First observed wild birth and acoustic record of a possible infanticide attempt on a common bottlenose dolphin (*Tursiops truncatus*)

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We observed the birth of a common bottlenose dolphin (*Tursiops truncatus*) followed immediately by a possible infanticide attempt in the estuary near Savannah, Georgia. Our report is unique in several ways: first, we witnessed the birth of the calf; second, we observed infanticidal behavior almost immediately afterward; and third, we obtained acoustic recordings concurrent with the possible infanticidal behavior. Our observations provide insight into aggressive, possible infanticidal, behavior in bottlenose dolphins.

Births of wild cetaceans have only been documented in the literature for a few species. These include several mysticetes [right whale (*Eubalaena glacialis*): Zani *et al.* 2008, Foley *et al*. 2011; humpback whale (*Megaptera novaeangliae*): Ferreira *et al*. 2011, Faria *et al.* 2013; and gray whale (*Eschrichtius robustus*): Balcomb 1974, Leatherwood and Beach 1975, Mills and Mills 1979] and odontocetes [sperm whale (*Physeter catodon*): Gambell *et al*. 1973, Weilgart and Whitehead 1986; beluga whale (*Delphinapterus leucas*): Beland *et al*. 1990; false killer whale (*Pseudorca crassidens*): Notarbartolo-di-Sciara *et al*. 1997; and killer whale (*Orcinus orca*): Stacey and Baird 1997]. Surprisingly, although they are among the most-studied cetacean species, there are no observations in the primary literature of wild bottlenose dolphin births.

Infanticidal behavior, whereby individuals kill conspecific infants, is widespread in the animal kingdom and has been described in several mammalian species (Hrdy 1979), including the common bottlenose dolphin (*Tursiops truncatus;* Patterson *et al*. 1998, Dunn *et al*. 2002, Kaplan *et al*. 2009, Robinson 2014). Initial records of infanticide in dolphins were from post-mortem examinations (Patterson *et al* 1998, Dunn *et al*. 2002). The few field observations of infanticidal behavior (Kaplan *et al*. 2009, Robinson 2014) involved calves whose ages were estimated to range from a few days old (Robinson 2014) to less than one year (Patterson *et al*.

1998, Dunn *et al*. 2002) to at least a year old (*i.e.*, 2/3 the size of adults in the group; Kaplan *et al*. 2009). There have been no previous reports of a calf being attacked within minutes of birth.

On August 23, 2013, as part of an intensive research project, researchers on three vessels were searching for common bottlenose dolphins. There were multiple groups of dolphins spread over a wide area near the northwest corner of Tybee Island, Georgia (Fig. 1). At 1145 we encountered a group of five dolphins, and shortly thereafter (1153) observed thrashing, followed by a newborn sighted in the group. Within the next minute, we observed red fluid in the water, assumed to be blood from the placenta, and around this time four additional individuals joined the group. Four minutes after the birth (1157), we witnessed extremely active behavior at the surface, including the neonate being pushed underwater by other animals and then being carried to the surface on the back of its mother. At 1159 we observed the umbilical cord still attached to the mother (Fig. 2).

The mother had been previously identified as part of an ongoing photo-identification effort; she had been previously sighted with a calf in 2010 (R. Perrtree and T. Cox, unpub. data). Two other group members had also been previously identified and had been together in all four of their previous sightings (in 2010 and 2011), during which neither was ever seen with a calf. In this sighting both were identified as males based on observations of penises observed, followed by a surfacing in which the dorsal fin was photographed. Therefore, they were presumed to be a male pair. Male pairs, or alliances, are a well-known social unit in other dolphin populations (*e.g.*, *Tursiops truncatus* in Sarasota, FL: Owen *et al*. 2002; *Tursiops aduncus* in Shark Bay, Australia: Connor *et al*. 1992). Researchers on one of our other vessels observed this pair flanking the mother at 1012, approximately 1.5 h before the birth, and the pair was heavily involved in the presumed infanticidal behavior, as described in greater detail below.

Four minutes after the birth (1157) one video clip was recorded (55 s duration, video file can be accessed in the supplemental materials). This video has been evaluated by four people, one of whom was not on the boat during the event. The video began with the mother pushing the neonate to the surface several times, the two identified males surfaced approximately one body length behind the mother. The two males then approached from behind, both mother and neonate submerged, and then the mother carried the calf to the surface on her back. Next the two males surfaced on opposite sides of the pair, ventral sides up with penises visible as they leapt out of the water and on top of the calf. Subsequently, surface activity increased with flukes splashing, after which the mother resurfaced with the calf on her head again. All other visual observations were made in the field or determined from photographs.

Throughout the initial 30 min period of observations after the new animals joined the group, there were five recorded bouts of surface active behavior. The mother was observed engaged in various active behaviors, including thrashing her flukes through the air, lunging, and a high-arch dive. Overall, the surface behavior was chaotic with considerable thrashing and white water. Aggressive behaviors were apparently being directed at the newborn calf, including what appeared to be forcible submergence of the neonate by the presumed male pair during at least four bouts over a 23 min period. The observation of submergence behaviors contrasts with previous literature on infanticidal behavior, which describes aggressive activities visible above the surface, such as "calf tossing" and "aerial flip rams" (Dunn *et al*. 2002, Kaplan *et al*. 2009, Robinson 2014).

We observed the animals for almost three hours, leaving them at 1430 to return to our previously scheduled research activities. We did not witness any activity indicative of aggression towards the neonate after the initial 30 min, although we have reason to believe that aggression may have continued based on the acoustic recordings (described below). At the beginning of the sighting, we were within 10-50 m of the dolphins, but then moved to approximately 100-300 m away so as to not affect the mother's interactions with her calf. It is likely that at these greater distances we were too far away to observe aggressive activities, especially if they were occurring beneath the surface.

Because there was vigorous activity and dorsal fins were not always visible, we could not positively identify all of the animals submerging the calf in every bout of surface active behavior; however, the two males were clearly identified in four of the bouts. We believe that the presumed male pair were the primary aggressors during the infanticidal behavior because their fins were the only ones identified in images just before, during, and after the bouts of aggressive activity, other than that of the mother. This pair continued to flank the mother and neonate for most of the 2.5 h after the initial attack. It is intriguing that they had also been sighted with the mother 1.5 h prior to the birth, possibly indicating they were tracking the birth in preparation for the infanticide attempt.

It is possible that the intention of the males was to mate with the mother rather than to act aggressively towards the calf. However, the immediate impression of the researchers in the field and analysis of the video was that this was an infanticide attempt. In addition, this alternate hypothesis is not supported by our multiple observations of individuals submerging the calf, followed by the mother raising the calf out of the water. It is clear that even if the males were targeting the mother, the neonate was in immediate danger as it was leapt upon by the males, and the mother frequently surfaced with the neonate on her head or back. Mating and infanticide are not mutually exclusive – in fact, one would expect them to coincide, since they may be trying to kill the infant in order to make the mother receptive.

We observed the neonate with its mother in a group of eight dolphins the following day (August 24, 2013). The group included four additional individuals from the previous day, two of which were the presumed male pair. Long-term survival of the calf after that time cannot be confirmed as the mother has not been subsequently re-sighted. We were able to find only one previous field observation of infanticidal behavior in dolphins that reported on survival of the calf. Robinson (2014) stated that the calf survived for eight months but was found to have acute scoliosis upon its death, which he speculated was due to injuries sustained during the attack.

Acoustic recordings began about one minute after the birth and continued throughout most of the observation period, for a total of approximately 2 h 10 min (occasionally recordings were stopped to make announcements or to replace media). This event was a rare opportunity to record dolphins during a known aggressive context. Although several studies of captive common bottlenose dolphins have documented various pulsed sounds associated with aggressive contexts (*e.g.*, Overstrom 1983, McCowan and Reiss 1995, Blomqvist and Amundin 2004), it is challenging to document context-specificity of sounds in wild dolphins, given that they spend most of their time out of sight of researchers. Connor and Smolker (1996) documented a "pop" sound associated with aggressive herding of females by a provisioned coalition of male Indo-Pacific bottlenose dolphins (*Tursiops aduncus*); however, no sounds definitively associated with aggressive contexts have yet been documented in wild common bottlenose dolphins.

Broadband, burst-pulsed sounds, similar to those that have been attributed to aggressive interactions between captive dolphins (*e.g.*, Blomqvist and Amundin 2004), were recorded during aggressive behavior toward the neonate (Fig. 3). However, another sound type (a low frequency tonal sound) was much more common throughout the recording (occurring approximately 6 times more often than burst-pulsed sounds: 834 *vs*. 142; Fig. 4). These low frequency tonal sounds shared at least superficial similarities with those reported in several other studies. For example, “low frequency, narrow band” (LFN) sounds were described by Schultz *et al*. 1995 and Simard *et al*. 2011, “thunks” were described by McCowan and Reiss 1995, and “gulps” were described by dos Santos *et al*. 1995. However, comparisons are difficult without standardization of spectral parameters among studies. McCowan and Reiss (1995) found “thunks” to be “maternal aggressive contact vocalizations” in their study of captive dolphins. In studies of wild dolphins (dos Santos *et al*. 1995, Schultz *et al*. 1995, and Simard *et al*. 2011) only correlative contexts could be proposed. While dos Santos *et al.* (1995) speculated a feeding context for “gulps,” both Schultz *et al*. (1995) and Simard *et al*. (2011) ascribed LFN sounds to loosely defined social contexts, although whether or not they were aggressive was not determined. As we were not able to confirm or refute whether the sounds we recorded during the infanticide attempt were the same as those described previously, we refer to them simply as “low frequency sounds.”

During the initial approximately four minutes of aggressive behaviors, low frequency sounds occurred at a rate of 31.9/min, along with body contact sounds (intense impact-like sounds; 3.7/min), burst-pulsed sounds (8.0/min), buzzes (4.3/min), and whistles (17.1/min). Although data are sparse for call rates in the wild, Cook *et al*. (2004) reported whistle rates of common bottlenose dolphin groups containing mother-calf pairs in Sarasota, Florida of only 0.38/min. The initial group whistle rate of 17.1/min is high even when compared to those for socializing groups, for which Cook *et al*. (2004) reported group rates of 2.4/min and Quick and Janik (2008) reported rates of 0.6/animal/min. During this initial period, 89% of whistles were of the same type (see examples in Fig. 4) and contained features possibly related to stress, such as amplitude modulation and increased loop number, as well as high rates of production (Esch *et al*.

2009). A total of 315 whistles of this type occurred throughout the recording session. Low frequency sounds occurred in bouts, which were defined as occurrences separated by at least 10 s. A total of 834 low frequency sounds occurred in 35 bouts consisting of 3 to 85 sounds each (mean = 23.8, std dev = 20.3). Bouts occurred throughout the recording session, with the last one only 4 min before we left the group. Thus, although we were too far away at this point for visual observations, the continued occurrence of low frequency sounds may indicate that aggressive behaviors continued throughout (and possibly beyond) our recording session.

We examined the tendency for whistles to co-occur with low frequency sounds by counting the number of times whistles of a given type occurred within 10 s of the beginning or ending of a bout of low frequency sounds. Of approximately 685 total whistles in the overall recording, there were at least six whistle types visually identified according to contour shape (as in Sayigh *et al*. 2007). The predominant type (see Fig. 4), which comprised 46% of whistles (315/685) was significantly more likely to co-occur with bouts of low frequency sounds (32 of 35 bouts) than a comparable sample size (n=314) of four other whistle types (18 of 35 bouts; Fisher exact test $P < 0.001$).

Overall, acoustic data from the infanticide event support the idea that low frequency sounds were associated with aggressive behaviors. These sounds contained features characteristic of aggressive motivation as described by Morton's classic "motivation-structural rules" (Morton 1977), including low frequencies, downswept contours, and overall "harsh" characteristics (Fig. 4, supplemental materials). High rates of one whistle type may reflect the stressful nature of the situation (Esch *et al*. 2009). Based on these high rates, and the co-occurrence of this whistle type with low frequency sounds, we speculate that it may be the signature whistle of the mother. This idea is also supported by one instance when the mother was very close to the boat, at which time we recorded very loud whistles of this type. We further speculate that the low frequency sounds may be aggressive signals produced by the males. However, given our inability to positively identify all aggressors or the identities of the vocalizing individuals, other scenarios are possible as well. Further studies are needed to determine if low frequency sounds are associated with aggressive contexts.

Our study provides unique insights into several aspects of bottlenose dolphin behavior. First, this is the only published report of a live birth of a wild bottlenose dolphin in the literature, indicating that bottlenose dolphin births are inconspicuous. Second, males may be monitoring the reproductive state of females as evidenced by the fact that the males were observed with the mother 1.5 h before the calf was born, in combination with the immediacy of the infanticidal behavior. Third, attacks may be conducted underwater, without tossing calves into the air; thus, infanticidal behavior may occur at a higher rate than previously indicated by the literature. Since we observed an aggressive interaction and submergence of the calf almost immediately after the birth, we believe it was more likely an infanticide attempt than a mating event. Although there is no way to know the intention of the males, the result was imminent danger to the neonate. Finally, the finding that low frequency tonal sounds are used in an aggressive context may enhance interpretations of acoustic recordings of wild dolphins for which contexts are usually ambiguous or unknown. The concurrent acoustic recording further substantiated an aggressive event while providing evidence that the encounter lasted much longer than our surface observations indicated. Despite the inability to definitively determine the purpose of the low frequency sounds, the visual observations and limited supporting literature seem to indicate that an aggressive interaction with the neonate occurred – highlighting the importance of coupling visual and audio recordings in the field to corroborate surface behavior with what occurs underwater.

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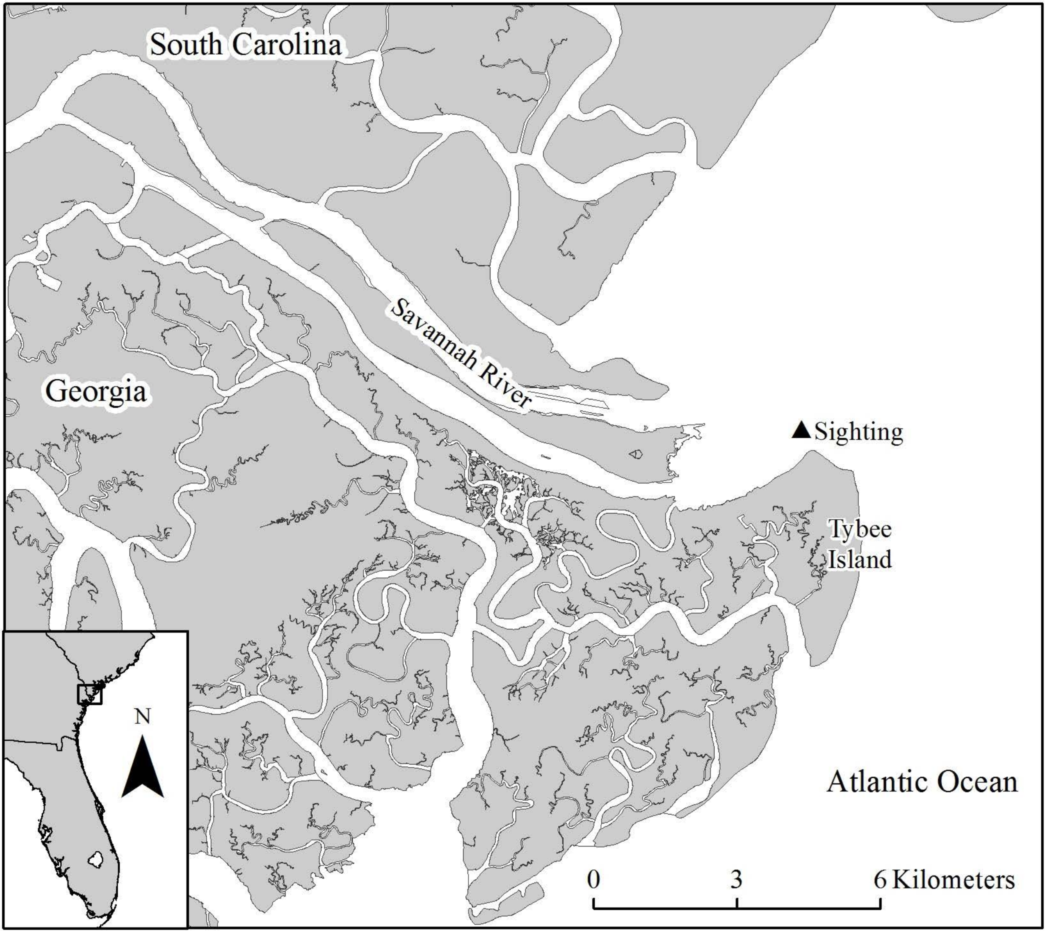
Figure 1. Initial sighting location of common bottlenose dolphins (*Tursiops truncatus*) near Savannah, Georgia.

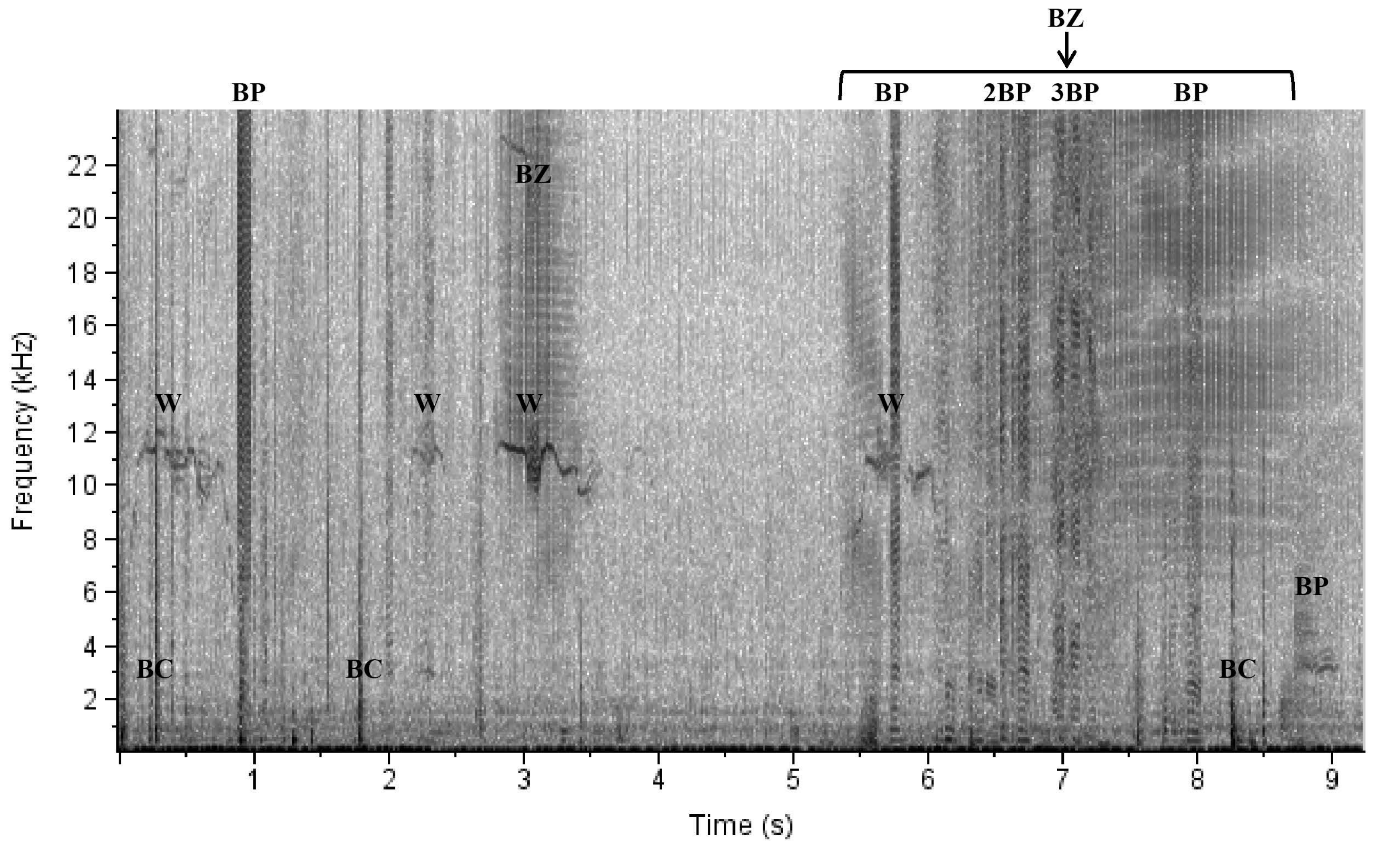
Figure 2. Photograph of the mother common bottlenose dolphin (*Tursiops truncatus*) with the umbilicus still attached.

Figure 3. Examples of various sounds that occurred during the possible infanticide attempt by common bottlenose dolphins (*Tursiops truncatus*), including burst-pulsed (BP) sounds, body-contact (BC) sounds, buzzes (BZ; evident at approximately 3 s and also in the bracketed area), and whistles (W). Low frequency sounds are shown in Fig. 4. Sound file can be accessed in the supplemental materials.

Figure 4. Low frequency tonal sounds and whistles that commonly co-occurred with the sounds recorded during the possible infanticide attempt by common bottlenose dolphins (*Tursiops truncatus*). A 1.5 s segment is enlarged in the inset to provide a closer look at the structure of the low frequency sounds. Note high repetition rate of whistles and multiple repetitive whistle loops, suggested by Esch *et al*. 2009 to be indicative of stress. Sound file can be accessed in the supplemental materials.



Source data: USGS National Hydrography Dataset. Projection: Transverse Mercator, UTM 17N, NAD 1983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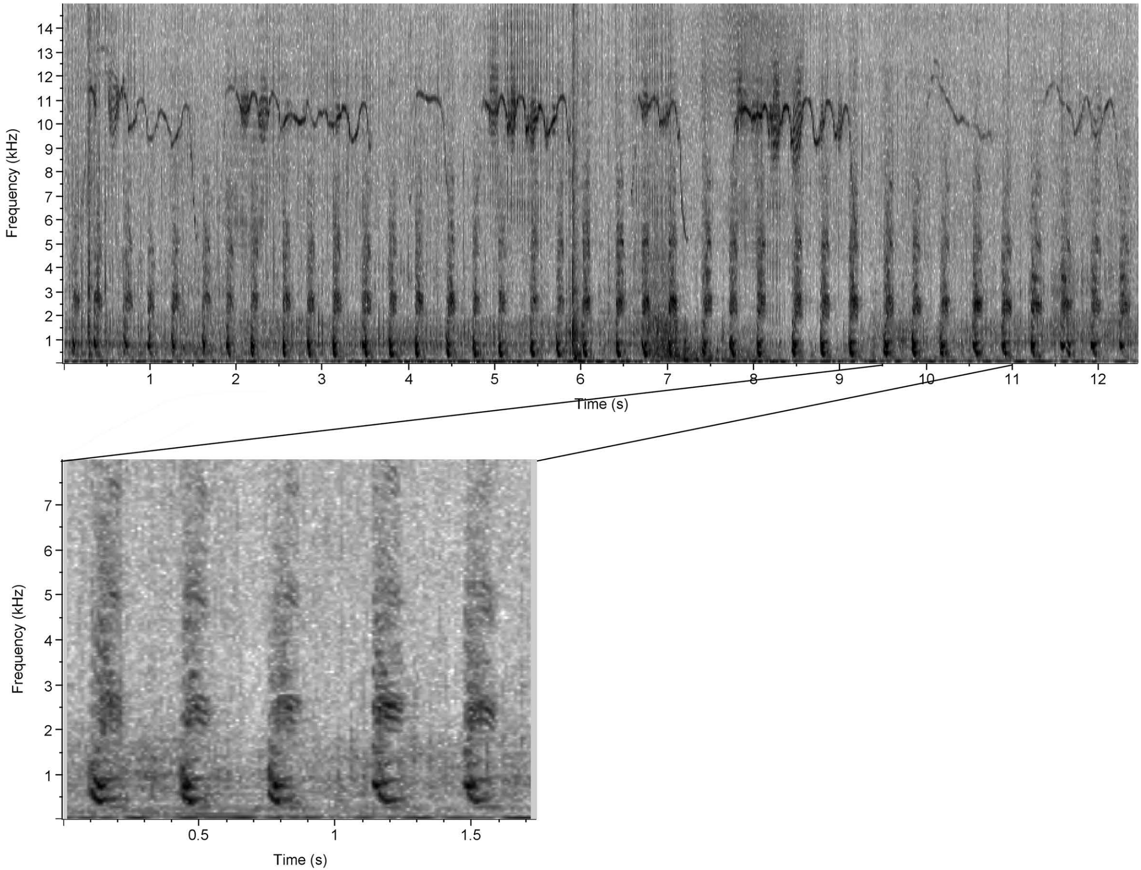

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