Report on Bird Inventory performed at Keta Lagoon Complex Ramsar Site in February 2025

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Summary

The Keta Lagoon Complex Ramsar Site is an important area for the conservation of migratory birds. However, this landscape is threatened by climate change and human practices. As part of the project "Conservation and sustainable management at the Keta Lagoon Complex Ramsar Site, Ghana, for birds and community climate resilience", an 8 days field trip was organized in February 2025 by A Rocha Ghana and A Rocha France in order to update bird inventories and train local wildlife officers. During this trip, 5 bird ringing and sound recording sessions were performed in different habitats located around the Keta Lagoon Complex Ramsar Site, as well as 9 bird count sessions. A minimum 87 different bird species were identified, including 35 migratory species and 3 red listed species. This field session showed the value of the combination of different bird inventory methods, as 2 thirds of the species listed were found with only one of the 3 methods, in the places where the 3 methods were used. Further data collection sessions using sound recorders are scheduled to complement the inventory throughout the year.

Introduction

The Keta Lagoon Complex Ramsar Site is located at the south-east border of Ghana, close to the border with Togo. This landscape is comprised of the open brackish water lagoon, extensive mangrove swamps and surrounding floodplain consisting of marsh, scrub and farmlands. The site is internationally recognised for the large number of waterbirds it supports, with around 80% of Ghana's listed wetland birds are found there.

Despite its biodiversity significance, the Keta Lagoon wetland is threatened by overexploitation of resources, mangrove deforestation, pollution from agrochemicals, fertilisers and household waste, and low community awareness of the importance of the site for nature and people. Compounding these are the lack of updated information on bird species (richness and numbers) and the habitats and sites most important for them; limited bird monitoring (due to skills gap and lack of a monitoring framework), and no restoration and conservation plan. Climate change is also a grave risk to the Keta Lagoon site and the surrounding communities due to sea level rise and storms of increasing frequency and intensity. Coastal vegetation, especially mangrove forests, is one of the most effective defences against floods and storms, but they are being overexploited.

The project "Conservation and sustainable management at the Keta Lagoon Complex Ramsar Site, Ghana, for birds and community climate resilience" focuses on conservation of bird species and their habitats, education on the importance of wetlands for biodiversity and ecosystem services, restoration and sustainable management of mangrove forests, and building local capacity for farm climate resilience. The project targets especially the migratory birds that the site is so important for. Among others, the project aims at producing updated habitat maps and bird species lists and establish local capacity for bird identification and monitoring. To this end, two field trips involving bird experts from A Rocha France have been scheduled during the course of the project. The first field trip took place in February 2025, from 13/02 to 20/02. This field trip aimed at starting bird inventories in

different habitats of the Keta Lagoon landscape, test different bird inventory methods and train the local A Rocha Ghana and Wildlife division teams. This report details the methods used, the main results – including the species listed in the different habitats, and a discussion of the methods and recommendations for future fieldwork.

Material and methods

Locations

Bird inventories were performed in 9 different locations situated within the Keta Lagoon Complex Ramsar Site. These sites consisted in lagoon shores (4 sites), degraded mangrove (2 sites), Typha reedbed (1 site), mangrove (1 site), bull rushes (1 site), elephant grass (1 site) and thickets (1 site), including 2 sites where 2 different habitats were sampled (Table 1). Bird counts were performed on all sites. However, bird ringing and sound recording were not performed in lagoon shores due to time constraints and habitat unsuitability for catching birds with mist nets.

Table 1: Habitat type and bird inventory methods used for each of the sites where bird inventories were performed in February 2025

Site name	Habitat	Counts	Bird ringing	Sound recording
Afiadenyigba_mangrove	Degraded mangrove	x	x	x
Afiadenyigba_lagoon	Lagoon shore	x		
Anyanui	Mangrove	x	x	x
Atito	Lagoon shore	x		
Kefti	Lagoon shore	x		
Keta	Lagoon shore	x		
Salo	Typha reedbed	x	x	x
Seva	Elephant grass / Degraded mangrove	x	x	x
Xavi	Thickets / Elephant grass	x	x	x

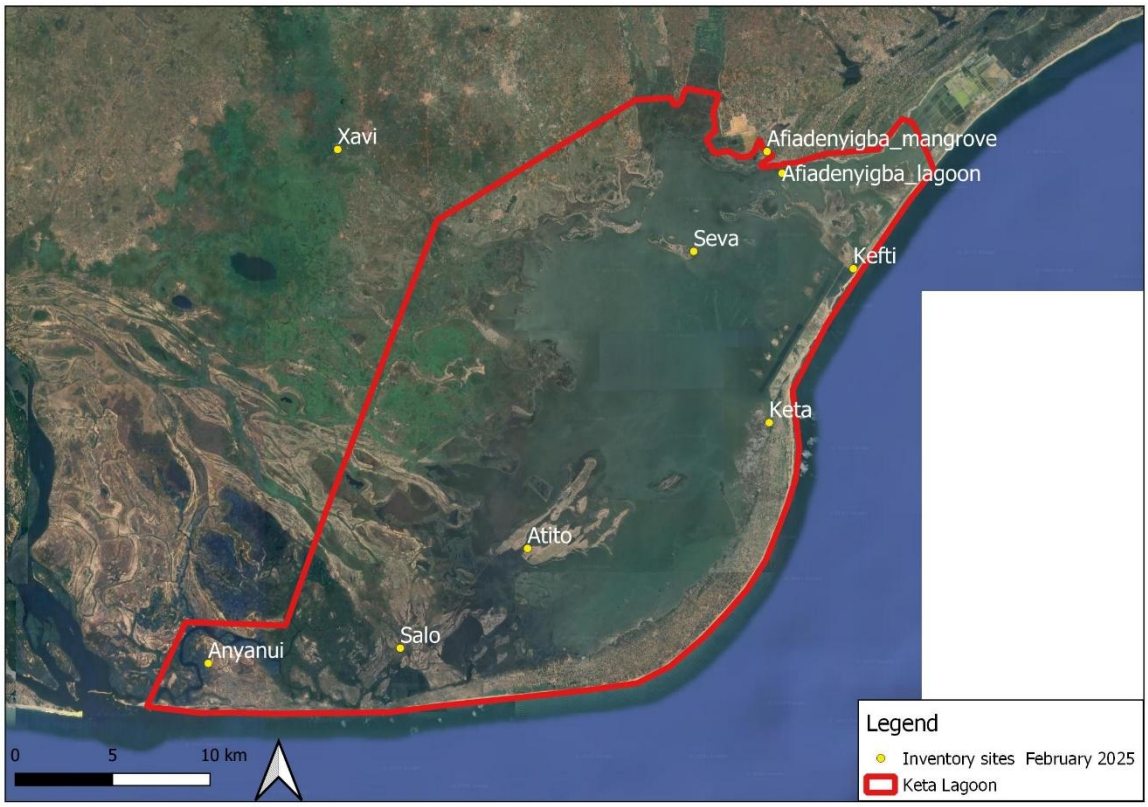

Figure 1: Location of the bird inventories performed in the Keta Lagoon Complex Ramsar Site in February 2025

Figure 2: Habitats where bird inventories were performed in Keta Lagoon in February 2025. A) Typha reedbed; B) Degraded mangrove; C) Thickets and cultivated land; D) Lagoon shore.

Bird ringing

7 to 10 nylon mist nests (12m x 2.5m, 16x16mm mesh, 5 pockets, brand: Ecotone) were deployed in 5 different sites located around the Keta lagoon in order to sample birds present in the corresponding habitats. Mist nests were placed inside homogenous habitat patches in each site in order to sample birds using the corresponding habitats. Mist nets were installed the day before in most cases, and opened averagely from 6:30am to 10:30am, when temperatures became too high to ensure bird safety when caught in a mist net (Table 2). However, the ringing session was shorter in Afiadenyigba due to late arrival on site and because we could only set up the nets the same morning.

During each session, mist nets were inspected every 30 minutes and any bird caught in the net was safely extracted with caution and temporarily placed in a cotton bag. Each bird was then identified, ringed with a metal ring provided by the Ghanaian ringing scheme containing a unique alpha-numerical identifier, measured (mass in g, length of the wing and of the tarsus in mm), pictured and inspected for moult patterns and fat storage and released. Every information was reported in a specific field sheet (see appendix 1).

Table 2: Description of the bird ringing sessions performed in Keta Lagoon Complex Ramsar Site in February 2025.

Site name	Habitat	Number of nets	Opening time	Closing time	Date
Afiadenyigba_mangrove	Degraded mangrove	7	08 :00	10 :30	15/02/2025
Anyanui	Mangrove	10	06 :00	10 :00	19/02/2025
Salo	Typha reedbed	8	06 :10	10 :00	18/02/2025
Seva	Elephant grass /Degraded mangrove	7	06 :45	10 :15	17/02/2025
Xavi	Thickets / Elephant grass	8	06 :45	10 :45	16/02/2025

Bird sound recording

We deployed 2 sound recorders (Song Meter Micro 2 / Wildlife Acoustics, Figure 3) during each ringing sessions (except for the first day when we deployed only one recorder) in order to record additional species that would not get caught in the mist nets. The sound recorders were deployed at 1 to 2m hight in the vegetation and were separated of around 50m to 100m from each other. On average, the 2 sound recorders were deployed from 6:30 to 10:00am, with variations per site described in table 3.

Table 3: Time of the deployment of sound recorders during the ringing sessions at Keta lagoon in February 2025

Site name	Start time / Sound recorder 1	Start time / Sound recorder 2	End time / Sound recorder 1	End time / Sound recorder 2	Date
Afiadenyigba_mangrove	08 :30	/	10 :30	/	15/02/2025
Anyanui	06 :23	06 :23	10 :00	10 :00	19/02/2025
Salo	06 :10	06 :10	10 :00	10 :00	18/02/2025
Seva	06 :42	06 :41	10 :00	10 :00	17/02/2025
Xavi	06 :37	06 :34	10 :00	10 :00	16/02/2025

Figure 3: Sound recorder Song Meter Micro 2 deployed in Keta Lagoon Complex Ramsar Site in February 2025.

Bird counts

Bird counts were performed during specific sessions along the shore of the lagoon (Table 1) as well as during bird ringing sessions.

On lagoon shores, birds were identified and counted using binoculars and spotting scopes from a fix point. Counting sessions lasted averagely 20 minutes to 1 hour.

During ringing sessions, birds present around the ringing site were identified and counted from the ringing table using binoculars, between each net inspection. Observations were reported in a specific field sheet (see appendix 2).

Data analysis and synthesis

Sound analysis

Sound recordings were analysed using the Birdnet analyser (Kahl et al. 2021) (specifications 15000Hz, sensibility 1, species list according to location set to Latitude: 6 degrees North / Longitude: 1 degree East). “BirdNET-Analyzer is an open-source tool for analyzing bird calls using machine learning models. It can process large amounts of audio recordings and identify (bird) species based on their calls” (Kahl et al. 2021).

We checked manually each recording of species identified by the software that was neither caught during bird ringing nor identified during bird counts, in order to confirm that the species allocation given by the software was accurate. Hence, we did not check recordings of suggested species which were caught or seen at the site during the ringing and count sessions as their presence on site was certain. We also stopped checking further recordings of a given species identified by the software when at least one recording unambiguously matched the sound of the species. In all these cases, we listed the suggested species as “confirmed”. When a recording matched the suggested species but was very similar to alternative more probable species, or when there was only one identifiable recording of a given species, we listed the suggested species as “probable”. When the sound matched a species that was not expected in the area or was not completely similar to known sounds of the

suggested species, we listed the species as “possible”. In all the other cases, the identification was rejected.

Bird species assemblage

We used a correspondence analysis to visually explore bird species assemblage in the different sites, with the “dudi.coa” function of the package “ade4” (Dray et Dufour 2007) in R (R Core Team 2017).

Results

Bird ringing

We caught 63 birds of 35 species during the 5 ringing sessions. Xavi was the site where we caught the most species and individual birds (21 and 38, respectively), while Seva was the site where we caught the smallest numbers (3 species and 3 birds) (Table 4) (Appendix 3).

Table 4: Number of species and individual birds captured during each ringing session at Keta Lagoon Complex Ramsar Site in February 2025.

Site name	Number of birds	Number of species	Habitat
Afiadenyigba	6	5	Degraded mangrove
Anyanui	5	3	Mangrove
Salo	11	5	Typha reedbed
Seva	3	3	Elephant grass /Degraded mangrove
Xavi	38	21	Thickets / Elephant grass

Bird sound recording

We identified 35 species with certainty from sound recordings, as well as 9 probable and 13 other possible species (so up to 57 species). When accounting for confirmed species only, the site with the highest recorded diversity was Xavi (19 species) and the sites with the least diversity were Afiadenyigba and Salo (4 species), but Afiadenyigba was the site with the least diversity when taking into account probable and possible species (Table 5) (Appendix 3).

Table 5: Number of species identified with bird sound recorders during each ringing session at Keta Lagoon Complex Ramsar Site in February 2025.

Site name	Number of species_confirmed	Number of species_confirmed, probable and possible	Habitat
Afiadenyigba	4	4	Degraded mangrove
Anyanui	11	14	Mangrove
Salo	4	8	Typha reedbed
Seva	12	19	Elephant grass /Degraded mangrove
Xavi	19	28	Thickets / Elephant grass

Bird counts

We counted a total of 894 birds of at least 49 species during the bird counts in the 9 different sites.

The site with the highest observed diversity was Atito (20 species) and the site with the least diversity was Xavi (4 species), while the site with the highest recorded abundance was Afiadenyigba (lagoon) (344 birds) and the site with the least recorded abundance was Xavi (7 birds) (Table 6) (Appendix 3).

Table 6: Number of species and individual birds counted during each bird count session at Keta Lagoon Complex Ramsar Site in February 2025.

Site name	Number of individuals	Number of species
Afiadenyigba_lagoon	344	12
Afiadenyigba_mangrove	18	8
Anyanui	16	5
Atito	202	20
Kefti	44	9
Keta	147	15
Salo	23	6
Seva	93	18
Xavi	7	4

Synthesis

Bird diversity in Keta Lagoon Complex Ramsar Site

We identified a minimum of 87 different species present and an additional 13 species possibly or probably present, in the different habitats studied at Keta Lagoon Complex Ramsar Site in February 2025. Among these 87 species, 35 are migratory species using the African-Eurasian flyway system. This result confirms that Keta lagoon is an important area for bird conservation and an important migratory stopover site.

Bird species assemblage in the studied habitats

We found that Atito, Kefti, Keta and Afiadenyigba_lagoon (lagoon shores) were very close to each other on the different axis of the correspondence analysis (Figure 4), suggesting that they had very similar species. In contrast, they were very distant from Anyanui, Afiadenyigba and Salo, suggesting their respective species assemblage differed strongly. However, Anyanui and Afiadenyigba (mangrove and degraded mangrove, respectively) were closer to each other than with other sites, suggesting that they shared several species together. Salo (reedbed) was very distant to all the other sites, suggesting the presence of unique and likely habitat-specific species on this site. Looking at individual species, the ward dendrogramme suggests that species assemblage vary significantly between the different studied habitats (Annexe 4).

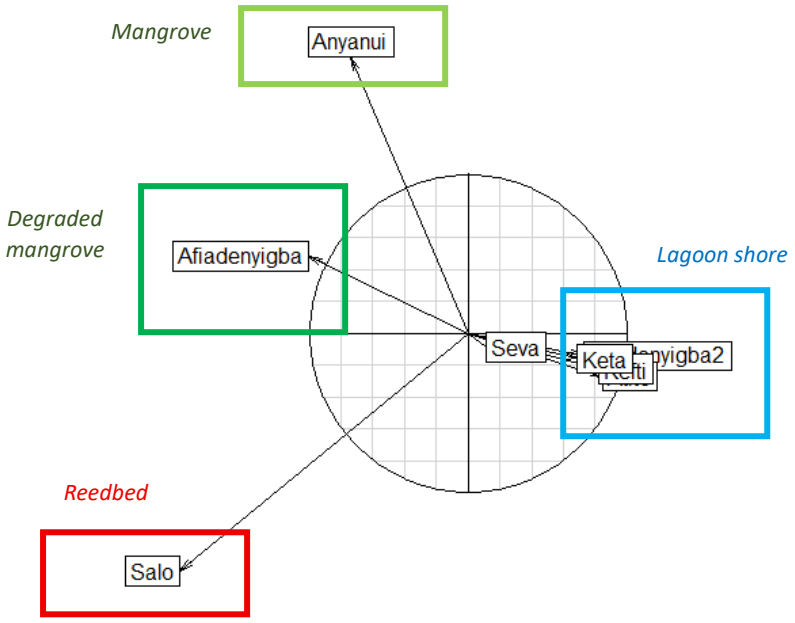

Figure 4: Position of the different bird inventory sites in Keta lagoon on the first and second axis of a 3-axis correspondence analysis of bird species and site.

Species of conservation interest

We found 3 species of conservation interest listed in the red list as Near-Threatened (Dunlin *Calidris alpina* and Eurasian curlew *Numenius arquata*) or Vulnerable (Grey plover *Pluvialis squatarola*) (IUCN 2025). All 3 species are migratory waterbirds species found mainly in lagoon shores. They were found in different places around the lagoon but always in small numbers (1 to 11 individuals together). Interestingly, Dunlins had not been observed during counts led by the Wildlife division on the site in the last 2 years.

Discussion

Complementarity of the different inventory methods

The inventory led by the A Rocha team at Keta Lagoon Complex Ramsar Site in February 2025 was based on 3 different methods that were used on 9 different sites. The 3 methods (i.e. bird ringing, bird sound recording and bird counts) were used together on 5 different sites while bird counts only were performed on 4 others (Table 1).

A total of 72 species were found on these 5 sites where the 3 methods were used. Bird ringing enabled to identify 35 species (49%), which is the same amount as for bird sound recording, while bird counts enabled to list 33 species (46%). 31% (n=22) of all species found on these 5 sites were only found during bird ringing. This proportion dropped at 19% for bird counts (n=14) and 15% for bird sound recording (n=11). Overall, 65% of all birds were only found with one of the 3 methods.

Looking at birds found on individual sites, each method was the most successful in terms of number of species identified in at least one site. Bird ringing was the most successful in Xavi, while bird sound recording was most successful in Anyanui and bird counts was the best method in the three other sites (Figure 5a). Furthermore, each method contributed to identify species that were not found using other methods on each site (Figure 5b).

Overall, these results highlight the complementarity of the three methods to inventory the bird species present in the different habitats of the Keta Lagoon Complex Ramsar Site.

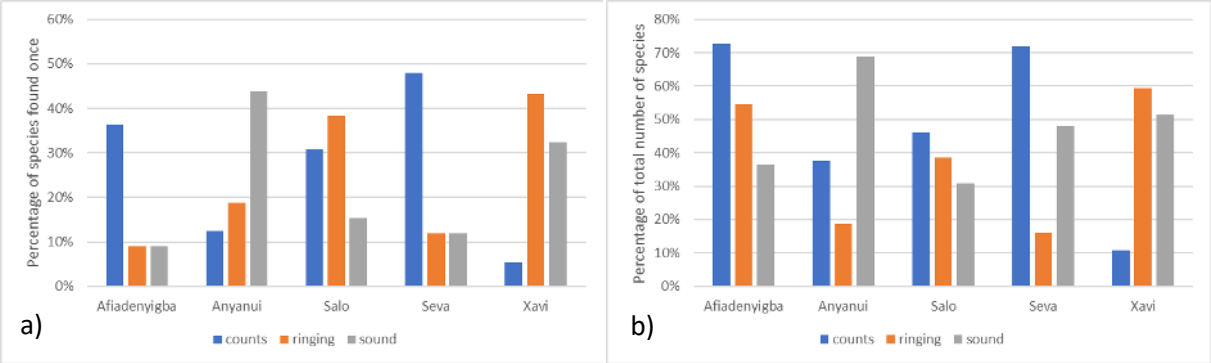

Figure 5: Percentage of total number of species (a) and of species found only once (b) per inventory method (bird counts / bird ringing / bird sound recording) in 5 different sites where bird inventories were performed at Keta Lagoon Complex Ramsar Site in February 2025.

Interest and limits of bird ringing

This study was one of the first ones using bird ringing to inventory birds in south-eastern Ghana. This method was very successful as many species were found solely through bird ringing. Many species are indeed hard to find without catching them because they hide in the bushes or keep silent during the day. Bird ringing is therefore a very useful method to complement bird inventories.

However, bird ringing has several flaws.

- First, it requires a ringing permit which is hard to get as it is associated with skills obtained through intensive training with another or several other bird ringers and a ringing center. Ghana has a ringing center but very few bird ringers to train with. Developing bird ringing trainings in Ghana would be crucial to develop the use of this technic in the future.
- Second, there is no resources available to identify birds in hands in Ghana other than the ones published for Europe, where trans Saharan migratory species are described; therefore, information on biometrics, plumage differences and moult patterns of resident birds are extremely scarce which makes it challenging to sex and age many of the birds caught, as well as identifying some species.
- Third, bird ringing in Ghana can only be performed during early hours of the day due to high temperatures, and specific weather conditions (low wind, no rain). However, this enables to combine bird ringing with other surveys the rest of the day.
- Fourth, we observed that local predatory birds quickly found out that mist nets were a very useful helper to catch preys, which led us to find a few birds killed by others in nets; this calls for more frequent tours to survey the mist nets than what is usually recommended in Europe;
- Fifth, in most habitats, we caught very few birds using bird ringing; this was probably due to limited numbers and movements of birds in these habitats; using speakers playing sounds of migratory species would be certainly useful to increase the numbers caught in the mist nets, without disturbing the locally breeding birds. This would however result in skewing the results of inventories by potentially attracting individuals from other habitats present nearby or flying over the area.

Interest and limits of sound recording

While bird counts and bird ringing have been traditional bird inventory methods worldwide for over a century, bird sound recording is a novel method that has been very little used for bird inventory in Ghana and western Africa to our knowledge.

In our study, 11 species out 72 found on the ringing sites (15%) were identified solely through sound recorders and this method enabled to identify 49% of the total number of species listed on these sites. This result confirms the interest of such devices to refine bird inventories. The interest of the method is that sound recorders are fast and easy to deploy and have a low cost. Furthermore, the Birdnet analyser makes it very simple to analyse audio recordings and gives directly a list of species recorded by the device.

However, the method suffers several flaws. First, audio files are particularly big. This makes it challenging to deploy the method on large time and space scales. Storing and sharing the data can be challenging, especially when internet connexion is bad which is still a common issue in Ghana. Furthermore, the size of the files makes the analysis slow and requires recent and thus more expensive computers. Beside these practicalities, the main flaw of the method is the risk of mistaking in sound identification. We manually checked all species listed by the software and found a very large number of mistakes. However, these were mostly the same mistakes repeated through the whole file and they were thus easy to fix. This highlights that the Birdnet analyser is still being developed and it does not yet include all species or all sounds made by each species in western Africa. This was expected in our study and the development of this software and other alternative ones should be checked regularly. We could expect to be able to re-analyse the sound files with more accurate softwares in the near future.

Overall, the sound recording method was a useful method to complement the bird inventory performed at Keta Lagoon Complex Ramsar Site. However, it was not as successful as the two other methods, which enabled us to identify more species during the study.

Future directions for bird inventories and monitoring in Keta Lagoon Complex Ramsar Site

This first inventory of birds present in Keta Lagoon Complex Ramsar Site enabled to complement bird knowledge in this important area for bird conservation. However, this inventory was led during a single week in February 2025, and this was thus not enough to inventory all the species using this site, especially migratory species that might not have been present during the survey.

Complementary inventory is therefore scheduled throughout the year, using bird sound recorders placed in different habitats around the lagoon at different seasons of the year. Furthermore, a second field survey is scheduled in October 2025. This will enable to deepen the training of the local team and to complement the inventory, especially thanks to the presence of most of the transsaharan migratory species. To this end, the use of speakers during bird ringing would be useful as it could help catching migratory passerine species which are hard to identify by sight and mostly silent during migration.

Acknowledgements

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APPENDIX 1: Bird ringing field form

A ROCHA FRANCE

BIRD RINGING GHANA 2025

Date______ / _ / 2025   Start time: End time: Length nets: Place & Habitat:

TIME	RING NUMBER	SPECIES	SEX	AGE	FAT	MOULT	WING	WT	TARSUS	RINGER	COMMENTS
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APPENDIX 2: Bird count field form

BIRD SURVEY FORM GHANA 2025

Date: Observers: Place: Habitats:

Species	Number	Comments	Species	Number	Comments

Date: Observers: Place: Habitats:

Species	Number	Comments	Species	Number	Comments

Date: Observers: Place: Habitats:

Species	Number	Comments	Species	Number	Comments

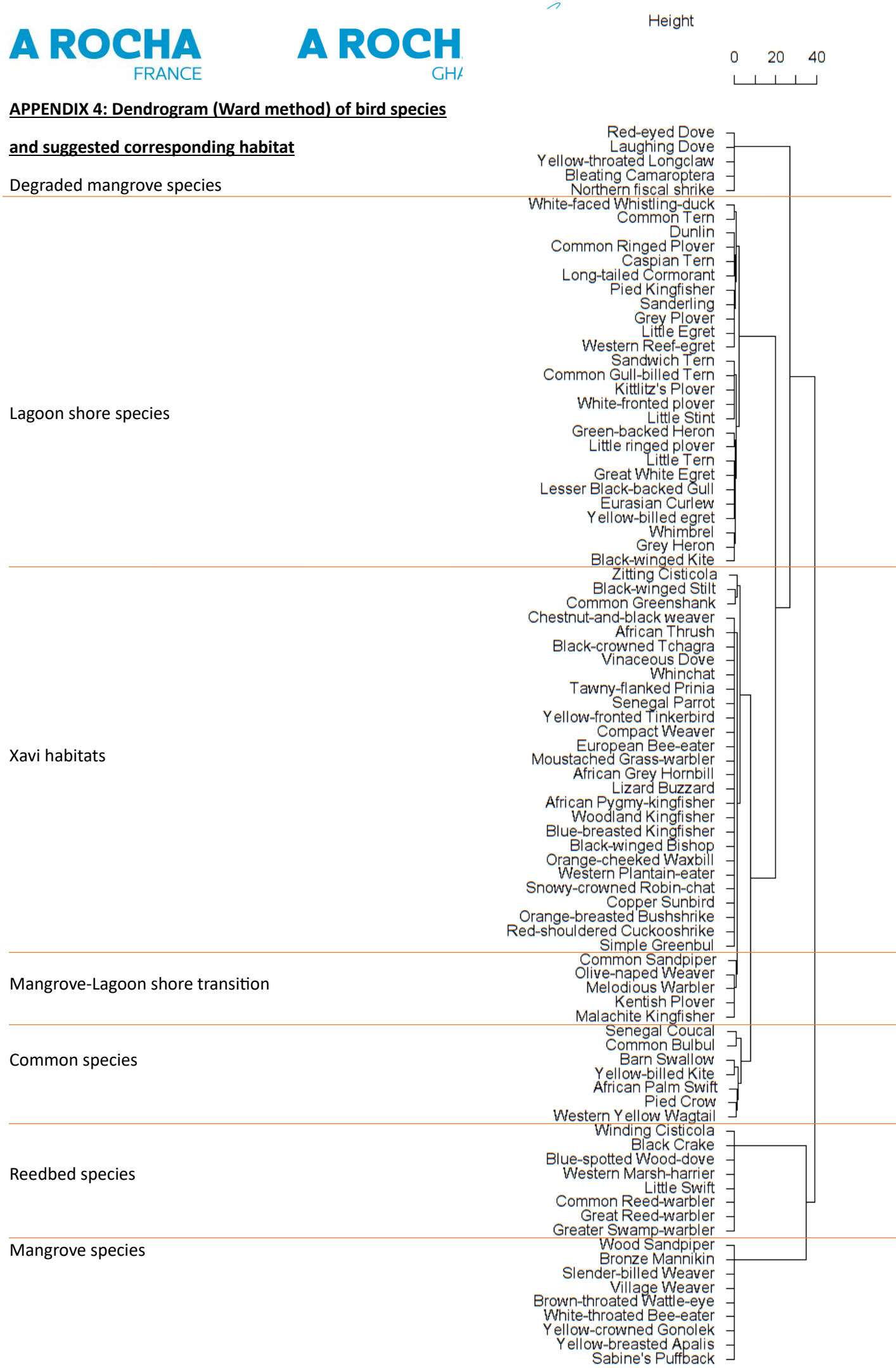
APPENDIX 3: List of bird species identified in Keta Lagoon Complex Ramsar Site in February 2025 and respective identification methods used.

Scientific name	Common name	Presence status	Red list status	Flyway status	ID Method used
Acrocephalus arundinaceus	Great Reed-warbler	confirmed	Least Concern	Least Concern	Ringing
Acrocephalus rufescens	Greater Swamp-warbler	confirmed	Least Concern		Ringing
Acrocephalus scirpaceus	Common Reed-warbler	confirmed	Least Concern	Least Concern	Ringing/Sound
Actitis hypoleucos	Common Sandpiper	confirmed	Least Concern	Least Concern	Counts/Ringing
Apalis flavida	Yellow-breasted Apalis	confirmed	Least Concern		Sound
Apus affinis	Little Swift	confirmed	Least Concern	Least Concern	Counts
Ardea alba	Great White Egret	confirmed	Least Concern	Least Concern	Counts
Ardea brachyrhyncha	Yellow-billed Egret	confirmed	Least Concern		Counts
Ardea cinerea	Grey Heron	confirmed	Least Concern	Least Concern	Counts
Butorides striata	Green-backed Heron	confirmed	Least Concern		Counts
Calidris alba	Sanderling	confirmed	Least Concern	Least Concern	Counts
Calidris alpina	Dunlin	confirmed	Near Threatened	Near Threatened	Counts
Calidris minuta	Little Stint	confirmed	Least Concern	Least Concern	Counts
Camaroptera brachyura	Bleating Camaroptera	confirmed	Least Concern		Counts/Ringing/Sound
Campephaga phoenicea	Red-shouldered Cuckooshrike	confirmed	Least Concern	Least Concern	Ringing
Centropus senegalensis	Senegal Coucal	confirmed	Least Concern		Counts/Ringing/Sound
Ceryle rudis	Pied Kingfisher	confirmed	Least Concern		Counts/Sound
Charadrius alexandrinus	Kentish Plover	confirmed	Least Concern	Least Concern	Counts
Charadrius dubius	Little Ringed Plover	confirmed	Least Concern	Least Concern	Counts
Charadrius hiaticula	Common Ringed Plover	confirmed	Least Concern	Least Concern	Counts/Sound
Charadrius marginatus	White-fronted Plover	confirmed	Least Concern		Counts
Charadrius pecuarius	Kittlitz's Plover	confirmed	Least Concern		Counts
Chlorocichla simplex	Simple Greenbul	confirmed	Least Concern		Ringing
Chlorophoneus sulfureopectus	Orange-breasted Bushshrike	confirmed	Least Concern		Ringing
Cinnyris cupreus	Copper Sunbird	confirmed	Least Concern		Ringing
Circus aeruginosus	Western Marsh-harrier	confirmed	Least Concern	Least Concern	Counts
Cisticola juncidis	Zitting Cisticola	confirmed	Least Concern		Counts/Ringing/Sound
Cisticola marginatus	Winding Cisticola	confirmed	Least Concern		Ringing
Corvus albus	Pied Crow	confirmed	Least Concern		Counts/Sound
Corythornis cristatus	Malachite Kingfisher	confirmed	Least Concern		Ringing
Cossypha niveicapilla	Snowy-crowned Robin-chat	confirmed	Least Concern		Ringing
Crinifer piscator	Western Plantain-eater	confirmed	Least Concern		Counts
Cypsiurus parvus	African Palm Swift	confirmed	Least Concern		Counts
Dendrocygna viduata	White-faced Whistling-duck	confirmed	Least Concern		Counts/Sound
Dryoscopus sabini	Sabine's Puffback	confirmed	Least Concern		Ringing
Egretta garzetta	Little Egret	confirmed	Least Concern	Least Concern	Counts
Egretta gularis	Western Reef-egret	confirmed	Least Concern		Counts
Elanus caeruleus	Black-winged Kite	confirmed	Least Concern		Counts
Estrilda melpoda	Orange-cheeked Waxbill	confirmed	Least Concern		Ringing
Euplectes hordeaceus	Black-winged Bishop	confirmed	Least Concern		Ringing
Gelochelidon nilotica	Common Gull-billed Tern	confirmed	Least Concern	Least Concern	Counts

Halcyon malimbica	Blue-breasted Kingfisher	confirmed	Least Concern		Ringing
Halcyon senegalensis	Woodland Kingfisher	confirmed	Least Concern	Least Concern	Sound
Himantopus himantopus	Black-winged Stilt	confirmed	Least Concern	Least Concern	Counts/Sound
Hippolais polyglotta	Melodious Warbler	confirmed	Least Concern	Least Concern	Ringing
Hirundo rustica	Barn Swallow	confirmed	Least Concern	Least Concern	Counts/Sound
Hydroprogne caspia	Caspian Tern	confirmed	Least Concern	Least Concern	Counts
Ispidina picta	African Pygmy-kingfisher	confirmed	Least Concern	Least Concern	Ringing
Kaupifalco monogrammicus	Lizard Buzzard	confirmed	Least Concern		Sound
Laniarius barbarus	Yellow-crowned Gonolek	confirmed	Least Concern		Counts/Sound
Lanius humeralis	Northern fiscal shrike	confirmed	Least Concern		Counts
Larus fuscus	Lesser Black-backed Gull	confirmed	Least Concern	Least Concern	Counts
Lophoceros nasutus	African Grey Hornbill	confirmed	Least Concern		Counts/Sound
Macronyx croceus	Yellow-throated Longclaw	confirmed	Least Concern		Counts; Ringing/Sound
Melocichla mentalis	Moustached Grass-warbler	confirmed	Least Concern		Ringing/Sound
Merops albicollis	White-throated Bee-eater	confirmed	Least Concern	Least Concern	Counts/Ringing/Sound
Merops apiaster	European Bee-eater	confirmed	Least Concern	Least Concern	Sound
Microcarbo africanus	Long-tailed Cormorant	confirmed	Least Concern		Counts
Milvus aegyptius	Yellow-billed Kite	confirmed	Least Concern		Counts/Sound
Motacilla flava	Western Yellow Wagtail	confirmed	Least Concern	Least Concern	Counts/Sound
Numenius arquata	Eurasian Curlew	confirmed	Near Threatened	Near Threatened	Counts
Numenius phaeopus	Whimbrel	confirmed	Least Concern	Least Concern	Counts
Platysteira cyanea	Brown-throated Wattle-eye	confirmed	Least Concern		Counts/Ringing/Sound
Ploceus brachypterus	Olive-naped Weaver	confirmed	Least Concern		Ringing/Sound
Ploceus castaneofuscus	Chestnut-and-black weaver	confirmed	Least Concern		Ringing
Ploceus cucullatus	Village Weaver	confirmed	Least Concern		Ringing/Sound
Ploceus pelzelni	Slender-billed Weaver	confirmed	Least Concern		Ringing
Ploceus superciliosus	Compact Weaver	confirmed	Least Concern		Ringing
Pluvialis squatarola	Grey Plover	confirmed	Vulnerable	Vulnerable	Counts/Sound
Pogoniulus chrysoconus	Yellow-fronted Tinkerbird	confirmed	Least Concern		Sound
Poicephalus senegalus	Senegal Parrot	confirmed	Least Concern		Sound
Prinia subflava	Tawny-flanked Prinia	confirmed	Least Concern		Sound
Pycnonotus barbatus	Common Bulbul	confirmed	Least Concern		Counts; Ringing/Sound
Saxicola rubetra	Whinchat	confirmed	Least Concern	Least Concern	Ringing
Spermestes cucullata	Bronze Mannikin	confirmed	Least Concern		Ringing/Sound
Spilopelia senegalensis	Laughing Dove	confirmed	Least Concern		Counts/Ringing
Sterna hirundo	Common Tern	confirmed	Least Concern	Least Concern	Counts
Sternula albifrons	Little Tern	confirmed	Least Concern	Least Concern	Counts
Streptopelia semitorquata	Red-eyed Dove	confirmed	Least Concern		Counts
Streptopelia vinacea	Vinaceous Dove	confirmed	Least Concern		Sound
Tchagra senegalus	Black-crowned Tchagra	confirmed	Least Concern		Sound
Thalasseus sandvicensis	Sandwich Tern	confirmed	Least Concern	Least Concern	Counts
Tringa glareola	Wood Sandpiper	confirmed	Least Concern	Least Concern	Sound
Tringa nebularia	Common Greenshank	confirmed	Least Concern	Least Concern	Counts/Sound
Turdus pelios	African Thrush	confirmed	Least Concern		Ringing
Turtur afer	Blue-spotted Wood-dove	confirmed	Least Concern		Ringing

Zapornia flavirostra	Black Crake	confirmed	Least Concern		Sound
Curruca hortensis	Orphean warbler	probable	Least Concern	Least Concern	Sound
Eurillas virens	Little Greenbul	probable	Least Concern		Sound
Illadopsis fulvescens	Brown Illadopsis	probable	Least Concern		Sound
Nycticorax nycticorax	Black-crowned Night Heron	probable	Least Concern	Least Concern	Sound
Turdoides reinwardtii	Blackcap Babbler	probable	Least Concern		Sound
Vanellus senegallus	Wattled Lapwing	probable	Least Concern		Sound
Vidua macroura	Pin-tailed Whydah	probable	Least Concern		Sound
Glaucestrilda caerulescens	Lavender waxbill	possible	Least Concern		Sound
Milvus migrans	Black Kite	possible	Least Concern	Least Concern	Sound
Porzana porzana	Spotted Crake	possible	Least Concern	Least Concern	Sound
Tringa totanus	Common Redshank	possible	Least Concern	Least Concern	Sound
Turdoides plebejus	Brown Babbler	possible	Least Concern		Sound
Upupa epops	Common Hoopoe	possible	Least Concern	Least Concern	Sound

APPENDIX 4: Dendrogram (Ward method) of bird species and suggested corresponding habitat



APPENDIX 5: Pictures of bird species seen and caught in Keta Lagoon Complex Ramsar Site, Ghana, in February 2025

Yellow-throated longclaw

Senegal coucal

Grey-backed camaroptera

African moustached warbler

Greater swamp warbler

Blue-breasted kingfisher

African pigmy kingfisher

Copper sunbird

Chestnut-and-black weaver

Bronzed manikin

White-throated bee-eater

Compact weaver

Simple leaflove

Brown-chested wattle-eye

African thrush

Olive-naped weaver

Orange-chicked waxbill

Red-shouldered cuckooshrike

Snow-crowned robin-chat

Black-billed forest wood-dove

Zitting cisticola

Melodious warbler

Malachite kingfisher

Greater reed warbler

Winding cisticola

Eurasian reed warbler

Slender-billed weaver

Sabine's puffback

Village weaver

Whinchat

Sulphur-breasted bushshrike

Laughing dove

Yellow-billed kite

White-faced whistling ducks

Pied kingfisher

Grey plover

Wattled lapwing

Whimbrel and sandpiper sp.

Western reef egrets (dark morph) with little egrets and a yellow-billed egret