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## Case Report

## Investigation into the illegal killing of a tagged Eurasian Curlew

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## ABSTRACT

On 9 August 2020, one of 10 tagged Eurasian curlews we tracked with GPS died on Ile Madame, France, and we managed to collect the corpse for further analyses. Our investigation proved that the bird was shot, as x-ray imagery revealed a single lead ball under the bill skin, while the bill had been recently broken. The study of the GPS tracks during the last days and hours of the bird's life indicated a normal foraging activity during the previous night. The bird moved to the high tide roosting bank of Ile Madame during the night, and was shot to death at sunrise. Directed intentionally or not towards the curlew, the shot was the cause of the death. The Eurasian Curlew is endangered to extinction, and as such is not huntable anymore across Europe. With an adult survival estimated at 92 %, any additional adult mortality can have a noticeable impact on population dynamics, hence on extinction risk. For the sample of 10 adult curlews we tagged, this single additional mortality by illegal shooting theoretically doubles the annual mortality rate. The tagged individual belonged to the small threatened Belgian breeding population estimated to count 170–230 breeding pairs.

## 1. Introduction

Eight species of curlews are currently recognized (Aves: Scolopaciidae), most being declining and at high risk of global extinction, while two species are probably already extinct: the Eskimo Curlew *Numenius borealis*, last sighted in 1987 in Nebraska, and the Slender-billed Curlew *N. tenuirostris*, last sighted in 1995 in Morocco [1]. Another species is listed as Endangered (the Far Eastern Curlew *N. madagascariensis*), one as Vulnerable (the Bristle-thighed Curlew *N. tahitiensis*), and one as Near-Threatened (the Eurasian Curlew *N. arquata*) to extinction on the IUCN Red List ([www.iucnredlist.org](http://www.iucnredlist.org)).

The Eurasian Curlew breeds in temperate Europe and Asia and migrates to spend the non-breeding season (June-March) on a variety of coastal and intertidal habitats of north-west Europe. The European population is estimated at 212,000–292,000 pairs and considered to have decreased by 30–49 % in 30 years so that the species is classified as Vulnerable to extinction in the regional IUCN Red List [2]. The species is therefore subject to numerous conservation efforts to preserve the birds and their habitats [3] and is listed on Annex II of the EU Birds Directive (Directive 79/409/EEC of the European Council of 2 April 1979 on the conservation of wild birds), permitting hunting in few listed Member States, e.g. Denmark,

France, Ireland and the United Kingdom. Since the 1979 agreement, because of the continuous declines in breeding populations, hunting bans have been implemented in Denmark, in the UK (1982 for Scotland, England and Wales; 2011 in Northern Ireland) and Ireland (2012). France implemented a five-year moratorium on hunting in 2008. This moratorium was largely lifted in 2012, to allow hunting at coastal sites from the first Saturday of August until the last day of January – the classical hunting period for waterbirds along at coastal sites. So the moratorium was then restricted to terrestrial sites from 2012 to 2018. It should be noted that a partial moratorium restricted to non-coastal sites is largely meaningless as the majority of Eurasian curlews that visit France outside of the breeding season stay on the coast [4]. Since 2012, France was, therefore, the only European country to hunt Eurasian Curlew, with a hunting bag estimated at approx. 7000 individuals (range 4400–9500) in 2013–14 [5]. After engaging in the process of adaptive management for that species, a governmental decree allowed the hunt of a quota of 6 000 individuals for the 2019–2020 hunting season, though the French Council of State later abrogated that decree, fixing the quota to zero. For the 2020–2021 hunting season, the French government published a decree fixing the quota to zero ([www.legifrance.gouv.fr/jorf/id/JORFTEXT000042176842](http://www.legifrance.gouv.fr/jorf/id/JORFTEXT000042176842)), so that any hunting action leading to the death of a Eurasian Curlew is illegal.

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In this conflictual context, we developed a research scheme aiming at unravelling migration connectivity in the species, to better appreciate the origins and destinations of those individuals under potential hunting pressure in France. For that reason, we captured, ringed and GPS-tagged wintering curlews in Western France, to further discover where these birds move to breed in the spring. In February 2020, we tagged 10 Eurasian curlews in a nature reserve there. Two of them stayed on the non-breeding grounds during the following breeding season, so are presumed to have been first-summers. Eight of them left the non-breeding area to reach their breeding grounds, including one which subsequently bred in Belgium. Depending on the success of their breeding attempts, such adults move back to the non-breeding grounds in June or July. While all eight birds moved back to coastal western Europe in June, the Belgian breeder died in France on 9 August. Although hunters were not allowed to shoot Eurasian curlews in France in 2020, this death occurred shortly after the opening of the waterbird hunting season (1 August). As a consequence, we decided to investigate this case to try to establish the cause of the death.

## 2. Material and methods

The curlew was captured, ringed and tagged on 23 February 2020 at Moëze-Oléron National Nature Reserve, Charente-Maritime, France (45.90 °N, 1.08 °W). We tagged the bird with Ornitrack-10 solar-powered backpack tag with GSM data transmission (weighing 10 g) and a

brown case, the harness being a leg-loop Teflon rubber (2.5 mm wide) closed by a glued knot. Data acquisition depended on battery charge, and range from one location recorded every minute to every hour. Data transmission occurred once a day, times provided were UTC. The bird was ringed with colour rings representing a unique combination to enable the distant individual identification by field observers (Fig. 1). The bird weighed 812 g, so the material (tag, harness and rings) represented, e.g. 1.5 % of the body mass. The bird was not sexed at ringing, because of an intermediate bill length (126 mm; see Ref. [6]), but further observations when paired on breeding grounds indicate that it was a male, because its partner was a larger and longer-billed individual (female).

The bird stayed in the wintering grounds of Pertuis Charentais until 7th March 2020, when it left between 21:31 and 22:31 to arrive on its breeding grounds in Belgium on 8th March between 05:33 and 06:34, lingering near Oosterlo at 51.11 °N 4.97 °E. Mid April the breeding pair moved to Wiekevorst/Herlaar (51.11N°, 4.74 E°) and started breeding at the beginning of May. The nest was found thanks to the tracking device, and further protected by an electric fence to prevent depredation by mammals (Fig. 1). Unfortunately the nest was predated just a few days before hatching. The tagged curlew left the breeding area on 25<sup>th</sup> June at 20:51, to arrive back in Pertuis Charentais on 27<sup>th</sup> June at 00:28.

On 9th August, the tag transmitted an alert for abnormal stationary locations, being located but totally immobile off Ile Madame, Charente Maritime (45.965 °N, 1.136 °W). The message alerted for a tag with null



**Fig. 1.** The Eurasian curlew that was found dead had been captured in western France on 28th February 2020, when it was colour-ringed and tagged with a GPSs-GSM transmitter. It later moved to Belgium to breed there in a grassland, though the breeding attempt was unsuccessful as its nest was depredated. (a) The curlew at ringing; (b) the curlew on its breeding territory in Belgium (photo by Nobert Goossens); (c) the nest of that curlew (photo Stefan Janssen); (d) the grassland near Herlaar where the nest was located (nest area fenced for protection; photo Griet Nijs).

accelerometer values, which should not occur if the tag is fixed on a live animal. The stationary location was a known high-tide shorebird roosting site. A visit to the site on 11th August allowed to collect the corpse (see Fig. 2) and the tag. The corpse was further frozen, transported to the National Museum of Natural History (MNHN) in Paris. The advanced state of decomposition did not allow to perform an informative necropsy, so we decided to led investigations with x-ray imagery. The only useful elements we obtained were that the stomach was empty, the tongue was intact, and the left flank had been extensively consumed by numerous maggots. The skeleton of the bird has been prepared by the museum oestologists and is now preserved in the MNHN collection under the catalog number ZO-MO 2020-491

### 3. Results

#### 3.1. X-ray imagery

Fig. 2 includes two x-ray images of the dead bird, with a global view revealing only one metal ball (approx. 1 mm diameter), located at the base of the left nostril, on the upper mandible of the bill. The ball was found just under the skin covering the bill. A magnet did not attract the ball, so we deduced that it was a lead ball. Fig. 3 presents different x-ray images of the

bill base after extraction of the lead ball, under various view angles. They reveal a recent, un-repaired fracture near the basis of the right bone of the lower mandible. Given fracture and lead ball positions, we deduce that the ball entered the bill from below and came from the front of the bird. There was no trace of bone remodelling, repair or consolidation, attesting that the breaking was very recent.

#### 3.2. GPS tracks

Fig. 4 reports the data collected by the embarked tag from 6 August 00:00 to 10 August 24:00, including (a) latitude and longitude, to detect locations of feeding and roosting sites and movements between such sites, and (b) the bathymetric locations compared to tide elevation of the locations where the bird was located while feeding and resting. Fig. 5 reports the same location data as in Fig. 4a but restricted to the last days of life of the curlew, and (b) the accelerometer values (in three dimensions: x, y, z) obtained by the tag for the same period.

By comparing the tide charts for August 2020 at Ile d'Aix (46.01 °N; 1°17 °W consulted here: <http://maree.info/128?d=20200808>), we can deduce that the bird roosted during all high tide events at the reserve where it had been ringed (45.90 °N, 1.08 °W). During the low tide, the bird moved to other places: a diurnal feeding area at an oyster farm

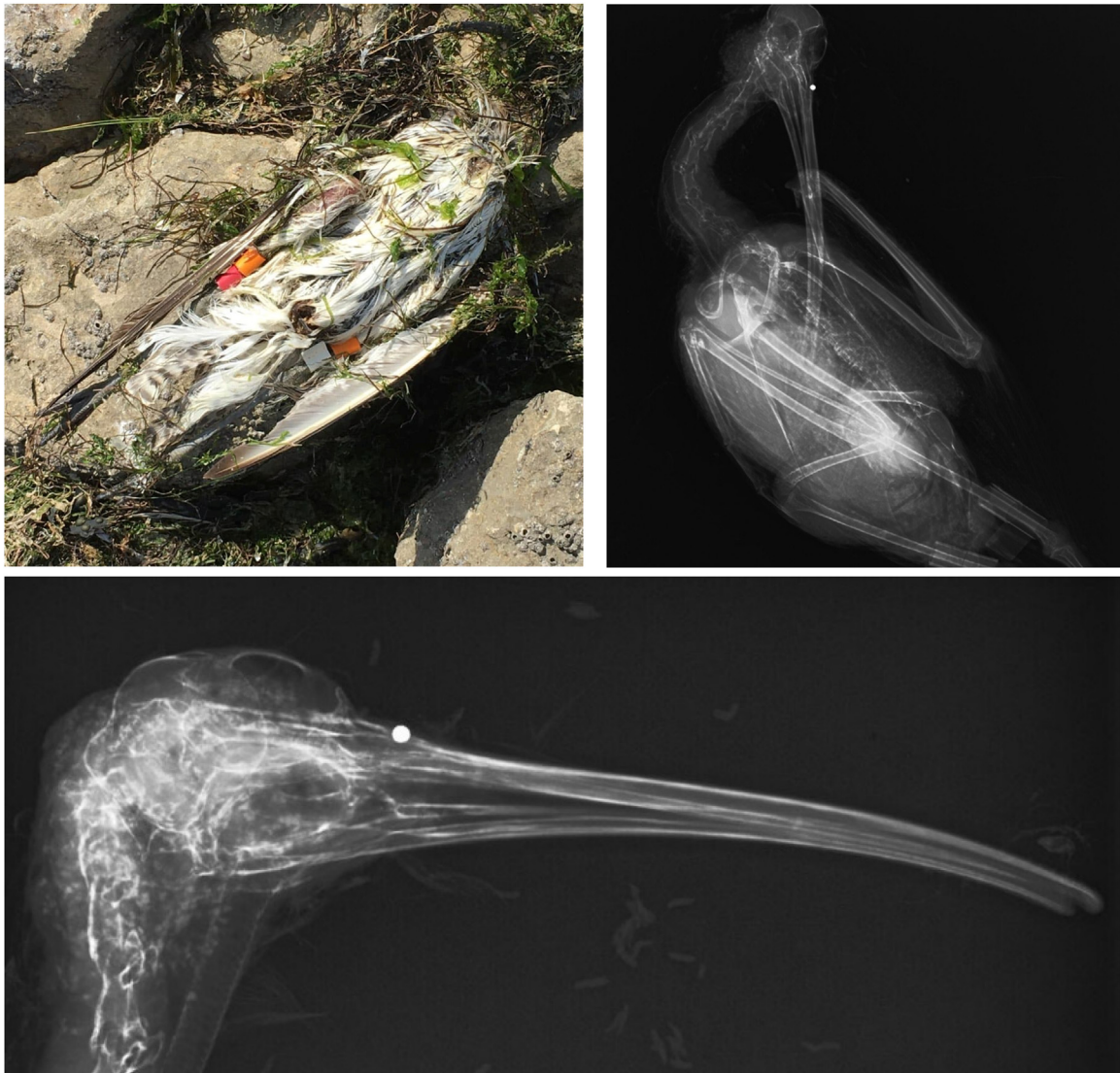
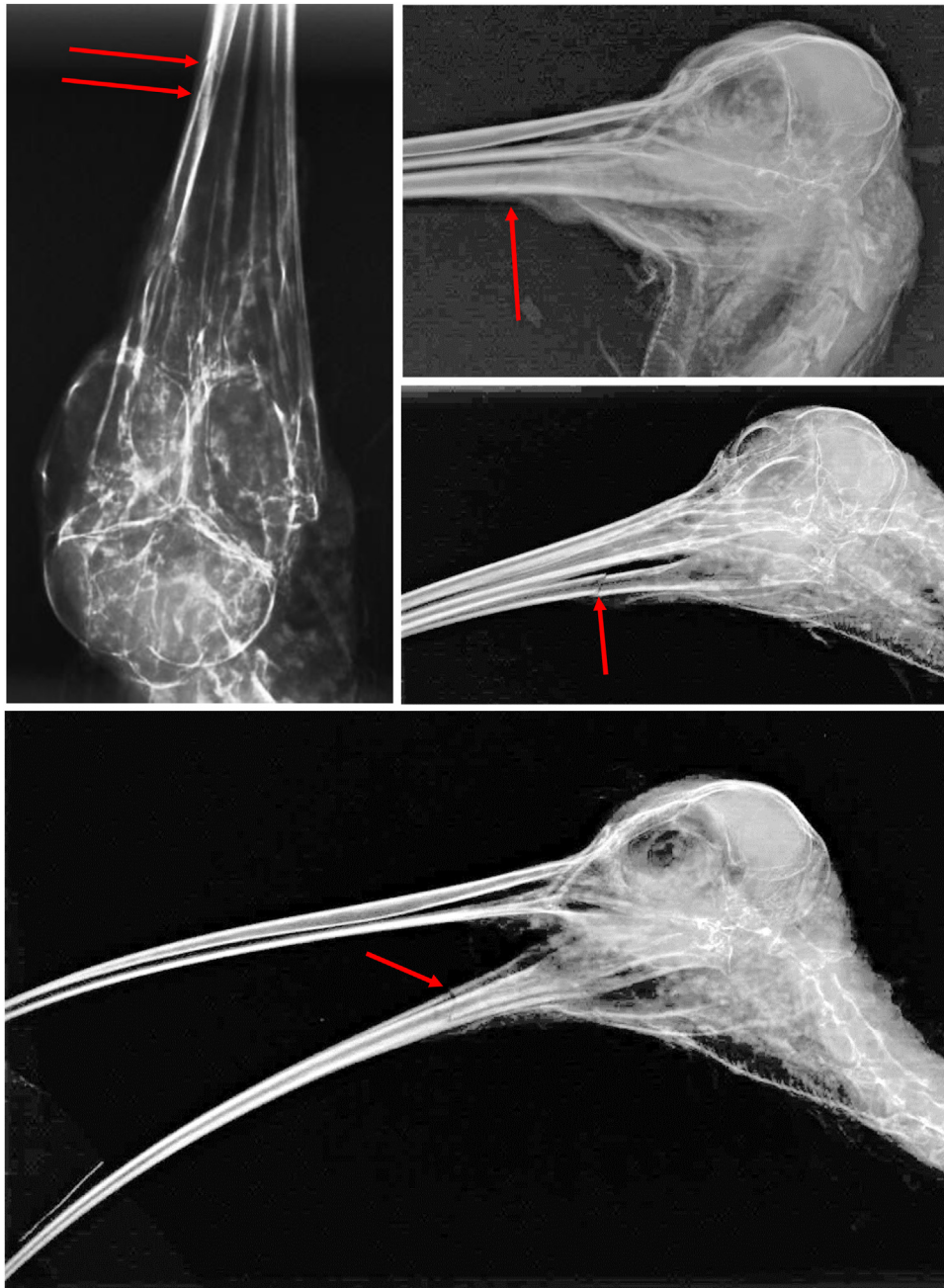


Fig. 2. The corpse of the curlew, as found on the rocky bank on Ile Madame on 11<sup>th</sup> August 2020 (a), and x-ray images of the whole body (b) and of the head (c) revealing the presence of a single ball, located at the bill base.



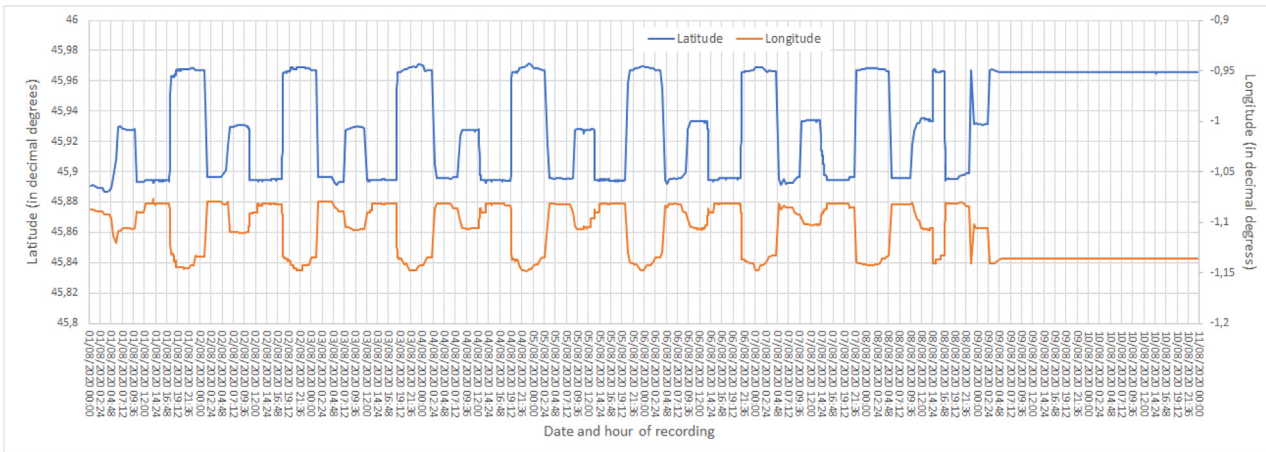
**Fig. 3.** X-ray images obtained after retrieving the lead ball. The red arrows point to the bone fracture at the right basis of the lower mandible. (a) view from below; (b) view from the left side; (c) view from below (angle  $\sim 45^\circ$ ); (d) view from the left side with bill open.

located (approx.  $45.93^\circ\text{N}$   $1.10^\circ\text{W}$ ) during the day, and a nocturnal feeding site on the rocky bank north-west of Ile Madame ( $45.96^\circ\text{N}$ ,  $1.13^\circ\text{W}$ ) – where it was found dead. The bird switched between these three sites like a metronome from the 1<sup>st</sup> of August onwards, but changed this habit on 8 August just after noon, when it moved from the feeding oyster farm to the rocky bank, then moved directly to the roosting site of the reserve at 17:00 to leave at 22:00 to fly back to the rocky bank (Fig. 6). This particular pattern is not unusual and had been observed at three low tides on 24–25 July.

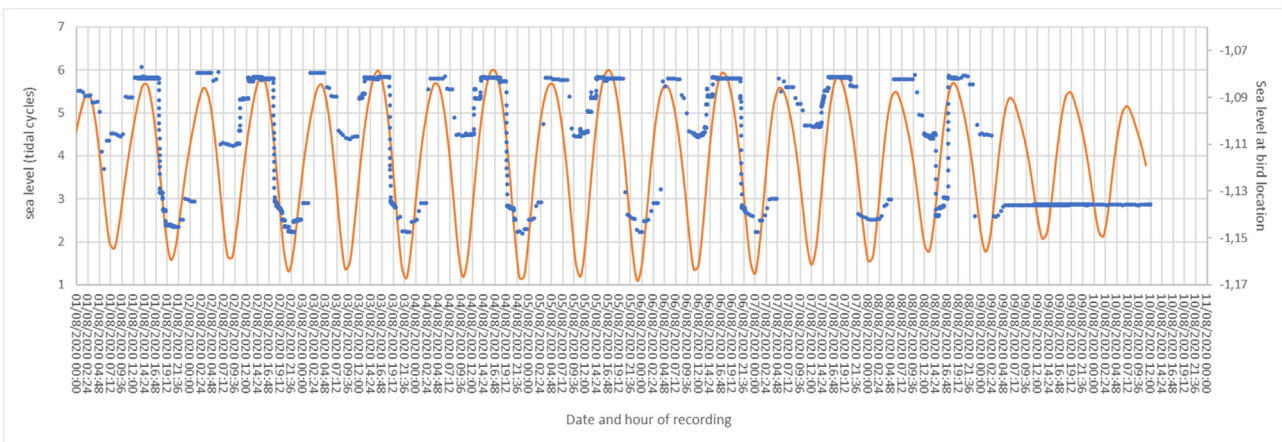
An unusual pattern occurred at the end of the night from 8 to 9 August. That night, the tag recorded positions only every 30 min, so the following timetable is not highly precise. The bird was still in the nature reserve at

22:13, then on the rocky bank at 22:42, at the oyster farm at 23:12 until 02:12 on 9 August, before moving back to the rocky bank at 02:53, to finally adopt an definitive fixed position from 05:13 onwards. Sunrise occurred at 04:57 on Ile Madame that day. Nevertheless, as during former days and nights, the bird's bathymetric location followed the tide level (Fig. 4) suggesting that the curlew maintained classical feeding activities the complete night before joining the high tide roost of Ile madame on 9 August. Flights between the nature reserve and the rocky high tide roost occurred when the tidal range was decreasing. This curlew seemed to use rocky roost when available. These activity patterns suggest that the bird was probably shot, injured and further succumbed to his wounds at the roosting site on Ile Madame at sunrise on 9 August 2020.

(a)



(b)



**Fig. 4.** Data recorded by the GPS tag of the curlew in August 2020. (a) latitudes and longitudes from 1<sup>st</sup> to 10<sup>th</sup> August 2020. The first date corresponds to the opening of the hunting season. (b) data on sea level (orange curve), illustrating the tidal cycles, and tidal position of the curlew (relative to sea level) for each GPS-acquired position (blue dots). When the dots are below the orange curve, the ground at the bird position is located below the sea surface; we interpret this as the bird flying over the sea.

**4. Discussion**

On 9 August 2020, one of the tagged Eurasian curlews we tracked died, and we managed to collect the corpse for further analyses. Our investigation aimed to determine the possible cause of the death of the animal, as the species was formerly a game bird in France, though a nongame since 2020.

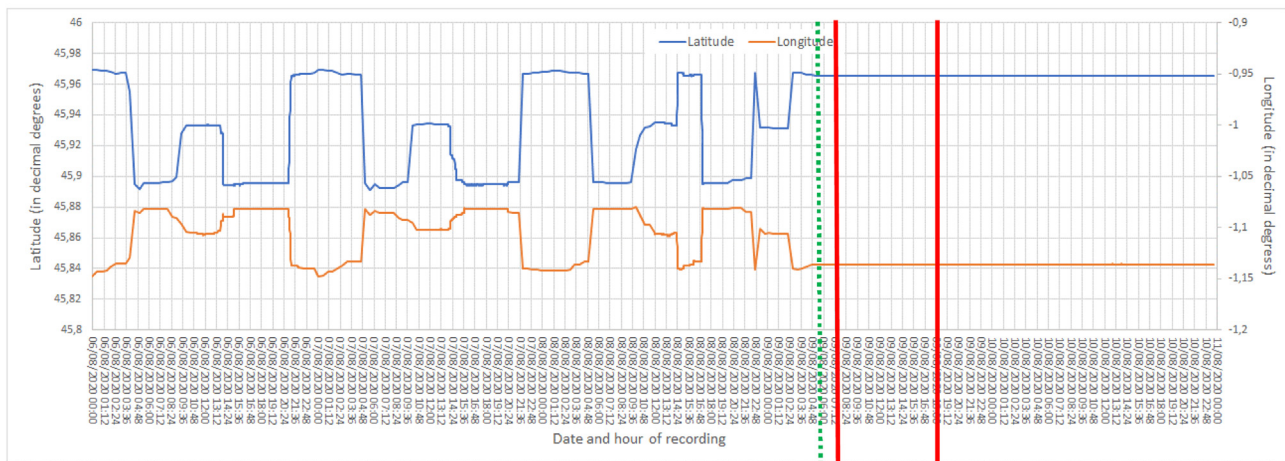
**4.1. Potential causes of death**

Thanks to x-ray imagery, we detected a single ball in the entire corpse of the bird, and a bone fracture on the right side of lower mandible of the bill. If the bird had been shot intentionally at a close distance, we should have found more balls in its body. The presence of a lone ball suggested either a distant shot, or collateral damage, either as the bird was in a flock and another bird was targeted, or because of a ricochet. The angle made by the alignment of the lead ball and the bone fracture is compatible with both, as the ball entered the bill from below, from the front and the right.

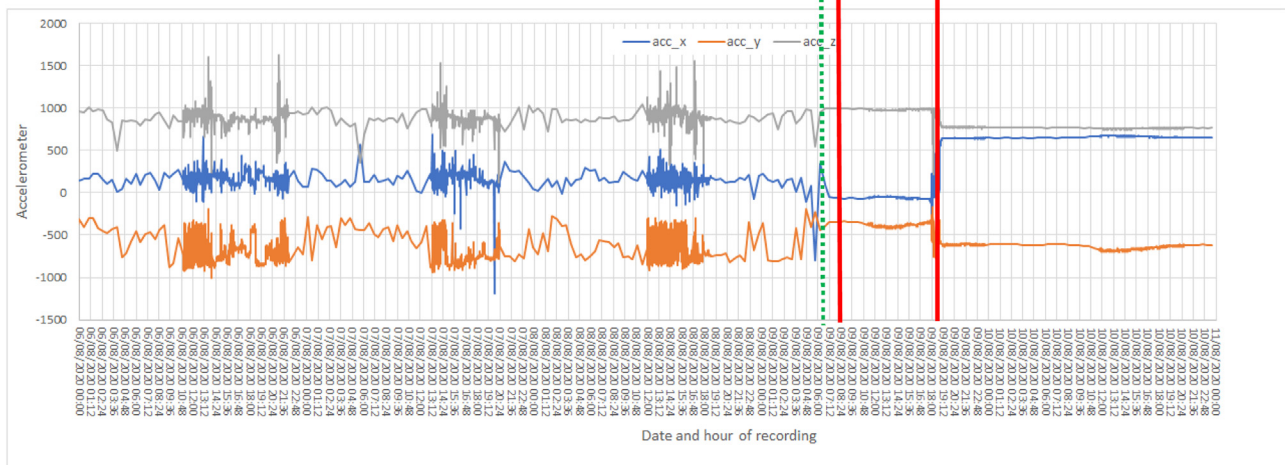
A next step was to determine if the ball had been stocked in the bill for a long time, after a non-lethal ancient shot, or if the shot was recent and

could be involved in the death of the bird. The bone fracture was not reduced at all, with no evidence of a bone callus or any recalcification, so we conclude that the fracture was very recent. To feed, a curlew sinks its remarkably long and downcurved bill in the mud, to forage for capture earthworms and deep-burrowing preys, as it feeds mainly on annelids, arthropods, crustaceans and molluscs. Having a neat fracture on the lower mandible of the bill, close to the basis, probably prevented the curlew to forage and feed. This injury probably explains why the stomach of the bird was empty. The study of the bird behaviour, using the GPS records and bathymetric locations, indicated that its foraging behaviour was classical even during the night before it died. We don't consider that the bill fracture could have occurred long before the death and could have induced a death from starvation. Such large-bodied long-lived species should be able to survive numerous days without feeding, and we documented examples of Eurasian curlews actively migrating during 64 h without stopping so without feeding [7]. The most plausible cause of death is therefore haemorrhage, while possible alternatives include an infection due to the wounds, and a brain injury due to the fall if shot in flight. As the lead ball crossed the bill right through, from bottom-right to top-left, we can it could have injured the tongue, which could have caused

(a)



(b)



**Fig. 5.** (a) Same latitude/longitude data as inf Fig. 4a but restricted to the 6<sup>th</sup> to 10<sup>th</sup> August. (b) Accelerometer data for the same restricted period. The green dashed line represent an abnormal event when latitude and longitude values became totally fixed (at approx. 06:00am), and the red lines indicate the changes in accelerometer values indicating a change in the tag position followed by immobility (first at approx. 07:00am, second at ~18:00pm).

haemorrhage and led to death. However, the tongue was intact, neither cut nor blessed. Further exploration to detect potential haemorrhage elsewhere in the corpse was not possible given the advanced decomposition stage of the corpse when collected, two days after the bird died, and after two days of hot temperatures (daily maxima of 31–34 °C for the 9th to 11th August 2020). It is however plausible that one or more other lead balls have injured the bird provoking haemorrhage, then exit the bird's body (or ejected during decomposition), precluding the possibility to detect their impact on a damaged corpse. Indeed, this is supported by the large open wound observed on the right flank of the corpse when collected. This wound was already inhabited by numerous maggots, which could have easily extracted any lead balls contained within the pectoral muscles.

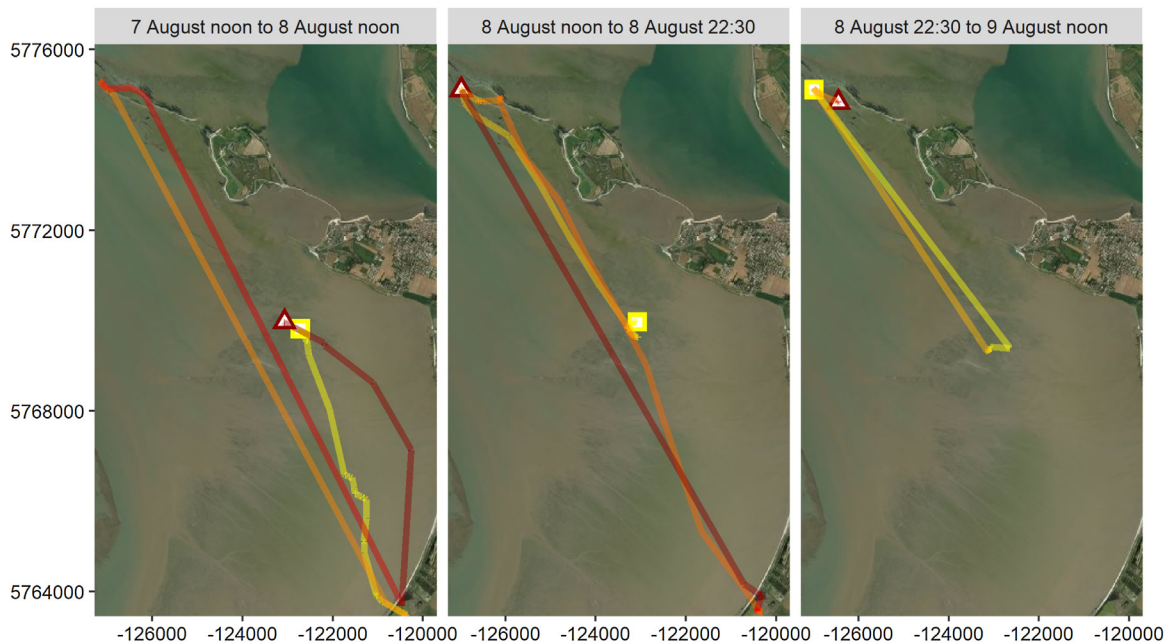
#### 4.2. Conclusions of investigations

Eurasian curlews are large and easily identifiable birds, though hunters might confuse the species with the very similar Eurasian Whimbrel *Numenius phaeopus*, which can be hunted legally in France. Directed intentionally or not towards the Eurasian Curlew we studied, the

shot was the cause of the death. The timetable of the bird suggests that it was shot while roosting on Ile Madame at sunrise on 9 August 2020. Sunday morning is the most popular moment for hunting. In addition, Ile Madame is highly touristic in August, and there were certainly tourists along the shores on 8 August evening, while coastlines are usually wild in the early morning at sunrise. There is one campsite on the island, with 50 camp places, and few residents working at a family oyster farm. Shooting activity at sunset the previous evening is thus hardly possible considering touristic activities, but hunting activity at sunrise on Sunday 9 August is highly probable.

#### 4.3. Implications for the conservation of the endangered Eurasian Curlew

The hide tide roost site on Ile Madame is known as the “rocher des palles”. It is a famous place for professional oysterfarms and recreative shellfish activities. This intertidal rocky shore remains unsubmerged at small tidal ranges and is isolated from the Ile Madame thus providing a secure place for several shorebird species. In July, before the hunting season, Ile Madame and the Rocher des Palles can host relatively high proportions of local non-breeding curlew numbers (up to 70 % of birds



**Fig. 6.** Tracks of the Eurasian curlew obtained from the GPS tag. Left: track of locations obtained between 2020/08/07 12:00 and 2020/08/08 12:00. Centre: track for locations obtained between 2020/08/08 12:00 and 2020/08/08 22:30. Right: track for locations obtained between 2020/08/08 22:30 and 2020/08/09 12:00. On each panel, the track starts at the yellow square and ends at the red triangle, and the colour of the track darkens (from yellow to red) as the time progresses.

counted during the monthly water bird census). Tracks of this curlew illustrated well that the ‘rocher des palles’ is an important secondary high-tide roost beside the Moëze-Oléron nature reserve – as it is for most locally wintering curlews. Hunting is allowed on Ile Madame from the first August Saturday (1st August in 2020), though the ecological importance of the roosting site for this red-listed species, and the potential for collateral damages and mortality, we recommend that the high tide roost of the rocher des palles should be excluded from the official hunting areas for any species.

The overall annual survival probability of adult Eurasian curlews is estimated at  $0.92 \pm 0.03$  in the absence of hunting [8], so that any additional adult mortality can have a noticeable impact on population dynamics, hence on extinction risk. For the sample of 10 adult curlews we tagged, single additional mortality by illegal shooting doubles the annual mortality rate, but this of course is based on a small sample. If such events are rare, they should not impact the global population dynamics, but if they are frequent, they might contribute to drive the decline of the breeding population. The tagged individual belonged to the already threatened Belgian breeding population with an estimated 170–230 breeding pairs [9]. We suggest that during this period of hunting ban in France, and after a long history of curlew hunting prior to the ban, illegal hunting could be more widespread than expected. Intensive tagging and tracking of non-breeding curlews could help to further examine this. Estimating the impact of an additive mortality also relies on the availability of robust demographic models across a species range. It is therefore crucial to develop such models given the intensive and expensive conservation efforts deployed for curlews across Europe. Finally, we must recommend to improve education and awareness towards hunters concerning hunting bans and the potential deleterious effects of such an illegal shooting, intentional or not, on population dynamics of an endangered species [10].

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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