calls of nearby cohorts. In captivity the little tinamou calls more frequently following rainfall (D. M. Brooks, unpublished data). Duet calls were more frequently initiated by females than by higher-pitched males, were elicited by separation of paired birds, and often stimulated calling by other pairs (Brooks 2015). The little tinamou begins to make contact calls at six months, and song repertoires are more developed in older birds, suggesting that calling ability develops with age (D. M. Brooks, personal observation).

Movement and territoriality

All Mexican tinamous are resident species (AOU 1998), although some make seasonal movements in response to flooding (Remsen and Parker 1983). Repeated observations of the great tinamou and other species at the same sites over time (P. L. R. Brennan, unpublished data; Brooks 2015) imply either strong site fidelity or strong preferences for particular site characteristics. In Amazonian Peru, the great tinamou was active in upland forest during the day and in edge habitat only at night (Brooks et al. 2001). In South America, Crypturellus spp., have been observed moving up to 1 km (0.62 mi) to reach preferred habitats (Schelsky 2004) and flying up to 500 m (1,600 ft) over open water to occupy islands exposed by receding seasonal floods (Remsen and Parker 1983).

Female great tinamou home ranges (3.2–15.0 ha, 7.9–37 ac) were at least twice as large as those of males (6.5–4.0 ha, 1.6–9.8 ac) during the breeding season in Costa Rica (Brennan 2005). Females stayed in small areas for up to eight days before moving to new sites, which is consistent with consecutive mating and laying behaviors. Home ranges overlapped in both sexes without apparent aggression (Brennan 2005). During the breeding season in Belize, male slaty-breasted tinamous establish exclusive breeding territories in overlapping home ranges of 11–19 ha (27–46.9 ac) (Lancaster 1964b). Most movements occur in the morning (over areas of 2–6 ha [4.9–14.8 ac] or linear distances of 365–550 m [1,200–1,800 ft]) and late afternoon, reaching daily totals of up to 1.6 km (1 mi), and are accompanied by territorial calling as males move erratically in response to other males. One slaty-breasted tinamou brood moved 155 m (500 ft) from the nest site and stayed within a 0.4-ha (0.98-ac) area for over two weeks (Lancaster 1964b). Schäfer (1954) reported little tinamou home ranges of 20 × 50 m (65 × 165 ft) in Venezuela.

Population Dynamics

Little is known about tinamou population structure, but there are reports that populations of all four species have equal sex ratios (Schäfer 1954, Leopold 1959, Lancaster 1964b). Numerous traits of tinamous appear to be adaptive to high natural mortality levels, implying high rates of population turnover (Gill 2007). In the tropics, predation risk for individuals and nests is relatively high in the terrestrial stratum (Martin 1988, Söderstrom 1999). Brennan (2010) found high rates of predation (75%) on great tinamou nests in Costa Rica. Nest predation occurred primarily during incubation when clutches were covered by the male, rather than during laying when eggs were exposed, suggesting that common nest predators do not rely on visual cues to locate nests. Nest predation experiments in Costa Rica did not find a significant difference in predation rates between artificial ground nests with glossy, brightly colored eggs and those with cryptically colored eggs (Janzen 1978).

Some potential nest predators are a threat primarily to clutches, including mammals such as the nine-banded armadillo (Dasypus novemcinctus), feral swine (Sus scrofa domesticus), collared peccary (Pecari tajacu), white-lipped peccary (Tayassu pecari), and large snakes (Poneus poecilonotus, Spilotes pullatus, and Drymarchon spp.). Potential predators of both clutches and adults in Mexico include the coati (Nasua narica), raccoon (Procyon lotor), didelphid opossums (Didelphis and Philander spp.), skunks (Conepatus, Mephitis, and Spilogale spp.), tayra (Eira barbara), and badger (Taxidea taxus). Mammalian predators include coyote (Canis latrans), gray fox (Urocyon cinereoargenteus), bobcat (Lynx rufus),...
jaguarundi (*Puma yagouaroundi*), ocelot (*Leopardus pardalis*), and margay (*L. wiedii*). Documented avian predators include forest falcons (*Micrastur ruficollis, M. semitorquatus*), white hawk (*Leucopternis albicollis*), and ornate hawk-eagle (*Spizaetus ornatus*); a number of other medium- and large-sized tropical raptors are also potential tinamou predators (Lamm 1974, Lyon and Kuhnigk 1985, Thorstrom 2000, Röhe and Antunes 2008).

**Status**

None of the Mexican tinamou species are globally threatened, although unsustainable hunting practices, deforestation, and other forms of habitat loss have resulted in fragmented distributions of the great and slaty-breasted tinamous, and to a lesser degree the little tinamou (Cabot 1992, IUCN 2011). In 2010, the official status of these three species in Mexico was changed from “Subject to Special Protection” to “Threatened,” and the classification of the thicket tinamou was changed to “Subject to Special Protection” (DOF 2002, 2010). These changes were based on a standardized nationwide evaluation of the extinction risk for native species (DOF 2010) rather than on specific systematic efforts to evaluate the status of populations across their respective distributions in the country.

Detailed descriptions of the current distribution and status of Mexican tinamous are unavailable. Some reported density estimates appear robust, but it is unclear whether these represent reproductive aggregations or overall population densities. The great tinamou can be locally common in protected forests (Cabot 1992). In northern Guatemala, great tinamou densities ranged from 5/km² (13.1/mi²) in areas with regular hunting pressure and limited agricultural disturbance, to 15/km² (39.2/mi²) in primary forest without hunting (Baur 2008). The thicket tinamou is common in many areas. Leopold (1959) reported estimates of six to eight breeding pairs of thicket tinamou per 100 ac (30–40/km², 78.3–104.4/mi²) in Tamaulipas. Mapping of male territories, with the assumption of equal sex ratios, indicated that slaty-breasted tinamou densities in northern Belize approached 20/km² (52.2/mi²) in areas where it was most common (Lancaster 1964b). In Peru, little tinamou densities ranged from 15–19/km² (39.2–49.6/ mi²) in preferred habitats to 4–6/km² (10.4–15.7/mi²) in other habitats (Schelsky 2004).

**Management**

**Harvest management**

We do not fully understand the response of tinamou populations to harvest pressure, and research is needed to develop evidence-based management recommendations for these species in Mexico. However, existing management principles for galliform species can guide related efforts. Subsistence hunting, which has been shown to have a negative relationship with great tinamou population density (Baur 2008), is widespread, especially in southern Mexico where most remaining forests are community managed (Weber et al. 2006). Efforts to control subsistence hunting or mitigate its impacts should be prioritized where management objectives include the conservation or sustainable use of tinamou populations.

Currently, the thicket tinamou is the only species people are permitted to hunt in Mexico; the slaty-breasted and great tinamous are officially threatened, and the little tinamou is not considered a game species because of its diminutive size. With adequate control of timing and intensity, populations of the three largest Mexican tinamous could likely be harvested sustainably and integrated into game management efforts to improve local food security in community-managed forests or to diversify sport-hunting options in UMAs. Until more information is available, restricting hunting from the fall through January should minimize interference with reproductive activities.

**Habitat management**

Little is known about how populations of Mexican tinamous respond to specific land-use practices. For the time being, only general management recommendations can be made based on habitat affiliations. Habitat management for great and slaty-breasted tinamous should emphasize forest conservation and restoration. In Guatemala, the great tinamou was less likely to occupy forest fragments than smaller *Crypturellus* species, and occupancy by the great tinamou exhibited a negative relationship with forest fragment density at the landscape scale, implying an adverse edge effect (Thornton et al. 2012). Habitat management efforts could target slopes and other areas less productive for agriculture on private or communal property, and the protection of existing forest and secondary growth from fire or other disturbance. In areas adjacent to existing forest
tracts, reforestation and silvicultural treatments that expedite the maturation of secondary growth would likely increase available habitat and connectivity between existing forest fragments.

Habitat management for thicket and little tinamou populations should emphasize conservation of natural scrub communities and retention of the maximum possible area of secondary scrub in deforested areas, preferably in contiguous tracts and areas that improve connectivity among habitat patches. In dry and semiarid areas, habitat management for the thicket tinamou could be as simple as timing brush control efforts to avoid interfering with reproductive activities and allowing scrub to remain or develop along linear landscape features such as ridges, drainageages, arroyo channels, and riparian areas.

**Coordination with other land uses**

Little information is available to inform land-use decisions with respect to tinamou population management in Mexico. Anecdotal evidence suggests that the management of thicket and little tinamou populations may be consistent with the production of cattle and other livestock, some plantation agriculture, and traditional swidden agriculture that maintains large areas in fallow growth. Forest fragment occupancy by the little tinamou in Guatemala exhibited a negative relationship with distance from human settlements, implying that management for this species could be appropriate in relatively disturbed habitats (Thornton et al. 2012). Rotational grazing; the use of trees that are important in tinamou diets for shade, forage, or as living fences or pasture borders; and mitigation of livestock damage to vegetation at stock tanks, ponds, and riparian areas by restricting livestock access should be explored as means of conserving or improving habitat availability and quality. Avoiding or intensively controlling burning and other brush control efforts immediately prior to and during breeding activity peaks also deserves consideration, along with retaining as much fallow growth as possible.

Areas subject to low-density, selective, certified timber extraction on the southern Yucatán Peninsula did not exhibit negative impacts on the abundance of great, thicket, or slaty-breasted tinamous (Radowcowsky 2004). Reforestation and timber enrichment efforts or plantations should be explored as potential forestry practices for tinamou population management. Valuable timber species such as *Aspidosperma megalocarpum, Calophyllum brasiliense, Dendropanax arboreus, Masticodonax foetidissimum, Pouateria amygdalina, and Swietenia macrophylla* provide important food resources for tinamous and should be considered in such efforts (Lancaster 1964a).

**Management Challenges in Mexico**

The relative obscurity of Mexican tinamous poses a challenge to management. Whereas the popularity of sport hunting for waterfowl, doves, and wild turkeys has led to research efforts and increased international cooperation and policy development in Mexico, tinamous have failed to attract similar attention. Because of the high degree to which some UMAs depend on foreign sport hunters (Valdez et al. 2006), it may be helpful to raise awareness of tinamous internationally, such as among residents of the border areas of the US. Such efforts could be as simple as featuring a thicket tinamou hunt in popular press magazines or related cable television programs. Alternatively, efforts could focus on promoting awareness of tinamous among the international and domestic memberships of user-based conservation groups already working in Mexico (e.g., Ducks Unlimited, National Wild Turkey Federation, Safari Club International). Efforts to promote domestic interest in tinamous could focus on Mexican sport-hunting organizations and UMA administrators.

It is remarkable that half a century after Leopold (1959) proclaimed the virtues of the great and thicket tinamous, we have made little advancement in our understanding of these or the other tinamou species native to Mexico. Tinamous merit increased research attention to learn more about their intriguing ecological and biological aspects (Brennan 2004), as well as to develop effective policies for their conservation and management. We need a greater understanding of their population dynamics, habitat suitability, dispersal, and population responses to different land uses and controlled harvest scenarios.

General challenges to tinamou management in Mexico include many issues that affect wildlife management nationwide. High rates of deforestation, rural poverty, limited law enforcement and rural governance capacity, and the challenges inherent in developing and administering regionally appropriate policies are wildlife management challenges that also apply to tinamou conservation (Valdez et al. 2006, Weber et al. 2006). Unfortunately, many of
these problems appear to be most severe in southern Mexico, where tinamou diversity is greatest (Bray and Wexler 1996, Weber et al. 2006).

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