

Migratory Shorebird Tagging and Monitoring Protocol and Best Practice Guide for The Philippines

**Ocean Energy
Pathway**

In partnership with

 The Biodiversity
Consultancy



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A Message from Ocean Energy Pathway

In response to the nation's ambitious goal of transitioning to renewable energy by 2050, it is essential to prioritise environmental protection and actively engage stakeholders throughout the process. Developing clear protocols is crucial for regulatory bodies to ensure the achievement of these goals, including measures to protect migratory shorebirds.

Migratory shorebirds face potential risks from offshore wind development, including collisions with turbines and power line infrastructure, barrier effects, and habitat disruption caused by onshore facilities. These potential risks can be effectively mitigated through a comprehensive understanding of migratory shorebird paths and the incorporation of this knowledge into offshore wind planning, design, and operations.

The shorebird tagging protocols outlined here are of utmost importance not only to the Department of Environment and Natural Resources, including the Biodiversity Management Bureau, but also for regional technical staff responsible for tracking and monitoring shorebird populations as they navigate areas impacted by offshore wind development. The protocols have been harmonised with global standards and established flyway tracking practices. The data collected through these efforts will be invaluable to both the Department and the developers of offshore wind projects.

We extend our sincere gratitude to the Department, particularly the Office of Finance, Information System, and Climate Change, Biodiversity Management Bureau, Wildlife Resources Division, and all relevant sections for their contributions to the realisation of this protocol.

We also recognise the leadership of The Biodiversity Consultancy, especially Aonghais, Ben, Cynthia, and Ward, for their guidance in formulating these protocols and the facilitation of the bird tagging training held last November 2025 in Manila, Philippines.

We eagerly anticipate the implementation of these protocols and the continued collection of data that will help safeguard our migratory shorebirds while supporting sustainable offshore wind development.

Rizaller “Jun” Amolo

Country Head, Philippines
Ocean Energy Pathway

A Message from the Department of Environment and Natural Resources (DENR)

The Department of Environment and Natural Resources (DENR) conveys its sincere appreciation for the report on the development of the Migratory Shorebird Tagging and Monitoring Protocol and Best Practice Guide, as undertaken in collaboration with the Department.

The DENR recognises this work as a highly important, relevant, and timely contribution in strengthening the country's capacity to conserve migratory shorebirds, particularly in the context of the Philippines' expanding offshore wind sector. Its comprehensive and technically rigorous approach provides a critical foundation for improving our understanding of migratory patterns, assessing potential risks, and informing science-based planning and mitigation measures.

The Department also extends its sincere appreciation to the various DENR bureaus, regional offices, and technical divisions that actively participated in the consultations and technical discussions and provided valuable inputs that strengthened the analysis, recommendations, and overall quality of the report.

The protocol's alignment with international standards and flyway-level initiatives, together with its clear guidance on standardised methodologies, data management, and capacity development, underscores its significance to national policy formulation, regulatory processes, and program implementation. Given the Philippines' vital role within the East Asian-Australasian Flyway, this work is instrumental in ensuring that biodiversity conservation remains central to the pursuit of sustainable and responsible development.

The DENR likewise extends its sincere gratitude to Ocean Energy Pathway (OEP) and The Biodiversity Consultancy (TBC) for their leadership, technical expertise, and steadfast commitment in advancing this initiative in partnership with the Department. Their contributions have been invaluable in delivering a resource of enduring relevance and practical utility.

The Department affirms that this report will not be put to waste. It will be actively utilised to inform policies, guide future research and monitoring efforts, and strengthen coordination across agencies and stakeholders. DENR looks forward to continued collaboration in advancing the implementation of these protocols and in reinforcing our shared commitment to the protection and management of migratory shorebirds and their habitats.

Atty. Analiza Rebuelta-Teh

Undersecretary for Finance, Information Systems, and Climate Change
Department of Environment and Natural Resources

Executive Summary

The Philippines is situated along the East Australasian Flyway and hosts critical habitats for migratory shorebirds. As the country looks to deploy offshore wind in its territorial waters, it is essential that the impact of these developments are minimised to avoid potential bird collisions with turbines and powerlines, habitat loss or barrier effects during migration. To address knowledge gaps and inform sustainable offshore wind planning, this protocol outlines best practices for shorebird tagging studies. Tagging provides valuable data on flight paths, altitudes, and site use, which can feed into better impact assessments and mitigation strategies. However, tagging is invasive and requires specialised skills, careful planning, and strict adherence to welfare standards. This report aims to provide recommendations for standardising tagging methodologies in the Philippines, in response to the country's responsibility as a key point on the East Asian-Australasian Flyway. The following recommendations are made to enable this:

- Research questions for tagging studies in the Philippines should be clearly defined and co-developed with funders and other key stakeholders (e.g., DENR Biodiversity Management Bureau, Department of Energy, NGOs) to ensure clear expectations are set, and to foster collaboration.
- Planning for tagging studies should begin at least six months, and ideally 12 months, prior to any fieldwork taking place to ensure sufficient time to secure all necessary permits and order tags.
- The specialised skills required for safely capturing birds and deploying tags means that, in the short-medium term, these studies will require the involvement of international experts. As a priority, all tagging studies in the Philippines should include requirements for the training of national researchers to increase capacity in the country and reduce reliance on international experts.
- The Philippines is a key point on the East Asian-Australasian Flyway. To maximise the value of any studies and data collected, projects should seek to engage with the flyway partnership for collaboration and technical support.
- All tagged birds should also be colour-marked following EAAF protocol (Black over Blue for the Philippines). Efforts should be made to promote colour-band resighting in the Philippines to improve understanding of movements across the flyway.

To maximise the value of studies, all tagging data should be archived in online repositories, such as Movebank, with colour-banding and resighting data shared via EAAF platforms. On completion of tagging studies, in addition to the reporting of results to funders and any scientific publications, feedback on the results of the work should be provided to the other stakeholders, including local communities, who facilitated the work both to provide insights and education about the connectivity of birds across the flyway, and to increase trust in researchers and build support for future studies.

1 Introduction

1.1 Offshore Wind in the Philippines

Globally, the offshore wind industry plays a critical role in the energy transition as part of efforts to mitigate climate change. As an archipelagic nation, the Philippines has a substantial offshore wind resource, with a total technical potential of up to 178 GW estimated in the World Bank Offshore Wind Roadmap for the Philippines¹. Much of this resource is located in waters deeper than 50 meters, meaning that floating offshore wind turbines are likely to be required to explore/utilise this potential fully. However, the floating offshore wind industry is still at an early stage of development with just four operational projects globally – Wind Float Atlantic in Portugal, Kincardine in Scotland, Hywind Tampen in Norway, and Hywind Scotland. Consequently, whilst a number of other floating offshore wind projects are under development, it is likely that the first projects in the Philippines will be fixed-bottom.

The Offshore Wind Roadmap for the Philippines envisages that up to 40 GW will be delivered by 2040. In support of this, by September 2024 the Department of Energy (DoE) had awarded 92 service contracts to offshore wind developers with a total capacity of 66 GW (Carbon Trust 2024). As a first step in meeting these ambitious targets, DoE recently announced the Fifth Green Energy Auction, focusing exclusively on fixed-bottom offshore wind, aiming to deliver 3,300 MW of capacity between 2028 and 2030².

1.2 Offshore Wind Impacts on Shorebirds

Reflecting its central position on the East Asian-Australasian Flyway (EAAF), the Offshore Wind Roadmap for the Philippines highlighted migratory shorebirds, and the legally protected and internationally recognised areas that support them, as Priority Biodiversity Values (PBVs) to which offshore wind farms may pose a particular risk. Particular concern may relate to birds which occur within wetlands designated as EAAF network sites, such as Olango Island Wildlife Sanctuary, Negros Occidental Coastal Wetlands Conservation Area, and Las Piñas-Parañaque Wetland Park.

The main negative biodiversity impacts associated with offshore wind energy are well established (Bennun *et al.* 2021) including: i) risk of collision mortality; ii) displacement due to disturbance (including noise impacts); iii) barrier effects (also including noise impacts); iv) habitat loss; and v) indirect ecosystem-level effects (Perrow 2019)³. These impacts are common across bottom-fixed and floating wind (with differences related to the magnitude of impact related to installation noise). A summary of the impacts of (bottom fixed) offshore wind, including landfall and transmission is presented in Figure 1.

¹ <https://doe.gov.ph/announcements/offshore-wind-roadmap-philippines>

² <https://legacy.doe.gov.ph/press-releases/doe-kicks-green-energy-auction-fixed-bottom-offshore-wind>

³ For more details on the major impacts of offshore wind energy on wildlife, see (Bennun *et al.* 2021).

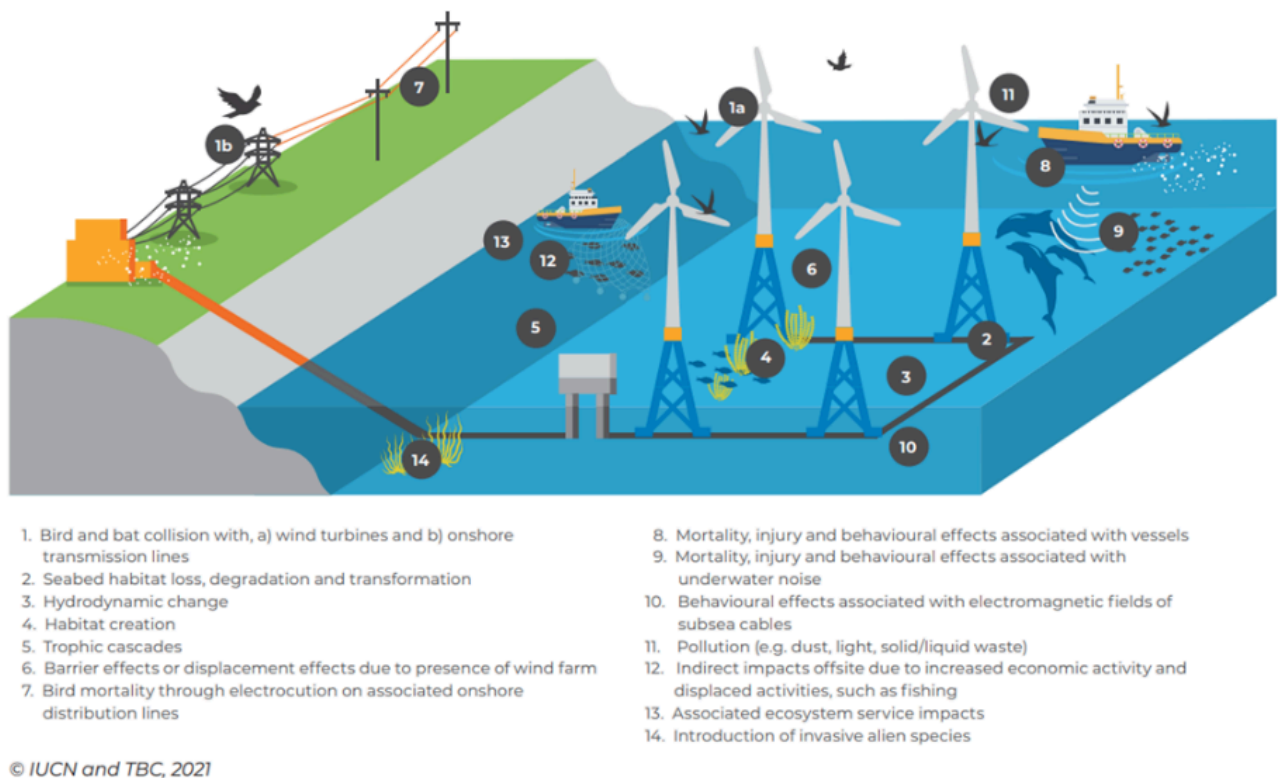


Figure 1. Potential impacts on biodiversity and the associated ecosystem services due to fixed bottom offshore wind developments (many will also apply to floating offshore wind) (Bennun *et al.* 2021).

For migratory shorebirds, the major risks are associated with a) collision with wind turbines and powerline infrastructure, and b) barrier effects, with projects perceived as a barrier by birds in flight and c) impacts to habitat from onshore development of associated infrastructure. Despite the emerging information on impacts from offshore wind farms on shorebirds, there are still significant knowledge gaps regarding the behaviour of most shorebird species both during migration generally, and on encountering offshore wind farms (Woodward *et al.* 2022). The majority of existing research on offshore wind impacts to birds has mostly occurred for seabirds in the Greater North Sea region (e.g. Schwemmer *et al.* 2023a, 2023b). Further data to elucidate the impacts on shorebirds will be important to better inform wind farm siting and mitigation planning. The major impacts on shorebirds can be summarised as follows:

1.2.1 Collision

Shorebirds are frequently observed migrating at substantial altitudes (>5,000 meters) over land (Senner *et al.* 2018), leading to assumptions that they are likely to fly too high to be at risk of collision with offshore wind turbines. However, post-construction monitoring reports record regular observations of shorebirds at altitudes that would place them at risk of collision (< 300 meters). Emerging data collected using GPS tracking reveals that over sea birds travel at lower altitudes than they do over land, and that a substantial portion of flight takes place at altitudes that would place them at risk of collision (Philipp Schwemmer *et al.* 2023). Given the large numbers of migratory shorebirds that may pass through the Philippines on an annual basis (Li *et*

al. 2019), and the susceptibility of these species to collision (Thaxter *et al.* 2017) there may be concern about the potential for negative impacts on populations of these species where projects overlap with key migratory bottlenecks.

1.2.2 Barrier Effects

Barrier effects are a behavioural response of birds to an offshore wind farm whereby they alter their flightpaths to avoid entering a wind farm. Typically, this results in a small deviation in a bird's flightpath. For example, Masden *et al.* (2009) found the Common Eider (*Somateria mollissima*) altered their flightpaths to avoid entering the Nysted Offshore Wind Farm in Denmark, adding approximately 500 m to their overall migration distance of 1,200 km. Similarly, Schwemmer *et al.* (2023) found that migrating Eurasian Curlews (*Numenius arquata*) exhibited avoidance behaviour in both horizontal and vertical planes at distances of 450-500 m from offshore wind farms. The key impact of these responses on the birds concerned is likely to be an increased energetic cost of migration. As noted by Masden *et al.* (2009), the consequences of this in relation to a single offshore wind farm are likely to be negligible in the context of the overall energetic cost of migration. However, where multiple offshore wind farms are encountered during a single migration, the costs may become more substantial. Furthermore, in extreme cases, where birds encounter clusters of multiple projects, this may contribute to them becoming disorientated. For example, GPS tracking of Black-faced Spoonbills (*Platalea minor*) tagged in South Korea found an example of a juvenile bird reversing its path, having almost completed its migration to China, on encountering, and circling around, several offshore wind farms (Figure 2, Lai *et al.* 2024). This behaviour is likely to incur a substantial cost to the bird at a time when it is energetically stressed.

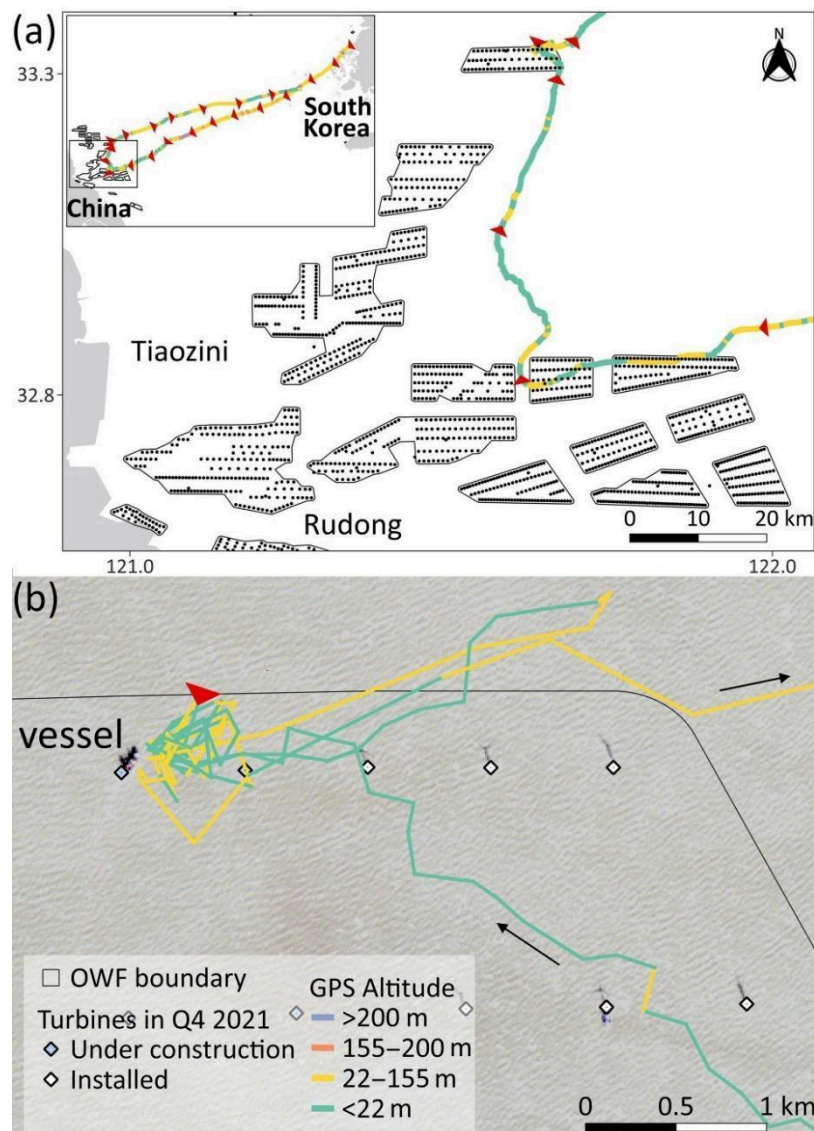


Figure 2. GPS tracking shows Black-faced Spoonbill (M03) encountering three offshore wind farms before returning to South Korea during its first southward Yellow Sea crossing (Lai et al. 2024).

1.2.3 Powerline Collisions

Offshore wind farms are composed of a range of additional infrastructure beyond the turbines themselves including subsea cables and overhead collector powerlines carrying electricity from the point where subsea cables meet the coast to the nearest substations on land. Whilst powerlines should always be buried wherever possible, geotechnical constraints can result in overhead powerlines presenting a potential collision risk for shorebirds.

Multiple factors render shorebirds vulnerable to collisions with powerlines including their flocking and gregarious behaviour, flight heights, long-distance migration, and nocturnal migration (Bernardino et al. 2018; RGI 2024). Across shorebird species, vulnerability will vary. Those with the highest risk are species with lower flight manoeuvrability as a result of comparatively larger body size and higher wing loading (Thaxter et al. 2017), for example species within the *Numeniini* family (curlews and godwits). Any topographical features, such as peninsulas or

isthmi, that concentrate birds into a narrow bottleneck represent a risk. This is especially the case as powerlines from offshore wind farms would typically arrive perpendicular to the coast and flight path for commuting and migrating waders. Whilst their low body weight and high visual acuity (including the position of the eyes on their head) often enable shorebirds to identify and avoid potential collision risks, circumstances such as low/no light conditions or being pursued by a predator may increase the risk of collision.

Shorebird collision with powerlines has been documented numerous times (Manville 2005; Jenkins *et al.* 2010; Loss *et al.* 2014); however factors such as the low detectability and carcass persistence rate (especially in intertidal areas) mean that any recorded mortalities are likely underestimated.

1.2.4 Loss or Damage to Key Stopover or Wintering Habitat by Onshore Infrastructure

Powerline construction onshore should maximise opportunities to demonstrate avoidance of sensitive habitats, including wetlands that represent important stopover and wintering habitats for shorebirds. If poorly planned, powerline construction could lead to fragmentation and loss of habitat for shorebirds (Stevens *et al.* 2008; Biasotto & Kindel 2018), with varying potential for restoration (Nickerson *et al.* 1989; Beauchemin 2019).

Furthermore, powerline construction can lead to reduction in habitat suitability. Birds adapted to open environments (such as coastal wetlands) are known to be affected by the visual disturbance of a powerline in an otherwise uninterrupted horizon and either the perceived or actual presence of predators (e.g., falcons perching on powerlines) (Gibson *et al.* 2018; Kohl *et al.* 2019; Pálsdóttir *et al.* 2022).

1.3 Shorebird Tagging

Detailed understanding of movements of birds in space and over time, at the level of the individual birds is invaluable for planning, design, and management of infrastructure development. An important source of such information can be obtained from data collected through tagging studies. Such data can provide invaluable information to improve our understanding of species ecology, and to support conservation efforts (e.g. Chan *et al.* 2019; Morrick *et al.* 2022). However, the capture, handling and deployment of tracking devices can have detrimental impacts on the species and individuals concerned if not done with care (Bodey *et al.* 2018; Geen *et al.* 2019). For this reason, in many countries, tracking studies are carefully regulated with requirements that those involved in the capture of birds and attachment of any bird-borne devices are appropriately trained. In many cases, training to the appropriate level can take many years, and comes under the responsibility of national bird banding centers. The application of bird tracking studies is a relatively recent development compared to the long history that bird banding (ringing) has, and in many countries bird tracking is not specifically regulated. In the Philippines, a National Banding Scheme was set in 1989 under DENR Administrative Order Number 54⁴, which aims to:

- Coordinate bird banding activities in the country;

⁴ <https://philchm.ph/wp-content/uploads/DAO-1989-54.pdf>

- Promote the conservation of migratory birds and their habitats;
- Enter and promote international cooperation in the protection and conservation of migratory birds;
- Monitor species composition, age structure, migration routes of migrating birds; and,
- Formulate conservation methods and strategies needed to safeguard and enhance migratory bird populations.

However, the policy was established well before the usage of bird-borne devices for monitoring bird movements became commonplace and therefore does not cater for tracking studies specifically. Consequently, to support the use of tracking technology to collect data to inform assessments of the impacts of offshore wind farms on migratory shorebirds, there is a need to update this policy to reflect the availability of this technology and highlight the considerations around its use.

Active engagement in bird banding and specifically in bird tracking studies in the Philippines has a limited track record and the national pool of skilled bird banders and especially taggers is very limited. There is however a significant pool of international expertise from which experts have worked in the Philippines, both from within the East Asian-Australasian Flyway (EAAF), that the Philippines is located in, as well as from other flyways. Both within the EAAF and beyond, there is an active community of researchers, many of whom have the appropriate skills and experience to support, and provide training in relation to, shorebird tagging in the Philippines. The East Asian-Australasian Flyway Partnership provides guidance on shorebird research and banding. Engaging with these researchers and the EAAFP guidance is likely to be crucial to the delivery of any shorebird tagging project in the short-medium term, and for maximising the value of any data collected in the long-term.

1.3.1 Data

Depending on the approach used, shorebird tagging data can provide data on the broadscale or finescale movements of birds, and aspects of their behaviour. From a spatial planning perspective, tagging data can be used to assess the extent to which species migratory routes may overlap with proposed offshore wind farm areas (Figures 3 & 4; Watts *et al.* 2022; Schwemmer *et al.* 2023), and the extent to which they may interact with wind farms, and even, potentially, individual turbines during the breeding or non-breeding seasons (Figure 5; Jiguet *et al.* 2021; Xu *et al.* 2021). This information can be used to identify species that are most exposed to offshore wind farms and prioritise research and mitigation actions accordingly (Green *et al.* 2025).

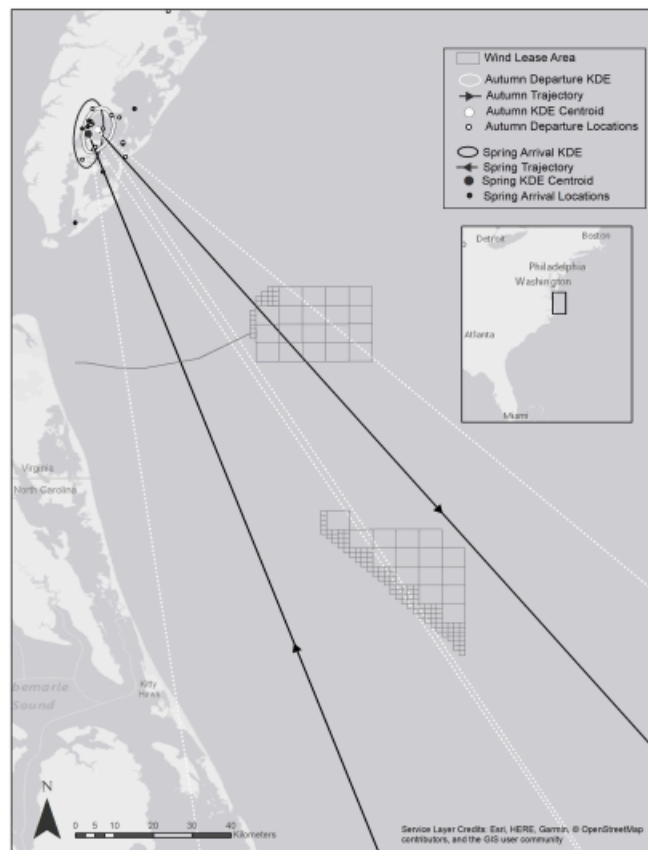


Figure 3. Satellite tracks of Whimbrel (*Numenius phaeopus*) showing possible interactions with proposed offshore wind farms on the East Coast of the US (from Watts et al. 2022)

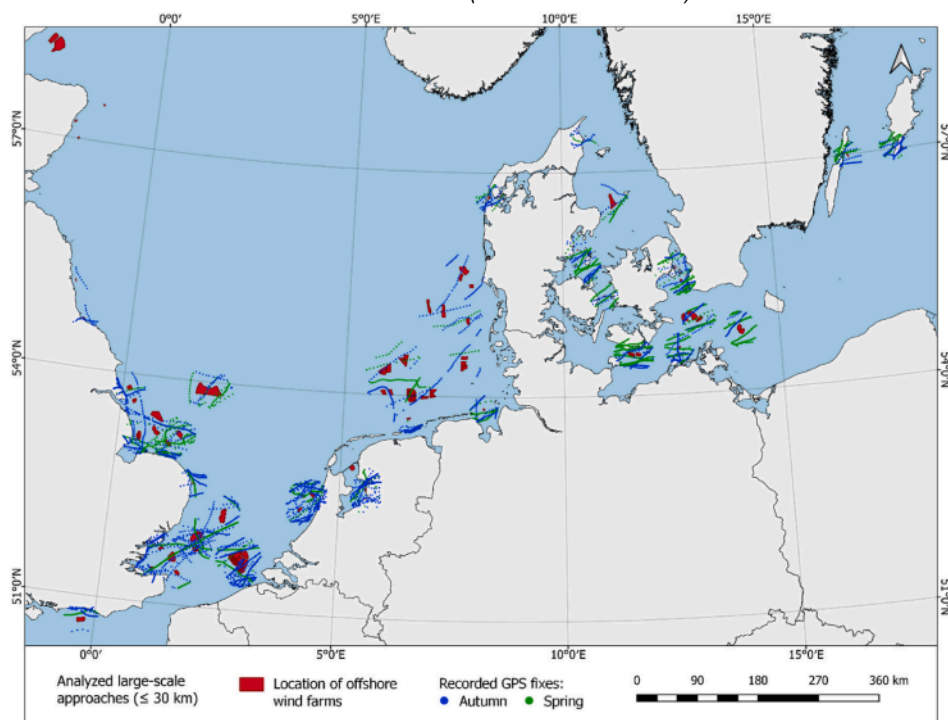


Figure 4. GPS tracks of Eurasian Curlews interacting with offshore wind farms (from Schwemmer et al. 2023)

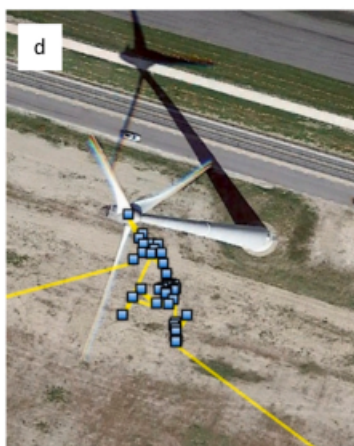


Figure 5. GPS track of a Eurasian Curlew (*Numenius Arquata*) interacting with a wind turbine (from Jiguet et al. 2021)

Beyond potential interactions with wind farms and turbines, tracking data can also provide valuable data to inform models underpinning assessments. Flight heights, flight speed and estimates of nocturnal activity levels are key inputs into assessments of collision risk (Cook et al. 2025). GPS tracking data was used to estimate pre- and post-migration speed (Duijins et al. 2019) and median flight height (Galtbalt et al. 2021), highlighting potential risks of collision for various shorebird species (Figure 6).

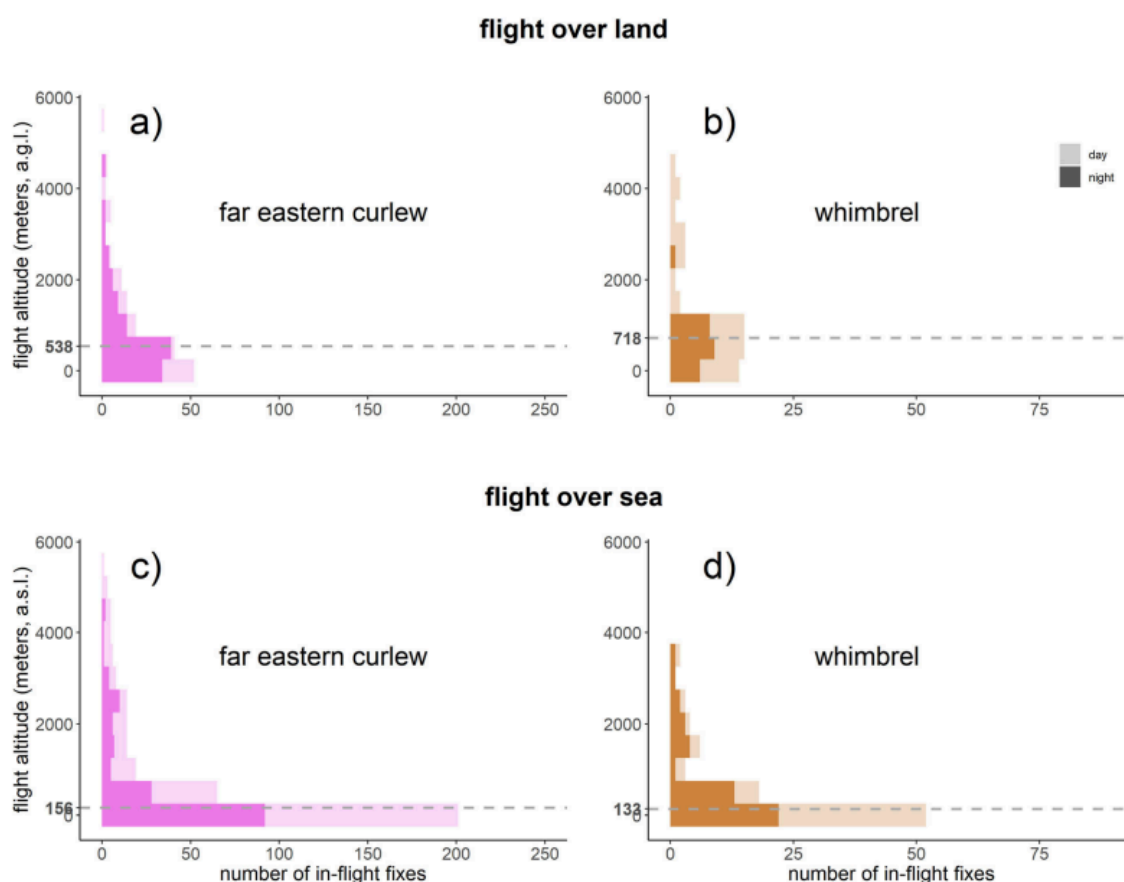


Figure 6. Flight heights of Far Eastern Curlews and Whimbrels over land and sea (from Galtbalt et al. 2021).

Increasingly, data from tracking studies are being integrated into tools used as part of the impact assessment process. The Stochastic Collision Risk Assessment for Movement (SCRAM) model was developed for use on the East coast of the USA (Figure 7; Gilbert *et al.* 2022). The model takes movement data collected using the Motus tracking network (Taylor *et al.* 2017) to assess collision risk in three species of migrating bird – Red Knot (*Calidris canutus*), Piping Plover (*Charadrius melodus*) and Roseate Tern (*Sterna dougalii*). This model is currently being updated to cover a wider range of species, and to utilise GPS tracking data, including making better use of the flight height data collected from migratory species. As the volume of data increases, it may be possible to use this to inform mitigation measures, such as smart curtailment plans (e.g. Bradarić *et al.* 2024)

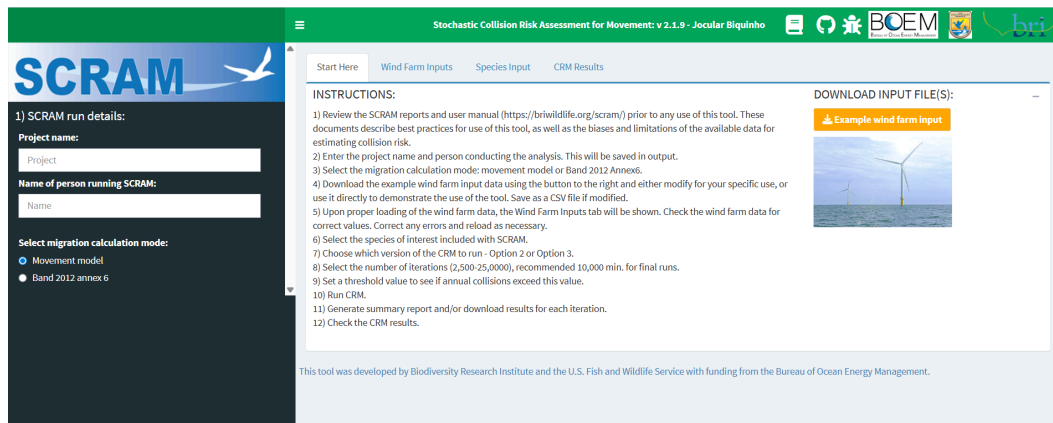


Figure 7. The Stochastic Collision Risk Assessment for Movement online tool

1.3.2 Device Effects

The potential for tags to negatively impact the individuals to which they are attached has been widely acknowledged (Vandenabeele *et al.* 2012, 2014; Bodey *et al.* 2018; Geen *et al.* 2019). These negative impacts may occur as a result of a number of factors including;

- The stress associated with capture and handling (D'Amico *et al.* 2017);
- The energetic cost associated with carrying the additional weight of the tag (Bodey *et al.* 2018);
- Tag placement impacting the aerodynamics of the bird in flight (Vandenabeele *et al.* 2014);
- Tag placement altering the centre of gravity of the bird (Vandenabeele *et al.* 2014);
- Impacts associated with tag attachment methodology, for example abrasion or feather wear resulting from the skin rubbing against harness material (Clewley *et al.* 2022).

These impacts may manifest themselves in behavioural changes, such as differences in foraging range or flight behaviour (Vandenabeele *et al.* 2014), reductions in breeding success, and increased risk of mortality (Bodey *et al.* 2018). Aside from the ethical considerations of wanting to avoid deleterious impacts on birds, from a practical consideration, it is desirable to minimise any potential tag effects to ensure that the data collected are a realistic representation of bird behaviour. Due to the potential for negative tag effects, it is desirable that devices should

be as light as possible ideally less than 3%, and certainly less than 5%, of the body weight of the individual concerned (Barron *et al.* 2010). Careful consideration should also be given to both attachment methodology and device placement to minimise deleterious impacts, and any impacts should be reported openly so that future studies may learn and adapt approaches accordingly.

1.4 What are tags suitable/not suitable for?

Tags are useful for understanding how, and where, birds may interact with offshore wind farms. As highlighted above, they can provide useful information in relation to aspects of behaviour, such as flight heights, which may inform pre-construction assessments of risk, for example in relation to collision with turbines. Following the construction of offshore wind farm projects the data may be valuable in relation to informing how birds interact with turbines, helping to develop an evidence base for future assessments. However, tagging data will not replace the need for the collection of baseline and post-construction monitoring data describing the abundance and distribution of birds in the vicinity of the project and its associated onshore infrastructure.

1.5 Who is this protocol for?

This protocol is aimed to inform developers and consultants who may be involved in the funding and commissioning of shorebird tagging studies in the Philippines, staff from the Department for Environment and Natural Resources, Local Government Units and Indigenous Peoples, who may be responsible for issuing permits and granting approval for studies to take place, and local site staff, who may be responsible for ensuring that studies are carried out in a safe manner with due consideration for bird welfare. It should be noted that capturing birds and fitting tags is a highly specialised skill which can take several years to acquire. Consequently, in the short to medium term, it is likely that international experts will be required to run studies. However, as a priority, these studies should be required to develop capacity building and the transfer of skills to local researchers.

2 Shorebirds in the Philippines

2.1 Species

This report focuses on migratory shorebirds, including species with migrant populations and those with both resident and migrant populations, from the order *Charadriiformes*, a diverse group of birds that encompasses some 200 species of shorebirds. While the order also includes gulls, terns, skuas, and skimmers, these are not the focus of this report, as these species already have an abundance of research that can be transferable to the Philippines.

The migratory shorebird species in this report consists of 35 species from four families – *Recurvirostridae*, *Charadriidae*, *Jacaniidae*, and *Scolopacidae* that have been documented in the Philippines following the reports from the Wild Bird Club of the Philippines (2024). Species descriptions and morphometrics, important for informing tagging options, are summarised in Table 1. Nomenclature followed BirdLife International. Species tagged as vagrant, and which may be observed during tagging activities, are listed in Table 2. The Philippines is among the countries in the EAAF with poorly studied coastlines for migratory shorebirds (Yong et al. 2022); future observations of vagrant species are crucial for providing clues to their presence and abundance in the Philippines, as their initial observations in the Philippines may indicate unknown staging or over summering sites for some of these species (Tan et al. 2023).

Table 1. Priority shorebird and waterbird species in the Philippines and their key morphometrics from Cornell Birds of the World. Values in **bold** indicate mean, range and sample size of masses collected from North Manila Bay in February 2024 by Ward Hagemeijer

	Common Name	Scientific Name	Migratory Status (M)igratory / (R)esident	Conservation Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ²	Mass ²	Occurrence in Philippines	Global Population Trend
<i>Recurvirostridae</i>	Black-winged Stilt	<i>Himantopus himantopus</i>	M, R	LC		marshes, swamps, flooded fields, coastal mudflats, salt pans	37.5–40 cm	67–83 cm	145–289 g		Increasing
	Pied Avocet	<i>Recurvirostra avosetta</i>	M	LC		muddy tidal flats, fishponds, rice fields, coastal marshes	42–45 cm	67–80 cm	195–397 g	November – May	Unknown
<i>Charadriidae</i>	Grey Plover	<i>Pluvialis squatarola</i>	M	VU		intertidal mudflats, beaches, and coral flats	27–31 cm	71–83 cm	165–395 g 241 g (214 – 268 g, sample size = 2)	September – May	Decreasing
	Pacific Golden Plover	<i>Pluvialis fulva</i>	M	LC		coasts, short grass fields, ploughed lands, saltmarshes, beaches, open sandflats, mudflats	23–26 cm	60–72 cm	100–228 g 117.6 g (88.0 – 136.8 g, sample size = 14)	September – May	Decreasing
	Little Ringed Plover	<i>Charadrius dubius</i>	R, M	LC		bare or sparsely vegetated flats of sand, shingle or silt, saline inland pools, rice fields, grassland, brackish lagoons, estuaries	14–17 cm	42–48 cm	26–53 g		Stable
	Tibetan Sandplover	<i>Charadrius atrifrons</i>	M	LC		tidal mudflats, beaches, sandflats, mangroves	18–21 cm	45–58 cm	55–79 g 52.3 g (33 – 65.3 g, sample size = 3)		Decreasing
	Siberian Sandplover	<i>Charadrius mongolus</i>	M	EN		tidal mudflats, sandy beaches, estuaries, mangroves	18–21 cm	45–58 cm	55–79 g	September – May, rarely June – July	Decreasing
	Greater Sandplover	<i>Charadrius leschenaultii</i>	M	LC		sandy or muddy beaches, estuaries, intertidal mudflats, sandbanks, reefs	20–25 cm	44–60 cm	55–121 g	August – May	Decreasing

	Common Name	Scientific Name	Migratory Status (M)igratory / (R)esident	Conservation Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ²	Mass ²	Occurrence in Philippines	Global Population Trend
	Malay Plover	<i>Charadrius peronii</i>	R	VU	VU	isolated sandy beaches, small bays with coral sand, open dunes	14–16 cm	42–45 cm	♂ 31–57 g, ♀ 34–66 g		Decreasing
	Kentish Plover	<i>Charadrius alexandrinus</i>	M	LC		coastal beaches, mud and coral flats, lagoons, lakes	15–17.5 cm	42–45 cm	32–56 g 43.1 g (35 – 61 g, sample size = 9)	August – April (rarely May)	Decreasing
<i>Jacanidae</i>	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	R, M	LC		freshwater marsh, lakes, ponds, reservoirs, paddies, swampy grounds	39–58 cm (including 25–35 cm tail; 31cm in non-breeding)	67 cm	♂ 120–140 g, ♀ 190–231 g		Unknown
<i>Scolopacidae</i>	Whimbrel	<i>Numenius phaeopus</i>	M	LC		tidal mudflats, dry to wet grassland, exposed reefs, muddy, rocky, or sandy beaches, rice fields, and mangrove swamps	40–46 cm	76–89 cm	310–493 g	August – April, some May – July	Decreasing
	Little Curlew	<i>Numenius minutus</i>	M	LC		dry inland grassland, bare cultivation, artificial shore-grass flats, freshwater such as swamps, pools, lakes, flooded ground	28–34 cm	68–71 cm	118–221 g	October – June	Decreasing
	Far Eastern Curlew	<i>Numenius madagascariensis</i>	M	EN	EN	estuaries, mangrove swamps, saltmarshes, intertidal mud, or sandflats	53–66 cm	97–110 cm	390–1350 g (♂ averaging 110 g lighter than ♀)	August – April	Decreasing
	Eurasian Curlew	<i>Numenius Arquata</i>	M	NT	OTS	muddy coastal, bays, estuaries, stubble fields, and pastures	50–60 cm	80–100 cm	♂ 410–1010 g, ♀ 475–1360 g	August – April, mid-June	Decreasing
	Bar-tailed Godwit	<i>Limosa lapponica</i>	M	NT		intertidal areas, sandy estuaries, mangrove-fringed	37–41 cm	70–80 cm	200–720 g	August – May	Decreasing

	Common Name	Scientific Name	Migratory Status (M)igratory / (R)esident	Conservation Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ²	Mass ²	Occurrence in Philippines	Global Population Trend
						lagoons, sheltered bay					
	Black-tailed Godwit	<i>Limosa limosa</i>	M	VU	VU	sheltered estuaries, lagoons, intertidal mudflats, sandy beaches, flooded grassland, and rice fields	36–44 cm	70–82 cm	♂ 160–440 g, ♀ 244–500 g 202 g (186.7-223.0 g, sample size = 3)	August – May	Decreasing
	Asian Dowitcher	<i>Limnodromus semipalmatus</i>	M	VU	VU	estuarine, intertidal mudflats, muddy lagoons, tidal creeks, salt works	33–36 cm	57–59 cm	127–245 g	September – April	Decreasing
	Red-necked Phalarope	<i>Phalaropus lobatus</i>	M	LC		at sea, marshy pools, saline lagoons	18–20 cm	32–41 cm	20–48 g	August – May	Decreasing
	Terek Sandpiper	<i>Xenus cinereus</i>	M	LC		open intertidal mudflats, estuaries, coral reefs, sandy beaches, coastal swamps, salt pans	22–25 cm	57–59 cm	58–105 g	August – May	Decreasing
	Common Sandpiper	<i>Actitis hypoleucos</i>	M	LC		coasts, estuaries, saltmarshes, inland wetlands, pools, and tidal creeks in mangroves, ricefields	19–21 cm	38–41 cm	33–93 g 47.2 g (44.2 – 50.5 g, sample size = 5)	July – May	Decreasing
	Gray-tailed Tattler	<i>Tringa brevipes</i>	M	LC		sheltered coasts with reefs and rock platforms, intertidal mudflats; rocky, single gravel or shell shores; mangroves	23–27 cm	60–65 cm	80–162 g	August – May, June	Stable
	Marsh Sandpiper	<i>Tringa stagnatilis</i>	M	LC		inland and brackish wetlands, paddyfields, swamps, salt pans, saltmarshes, estuaries, lagoons, intertidal mudflats	22–26 cm	55–59 cm	43–120 g 64.7 g (56.5 – 74 g, sample size = 13)	August – May	Decreasing

	Common Name	Scientific Name	Migratory Status (M)igratory / (R)esident	Conservati on Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ²	Mass ²	Occurrence in Philippines	Global Population Trend
	Common Redshank	<i>Tringa totanus</i>	M	LC		rocky, muddy, and sandy shores, saltmarshes, open mudflats, freshwater lagoons, saltpans	27–29 cm	59–66 cm	85–155 g 122.1 g (96 – 160.9 g, sample size = 38)	August – April (rarely May – July)	Unknown
	Common Greenshank	<i>Tringa nebularia</i>	M	LC		sandy or muddy coastal flats, saltmarshes, mangroves, swamps, lakes, saltpans	30–35 cm	68–70 cm	125–300 g 154.1 g (149 – 164.4 g, sample size = 4)	August – May (rarely June, July)	Stable
	Ruddy Turnstone	<i>Arenaria interpres</i>	M	NT		coastal; rocky, shingly, and stony shores, sandy beaches with washed up seaweeds, mangroves, exposed reefs, mudflats	21–26 cm	50–57 cm	84–190 g 106 g (sample size = 1)	August – May	Decreasing
	Great Knot	<i>Calidris tenuirostris</i>	M	EN	EN	intertidal mud and sandflats, coral reefs	26–28 cm	56–66 cm	115–248 g	September – April	Decreasing
	Red Knot	<i>Calidris canutus</i>	M	NT		large tidal mudflats, sandflats	23–25 cm	45–54 cm	85–220 g 112.8 g (98 – 122.8 g, sample size = 12)	September – April	Decreasing
	Ruff	<i>Calidris pugnax</i>	M	LC		muddy margins of lakes, pools, marshes, rice fields, flooded grasslands, tidal mudflats, lagoons	26–32 cm (male), 20–25 cm (female)	54–58 cm (male), 48–52 cm (female)	130–254 g (male), 70–170 g (female)	August – January, February–May	Decreasing
	Broad-billed Sandpiper	<i>Calidris falcinellus</i>	M	VU		shallow lagoons, flooded rice fields, intertidal mudflats, saltpans	16–18 cm	34–37 cm	28–68 g 36 g (sample size = 1)	(July – August), September – April	Decreasing
	Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	M	VU		coastal and inland wetlands including intertidal mudflats, shallow brackish lagoons, flooded	17–22 cm	36–43 cm	53–114 g (male), 39–105 g (female)	(August), September – April	Decreasing

	Common Name	Scientific Name	Migratory Status (M)igratory / (R)esident	Conservation Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ²	Mass ²	Occurrence in Philippines	Global Population Trend
						grassland, rice fields					
	Curlew Sandpiper	<i>Calidris ferruginea</i>	M	VU		tidal flats, coastal lagoons, estuaries, saltmarshes; inland at muddy edges of marshes lakes, salt pans, flooded fields	18–23 cm	38–46 cm	57 g 58.6 g (47.3 – 61.9 g, sample size = 10)	August – April	Decreasing
	Long-toed Stint	<i>Calidris subminuta</i>	M	LC		rice fields, muddy or vegetated edges of coastal and shallow freshwater and brackish wetlands, salt pans	13–16 cm	26–35 cm	20–37 g 27 g (26.3 – 27.7 g, sample size = 2)	August – April (rarely May)	Decreasing
	Red-necked Stint	<i>Calidris ruficollis</i>	M	NT		intertidal mudflats, sheltered inlets, bays, lagoons; freshwater, brackish, and saltwater wetlands	13–16 cm	29–33 cm	18–51 g 34 g	(July) August – May	Decreasing
	Sanderling	<i>Calidris alba</i>	M	LC		open sandy beaches exposed to swell of open sea, sandy outer reaches of estuaries	18–20 cm	35–39 cm	40–100 g	September – May	Decreasing

¹Body length data taken from Allen, D. 2020. *Birds of the Philippines*. Lynx Edicions, Barcelona, Spain. ²Wingspan and body mass data taken from Cornell Lab of Ornithology. *Birds of the World*, birdsoftheworld.org/bow/home

Table 2. List of vagrant migratory shorebird species in the Philippines (as of 2024), morphometrics from Cornell Birds of the World. Values in **bold** indicate mean, range and sample size of masses collected from North Manila Bay in February 2024 by Ward Hagemeyer

English Name	Scientific Name	Conservation Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ²	Mass ²	Global Population Trend
Eurasian Oystercatcher	<i>Haematopus ostralegus</i>	NT		mudflats, coral flats, mussel beds	40–47.5 cm	76–86 cm	520 g	Decreasing
Common Ringed Plover	<i>Charadrius hiaticula</i>	LC		sand or shingle beaches, mudflats, lagoons, rarely flooded fields	18–20 cm	48–57 cm	42–78 g	Decreasing
Long-billed Plover	<i>Charadrius placidus</i>	LC		shingle banks of large rivers, muddy areas, beaches, sewage ponds	18–21 cm	45 cm	41–70 g	Decreasing
Northern Lapwing	<i>Vanellus Vanellus</i>	NT		ploughed fields, pastures, mudflats	28–31 cm	82–87 cm	128–330 g	Decreasing
Gray-headed Lapwing	<i>Vanellus cinereus</i>	LC		swamp, rivers, ricefields	34–37 cm	75–76 cm	236–296 g	Stable
Oriental Plover	<i>Charadrius veredus</i>	LC		open grasslands, sparsely in vegetated inland plains, interspersed with dry bare ground; clay-pans, playing fields, lawns, cattle camps, recently burnt fields, bare margins of wetlands, mudflats, sandbanks, often far from water but possibly roosts in beaches during day	22–25.5 cm	46–53 cm	95 g	Stable
Bristle-thighed Curlew	<i>Numenius tahitiensis</i>	NT	VU	tidal mudflats, exposed reefs, salt pans, grassy fields	40–44 cm	82–90 cm	310–800 g	Decreasing
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	NT		freshwater marshes, lakes, rice paddies, saltmarshes, mudflats	24–30 cm	46–52 cm	90–131 g	Decreasing
Jack Snipe	<i>Lymnocyptes minimus</i>	LC		brackish and freshwater habitats, with moist and waterlogged mud and tussocks of vegetation	17–19 cm	34–42 cm	28–106 g	Stable
Red Phalarope	<i>Phalaropus fulicarius</i>	LC		at sea	20–22 cm	37–40 cm	46–77 g	Unknown
Spotted Greenshank	<i>Tringa guttifer</i>	EN	EN	coastal mud or sandflats, salt pans, shallow lagoons, mangroves	28.5–34 cm	55 cm	125–170 g 172.5 g (sample size = 1)	Decreasing
Spotted Redshank	<i>Tringa erythropus</i>	LC	EN	freshwater and brackish wetlands, including irrigated rice fields, saltmarshes, salt pans, sheltered muddy shores	29–32 cm	61–67 cm	97–230 g	Stable
Spoon-billed Sandpiper	<i>Calidris pygmaea</i>	CR/CR		muddy coasts, salt pans, intertidal mudflats, coastal lagoons	14–16 cm	32–38 cm	29.5 (male), 34 g (female)	Decreasing

English Name	Scientific Name	Conservation Status (IUCN)	Conservation Status (DENR)	Habitat	Length ¹	Wingspan ₂	Mass ²	Global Population Trend
Dunlin	<i>Calidris alpina</i>	NT		estuarine mudflats, coastal areas but also freshwater and brackish wetlands including lagoons and wet rice paddies	16–22 cm	33–40 cm	48–64 g	Decreasing
Little Stint	<i>Calidris minuta</i>	LC		estuarine mudflats, lagoons, tidal creeks, open pools in marshes, paddyfields	12–14 cm	28–31 cm	17–44 g	Increasing
Pectoral Sandpiper	<i>Calidris melanotos</i>	LC		freshwater and brackish wetlands, including saltmarshes, swamps, lakes, wet grassland, and coastal lagoons	19–23 cm	37–45 cm	45–126 g (male), 31–97 g (female)	Unknown

¹Body length data taken from Allen, D. 2020. *Birds of the Philippines*. Lynx Edicions, Barcelona, Spain. ²Wingspan and body mass data taken from Cornell Lab of Ornithology. *Birds of the World*, birdsoftheworld.org/bow/home

Tables 1 and 2 indicate the range of weights typical for each species, which will determine the maximum tag weight which can be used. These are illustrative weights taken from the Cornell Lab of Ornithology Birds of the World⁵. However, it is important to note that the weight of shorebirds varies seasonally, and between sexes, hence the wide range of reported weights for many species in Tables 1 and 2. Sexual dimorphism, wherein females tend to be larger than males, as well as the age of birds, will influence the body size and general morphometrics of captured species. Furthermore, birds arriving in the Philippines at the onset of the winter migration tend to be lighter as they burn fat reserves and reduce energy needs during their flights; some migratory birds will lose half of their weight during migration. They will regain their weight in a few weeks, depending on the species and the length of their migration, after reaching their wintering grounds – provided that ample food and shelter are available. They will refuel and restore their fat reserves in preparation for their northern migration to the Arctic breeding grounds. For example, adult and first-cycle Terek Sandpipers (*Xenus cinereus*) monitored in Malaysia weighed an average of 58.4-82.5 g from August to February and increased their weights from 80-105 g by April (Mlodinow et al. 2024). These factors need to be taken into consideration when selecting appropriate tags. To aid these considerations, it may be possible to summarise body weight data from elsewhere within the flyway, for example Hong Kong, China, or Australia, where extensive shorebird banding takes place.

Of the 38 species in the list, seven are classified as threatened under the IUCN (Endangered = 3, Vulnerable = 4), while six are included in the DENR National List of Threatened Species (Endangered = 2, Vulnerable = 3, Other Threatened Species = 1). In addition, seven species are considered as priority species for the EAAF Partnership: Far Eastern Curlew (*Numenius madagascariensis*), Eurasian Curlew, Black-tailed Godwit (*Limosa limosa*), Asian Dowitcher (*Limnodromus semipalmatus*), Great Knot (*Calidris tenuirostris*), Red Knot, and the Curlew Sandpiper (*Calidris ferruginea*). The EAAF Partnership prioritises these species because of the significant decline in their global population, mostly attributed to the declining quality of their habitat. For long-distance migrants, like shorebirds, their dependence on limited key habitats is crucial for their survival (Conklin et al. 2014); hence, while the numerous species of shorebirds are widely distributed and ecologically diverse, many are highly threatened. In the EAAF, considered as the most vulnerable among the flyways, threats often relate to hunting and widespread habitat loss across their annual life cycle (breeding, passage, and wintering ranges) (Yong et al. 2017; Koleček et al. 2021; Santos et al. 2023). For populations passing through the Philippines, habitat loss in the Yellow Sea region has been a well-recognised threat in the region (Wang et al. 2022). In the Philippines, significant disturbances, and conversion of wetlands, especially mudflats and intertidal areas, dredging, pollution from domestic and industrial wastes contribute to their declining populations (BCSP 2020; Jensen 2018). Coastal wetlands in particular are prone to human disturbances and intrusions such as land encroachment, aquaculture, sand mining, large-scale reclamation projects, and tourism (Tan et al. 2023).

2.2 Key Sites for Migratory Shorebirds in the Philippines

The East Asian-Australasian Flyway (EAAF) is one of the eight globally recognised flyways that serve as an important route for migratory birds during the migration season (EAAFP, 2020). The EAAF, which overlaps with 22 countries from Alaska and Russia to New Zealand, including the

⁵ Cornell Lab of Ornithology Birds of the World <https://birdsoftheworld.org/bow/home>

Philippines (Szabo et al. 2016; Conklin et al. 2014), serves more than 492 species comprising 50 million migratory waterbirds during their annual migration period (Li et al. 2019). At least 36 of these species are globally threatened, making the EAAF among the most vulnerable flyways in the world (EAAFP, 2020).

Migratory shorebirds use many and varied wetlands along the EAAF as they embark on their annual migration cycle. The Southeast Asian region holds one of the largest tracts of mangroves and mudflats, and the longest coastlines in the EAAF (Yong et al. 2022). The Philippines, being archipelagic, is among the countries in the EAAF with the most extensive coastline and numerous wetlands and rice fields that are ideal for shorebirds migrating during the non-breeding season. The distribution of migratory shorebirds in the country would then depend on good habitat structure, food availability, and the presence of resident shorebird populations (Oracion et al. 2022).

It is for this reason that the East Asian-Australasian Flyway Partnership (EAAFP), a partnership among governments, intergovernmental organisations, and other non-state actors, created a flyway-wide framework to promote dialogue, cooperation, and collaboration among the different stakeholders in the flyway. Included in its mission is the designation of Flyway Network Site (FNS) to support the sustainable management of internationally important sites for migratory waterbirds. In the Philippines, seven FNS have been identified as of the 12th Meeting of Parties in 2025, including the Olango Island Wildlife Sanctuary, Naujan Lake National Park, Tubbataha Reefs Natural Park, Negros Occidental Coastal Wetlands Conservation Area, Lake Mainit, Agusan Marsh Wildlife Sanctuary, and the Sibugay Wetland Nature Reserve.

In 2021, the Asian Development Bank (ADB), with BirdLife International and the EAAFP, embarked on a project to identify the most critical wetlands for migratory birds in the region. The Regional Flyway Initiative (RFI) aims to complement the Flyway Network Sites and improve the management, conservation, and strategic investments of wetlands important for migratory birds in 10 countries in East, South, and Southeast Asia. In the Philippines, 12 wetlands (nine coastal and three inland wetlands) have been identified by the RFI as sites that support $\geq 1\%$ of the global population of 28 shorebird species such as the Great Knot (EN), Chinese Egret (VU), Grey-tailed Tattler (NT), Red-necked Stint (NT), Chinese Crested Tern (CR) and several species of plovers, sandpipers, and terns (Table 3).

Table 3: Species with ≥1% of global population at Regional Flyway Initiative sites in the Philippines

SITE	PROVINCE	SPECIES (≥1%)
North Manila Bay (includes Pampanga River East Bank-Santa Cruz-Caliligawan-Pamawaran-Na votas-Talipit-Tanza)	Bulacan	Kentish Plover, Pacific Golden Plover, Lesser Sand Plover, Marsh Sandpiper, Whiskered Tern, Common Redshank, Curlew Sandpiper, Caspian Tern
North Manila Bay (Pampanga) (includes Pampanga River Westbank-Sasmuan Pampanga Coastal Wetlands)	Pampanga	Kentish Plover, Intermediate Egret, Whiskered Tern, Great White Egret, Black-headed Gull
Olango Island Wildlife Sanctuary	Cebu	Lesser Sand Plover, Common Tern, Grey-tailed Tattler (NT), Ruddy Turnstone, Kentish Plover, Whimbrel, Red-necked Stint (NT)
Bangrin Marine Protected Area	Pangasinan	Intermediate Egret, Great White Egret
Negros Occidental Coastal Wetlands Conservation Area (NOCWCA)	Negros Occidental	Little Egret, Black-tailed Godwit (NT), Kentish Plover, Caspian Tern, Chinese Egret (VU), Broad-billed Sandpiper, Great Knot (EN), Pacific Golden Plover, Intermediate Egret
Lake Mainit	Agusan del Norte, Agusan del Sur	Tufted Duck
Agusan Marsh Wildlife Sanctuary	Agusan del Sur	Intermediate Egret
Candaba Wetlands	Pampanga	Garganey
Kabasalan-Siay Wetland Area (also known as Sibugay Wetlands)	Zamboanga Sibugay	Great White Egret, Intermediate Egret
Panabo Coast	Davao del Norte	Chinese Crested Tern (CR)
North Manila Bay (Bataan) – Balanga Wetlands Park- Pilar Wetlands	Bataan	Kentish Plover, Great White Egret
Tubbataha Reef Natural Park	Palawan	Greater Crested Tern, Black Noddy

Source: Regional Flyway Initiative, Crosby et al, 2025.

The Philippines is also a signatory to numerous multilateral environmental agreements (MEA) for the conservation of habitats and species, sustainable development, and the mitigation of and adaptation to climate change. The foremost international agreement on wetland wise use and conservation is the Ramsar Convention on Wetlands, which the Philippines ratified on 8 November 1994. Since then, 10 Ramsar sites have been identified: Olango Island Wildlife Sanctuary, Naujan Lake National Park, Agusan Marsh Wildlife Sanctuary, Tubbataha Reefs Natural Park, Puerto Princesa Subterranean River National Park, Negros Occidental Coastal Wetlands Conservation Area, Las Piñas-Parañaque Wetland Park, Sasmuan Pampanga Coastal Wetlands, Sibugay Wetland Nature Reserve, and Del Carmen Mangrove Reserve.

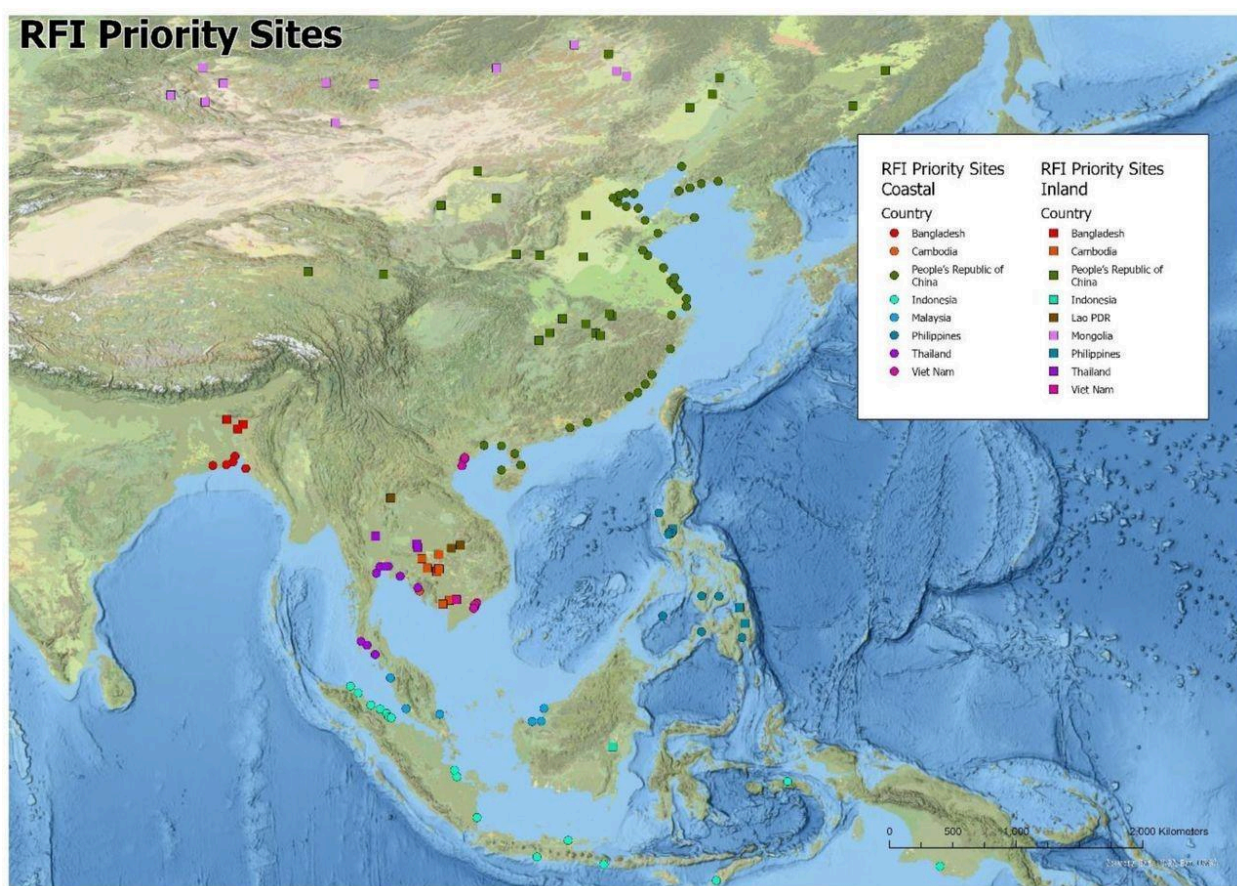


Figure 8. East Asian-Australasian Regional Flyway Initiative Priority Sites.

As part of its commitment to the Convention on Biological Diversity (CBD) and the Kunming-Montreal Global Biodiversity Framework (GBF), the Philippines pledges to protect 24% of land and 16% of marine areas by 2040, while also reversing biodiversity loss by the same year (DENR-BMB, 2024; DENR Administrative Order 2025-23). As of 2025, the Philippines has identified 322 key habitats for immediate protection. Of the total 53,038,338.53 ha designated as proposed or existing KBA, 46,360,259.75 hectares are classified as marine or integrated terrestrial and marine ecosystems (Table 4).

Table 4: Classification of proposed and existing KBA

KBA Classification	Number	Area (in hectares)
Integrated KBA	22	12,556,679.10
Integrated KBA-proposed	7	24,586,773.72
Marine KBA	107	9,216,806.93
Terrestrial KBA	105	5,605,853.70
Proposed Terrestrial KBA	81	1,072,225.08
Total Proposed and Existing KBA	322	53,038,338.53

Source: DENR-BMB, 2025

Some of these KBAs overlap with important wetlands for migratory birds represented by the 12 RFI sites, the 10 Ramsar sites in the country, and the EAAFP Flyway Network Sites. In addition, among the key sites for migratory shorebirds are the Important Bird and Biodiversity Areas (IBA), identified by BirdLife International as sites that are internationally important for the conservation of birds and other biodiversity (Table 5). In Southeast Asia, 181 of the more than 600 IBAs are within coastal wetlands. The Philippines has 27 IBAs within coastal zones, totalling an area of 8,321 square kilometres (Yong et al. 2022).

Table 5: Important Wetlands Sites for Migratory Birds

Sites for Migratory Birds		RFI	Ramsar	FNS	KBA	IBA
1	North Manila Bay (Pampanga River East Bank - Santa Cruz - Caliligawan - Pamawaran -Navotas - Taliptip - Tanza)	X			X	X
2	Olango Wildlife Sanctuary	X	X	EAAF 007	X	X
3	Bangrin Marine Protected Area	X			X	
4	Negros Occidental Coastal Wetlands Conservation Area	X	X	EAAF 135	X	
5	Lake Mainit	X		EAAF 158	X	
6	North Manila Bay (Pampanga River Westbank - Sasmuan Pampanga Coastal Wetlands)	X	X		X	X
7	Agusan Marsh Wildlife Sanctuary	X	X	EAAF 159	X	X
8	Candaba Wetlands	X	Ramsar City		X	X
9	Sibugay Wetland Nature Reserve	X	X	EAAF 158	X	
10	Panabo Coast	X			X	
11	North Manila Bay (Balanga Wetlands Park - Pilar Wetlands)	X			X	X
12	Tubbataha Reefs Natural Park	X	X	EAAF 123	X	X
13	Las Pinas Paranaque Wetland Park		X		X	X
14	Naujan Lake National Park		X	EAAF 062	X	X
15	Puerto Princesa Subterranean River National Park		X		X	X
16	Del Carmen Mangrove Reserve		X		X	X

With the GBF in mind, it is expected that the Philippines will strengthen efforts to establish new protected and conservation areas, including Other Effective Area-based Conservation Measures (OECMs) and indigenous land and water domains, to meet its commitment towards the 30x30 targets.

2.3 Seasonal Patterns of Shorebird Abundance in the Philippines

Each year, migratory shorebirds make their annual migration from their northern breeding grounds in Russia and East Asia to their wintering, non-breeding sites in Asia and Australasia.

Typically, migratory shorebirds arrive in the Philippines in August and September, during the onset of winter in their northern habitats, leaving for their northward migration in April (Jensen 2018). The peak migration of Charadriidae and Recurvirostridae is towards the end of September, while Scolopacidae starts in August (Tan et al. 2023). The study by Tan et al (2023) further suggests that Manila Bay supports over-summering populations of at least 31 species of shorebirds, including the globally threatened Great Knot and Far Eastern Curlew, documented in June and July. According to the study, most over-summering birds are immature, adding to the recommendation that the site is crucial for maintaining global populations, especially of threatened shorebirds.

Transmigratory birds are also documented in September and October, suggesting the Philippines as a passage route to countries further south, such as Indonesia and Australia (Jensen 2018). It was observed that long-distance migratory birds fly from the Arctic to their non-breeding grounds in New Zealand and Australia, in contrast to short and medium-distance migratory birds that spend their non-breeding season closer to the equator (Li et al. 2019).

3 Formulating a Research Question

The first step in any tagging study must be to look back at the objectives of the study, including the issue at hand and the research question that was formulated in response to that issue, which led to the decision that tagging was necessary or desirable. A tagging study is a relatively 'heavy' mechanism in the sense that it is expensive and potentially with impact on the species to be researched, more so than other, less invasive methods like counting, metal banding, or colour banding.

The next step in any tagging study must be to clearly state and describe the research question at hand. This will inform all subsequent aspects of the study from the type of tag used to when, and how, the birds are caught. This research question must be co-developed with the organisation funding the work, and in consultation with other interested parties (e.g., DENR Biodiversity Management Bureau, Department of Energy, local NGOs). These discussions should cover the species of interest, the sites at which the data will be collected and the types of data that will be collected. This will help set clear expectations in relation to what can be achieved as part of the study and how it will address the questions of primary interest to key stakeholders. It will also help to foster an effective working relationship between the contractor(s) and the client(s). Examples of questions that could be asked in relation to the interaction between migratory shorebirds and offshore wind farms in the Philippines include;

- What is the likelihood that the population of a given species migrating through the Philippines will interact with the planned offshore wind farm zones?
- How do the movements of a population of wintering birds within the Philippines bring that population into contact with an offshore wind farm and its associated infrastructure?
- What proportion of flight activity for a given species occurs at a height that is likely to place it at risk of collision with offshore wind turbine blades?

The appropriate choice of tag depends on a range of considerations starting with the purpose of the study. Gould et al. (2024) produced a review of scientific literature and commercially available devices. Aspects of these decisions are discussed in more detail below.

3.1 Data Considerations

The data the tags can collect varies in relation to factors including;

- The spatial resolution of the data that can be obtained;
- The number of locations that can be determined over a given time period, usually referred to as the fix-rate, with more frequent fixes offering a more detailed understanding of movement in time;
- The ability to collect supplementary data, for example on flight heights, flight speeds, temperature, pressure (useful for GPS independent altitude information or for inferring diving behaviour), accelerator (3D) data, informing about activity levels, and records of

whether tags are wet or dry (useful for inferring if birds are on the water surface).

In reality, tags are usually not able to collect all types of data, meaning that trade-offs will be required when designing studies. A key consideration as part of this is the battery life of the tags concerned, with higher fix rates resulting in more data, acting as a greater drain on batteries. In the case of short-term deployments of archival tags, which do not require data to be transmitted, this may be less of an issue. However, for longer-term deployments fix rates may need to be managed to ensure continuous data coverage. The use of tags with in-built solar panels may help to manage this, though these add additional weight to the tags. Many tags now have a level of 'intelligence' that makes fix rate and transmission scheduling respond to battery levels. To further aid battery management, many tags can now be programmed, both before deployment and often also once deployed on a bird, as long as contact can be established with the tag.

Where other data are required, for example in relation to flight heights or speed, care must be taken to ensure that the selected tags are capable of collecting these data. This can often be determined through early engagement with tag manufacturers, some of whom may be willing to accommodate requests for additional data if required. Many modern tags combine multiple sensors in a tag, even low-weight tags.

3.2 Species Considerations

There are a number of species-specific considerations in relation to deploying tags. As highlighted above, the most widely known of these relates to tag weight as a proportion of the overall body mass of a bird (e.g. Bodey *et al.* 2018; Geen *et al.* 2019). As a generic rule of thumb, we suggest that tag weight (including weight of the deployment method) should be no more than 3% of body weight. Specific consideration, e.g. related to the ecology of the species, may lead to slightly deviating from that, upwards or downwards, though 5% of body weight should be taken as an absolute maximum. These considerations and the final decision on the threshold percentage to be used are to be specified and approved in the research and ethical permit (if applicable). Beyond the additional weight of the tag, there is the potential for the position of the tag on the body to have an adverse impact on the energetic cost to the bird. If not streamlined, tags may increase drag either whilst birds are in flight, or, in the case of diving species, underwater (Kay *et al.* 2019). Inappropriately placed tags may also impact a bird's centre of gravity (Vandenabeele *et al.* 2014), further increasing energetic costs. These factors will influence both the size of the tag that can be deployed, and also how, and where, it can be attached to the bird.

3.3 Other Considerations

In addition to those related to the species concerned and data that will be collected, other considerations relate to how the data will be retrieved and the extent to which tags are programmable.

As discussed below, methods for data retrieval vary by tag type. If archival tags are used, birds must be able to be reliably re-trapped within the time period over which the tag will remain attached. In the case of band-mounted tags, this period may be in excess of a year. However, for tape, or glue-mounted tags, it must be possible to retrap birds within a period of weeks, or possibly days, to ensure data is not lost. Where tags download to a base station, there must be

somewhere that this base station can be located within range of the areas used by the birds, which is safe from accidental or deliberate damage. Where tags transmit data via the wireless telephone network, coverage of the areas used by the birds must be confirmed prior to the deployment of any tags, noting that the signal on a mudflat may be substantially weaker than on the shoreline. It is sufficient if the bird is within range of either a receiving base station or a telephone network on a regular basis for it to transmit the data. Telephone network transmission can use various standards: 2G (GSM), 3G, 4G or 5G. Some trackers are able to transmit on multiple signals. It is important to understand the coverage of the various standards in the study area or along the migration route. For example, 2G is being phased out in Europe and in several Asian countries (e.g. Japan, Korea, Taiwan) is no longer supported. A bird tagged in the Philippines can seemingly ‘disappear’ if it migrates into such countries. However, as long as it returns to an area with coverage on an appropriate network, data can be retrieved.

When a device is out of range of a compatible signal for a long time, a log of data is accumulated within the tag. When reaching a compatible signal this results in high transmission volumes, which may deplete the battery. Newer tags often have a protection programmed in, which prolongs the download time of data, but avoids deep depletion of the battery.

It is useful to consider the extent to which aspects such as fix-rate and transmission schedule can be programmed. For example, in the case of species spending the boreal winter in tropical areas, it may be desirable to maintain a high fix rate when the birds are on the sites over ‘winter.’ Fix rates during migration may be set depending on the research question and on anticipated charging conditions, in order to preserve battery life by switching to a lower fix rate.

4 Tag Types

The gathering of data and especially the transmitting of it, requires energy. Depending on how long the tag is expected to function, this energy can be generated from a fixed, static battery, or it can be generated by a battery that is recharged by energy from a solar panel incorporated in the tag. This way, the tag can (theoretically) continue functioning for the lifetime of the battery, although there are several other events that can lead to the end of data reception. Such events may include malfunctioning of the GPS antenna or the transmission antenna, malfunctioning of the solar panel, malfunctioning of the battery, coverage of the solar panel by feathers, lack of network to connect to, loss of the tag, and death of the bird.

4.1 Flag / Colour Bands

Colour-marking birds, whether through the use of leg flags or colour bands, provides a means to identify individual birds in the field. A relatively cheap approach, large numbers of birds can be marked in a short time period, potentially yielding large quantities of resighting data across the flyway where there is an established network of observers. Such data can reveal information about migratory routes, and hence highlight the potential for interactions with offshore wind farms in different regions (Green et al. 2019), and generate data that can be used to estimate apparent survival rates, providing insights into the demographic consequences of anthropogenic pressures (Piersma et al. 2016). Any tagged bird should be colour-marked as standard. However, it is also valuable to consider colour-marking other individuals (not fitted with a tracker) of the target

species, because re-sightings may provide information on the apparent survival rates of that group and allow comparison with the group of birds with trackers. Furthermore, there may be value in a wider, more co-ordinated colour-marking effort in the Philippines with a view to gaining a clearer understanding of the demography and movements of migratory shorebirds. Any such effort should follow the EAAF Shorebird Colour Marking Protocol, with flags applied using the code for the Philippines (Black over Blue).

4.2 Geolocator

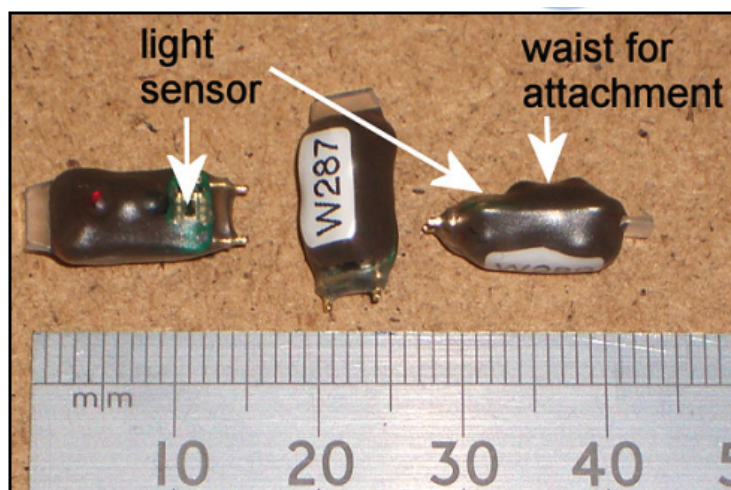


Figure 9. An example of a geolocator (Intigeo-W65A9-SEA from Migrate Technology) suitable for use on a shorebird leg ring.

Light level geolocators (Figure 9) offer several advantages in relation to tracking migratory shorebirds. They are relatively small, often weighing less than 1 gram, cheap, and can be mounted on leg bands (Porter & Smith 2013). They are relatively long-lasting, capable of collecting data over a period of up to two years in some cases. However, as archival devices, birds must be recaptured in order to recover data. Consequently, birds should be fitted with a leg flag or colour band in addition to a geolocator to enable researchers to identify and target individuals for recapture when they are present on a site.

Light level geolocators work by recording light levels in order to estimate day length, which can be used to infer latitude, and the timing of noon at the location of the bird, which is used to infer longitude (Porter & Smith 2013), though the reliance on light levels means that uncertainty is greatest closer to the equator and during the spring and autumn equinoxes. A key disadvantage of this approach is that the spatial resolution of the resulting data is limited, with the accuracy of positions varying from ± 50 km to ± 500 km, depending on the device used and approach taken to process the data (Rakhimberdiev et al. 2016). For this reason, geolocators are best used to investigate the migratory routes used by birds, rather than local movements. These data can be used to identify species whose migratory routes are likely to overlap with planned offshore wind farms (e.g. Burger et al. 2012). Recent developments have included the use of multisensor geolocators that measure movement (accelerometer), temperature and atmospheric pressure, in addition to light (Liechti et al., 2018, Rhyne et al. 2024), offering the potential to collect data on species flight heights, which is likely to be valuable in relation to assessing collision risk, alongside information on their migratory movements. Furthermore accelerometer and pressure

data help to improve the position estimate of the light-level geolocator (Nussbaumer et al. 2023),

4.3 Radio Telemetry

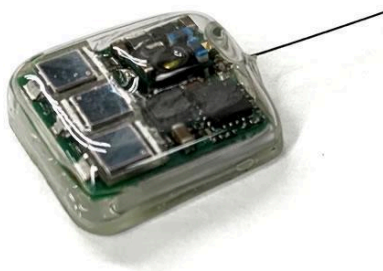


Figure 10. An example of a VHF radio tag (an NTS-1 Solar NanoTag from Lotek) suitable for use on a shorebird

Radio telemetry has been widely used to study the movements of many species, including shorebirds (Warnock & Takekawa 2003). Devices are typically very small (1-2 cm long, <4 g in weight) and transmit continuously at rates of 0.5 – 1.5 pulses per second (Figure 10). These signals are then detected by receivers, which can be used to triangulate the location of birds. Traditionally, collection of these data has been very labour-intensive, requiring researchers to spend long days in the field to collect information on species locations and movements. For this reason, radio telemetry has been increasingly replaced by alternative methods, such as GPS tracking. However, in recent years, the development of a network of remote receivers, in combination with the relatively low cost of the tags, has led to a resurgence in the use of this technology to investigate species movements (Taylor et al. 2017). Such a network may offer a means for collecting information on the local movements of birds, for example within Manila Bay.

4.4 Satellite Tags (PTT)



Figure 11. An example of a Satellite or Platform Terminal Transmitter tag (PinPoint GPS Argos Solar Tag from Lotek) suitable for use on a shorebird.

Satellite tags, or Platform Terminal Transmitters (PTT) (Figure 11), are tags that use satellites to transmit their information (where other tag types use for example telephone network or Bluetooth receivers). These devices estimate location via the Argos satellite system's Doppler shift and calculate a probability distribution within which the estimate lies. The standard deviation of this distribution gives an estimate of the location accuracy and assigns it to a 'location class' (LC) of 3 (≤ 150 m), 2 (150–350 m), 1 (350–1,000 m), 0 ($> 1,000$ m), A (location based on three messages; no accuracy estimate), B (location based on two messages; no accuracy estimate), or Z (location process failed; CLS 2011). Modern – and typically heavier – PTT units often integrate a GPS sensor for much higher accuracy (e.g., ± 18 meters). These GPS PTT tags then transmit the precise GPS location data via the Argos satellite network.

Argos was set up as a French-American initiative involving the Centre National d'Études Spatiales (CNES), the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) for the purposes of environmental monitoring. The signals from the tags are detected during 5–15-minute satellite overpasses that occur every 1-2 hours. Consequently, whilst tags may provide useful information on broadscale species movements, they are of limited value for assessing fine scale interactions with proposed offshore wind farm areas.

4.5 GPS

GPS tags are tags that contain a GPS sensor. In contrast to 'traditional' PTT tags (above), that use doppler shift position estimation, GPS tags estimate position by connecting to at least 4 satellites within the global navigation system network (Iverson et al. 2023). Consequently, the resulting fixes have a greater accuracy than can be obtained using doppler PTT tags. The GPS sensor causes these tags to start from some 3.5 grams (as per 2025, technology advances towards lighter models), while doppler PTT tags are available from 1.6-1.8gram. The temporal resolution of GPS tags varies and can often be set according to the aims of the study. Setting these fix rates can either be done before deployment, or reprogrammed through remote contact with the tag, or is managed by a programme in the tag itself, triggered by battery levels or e.g. activity of the bird. High fix rates (< 10 seconds) can be chosen when fine scale data are required, as might be the case if interactions with wind turbines are the focus of the study, or lower fix rate (> 30 minutes, up to 12 or 24 hours) if broader scale data will suffice, as might be the case if migratory routes are the primary focus of the study (Bouten et al. 2013). Generally, higher fix rates will result in higher energy use, resulting in a more rapid depletion of battery life. Many tags for longer term use have solar panels to recharge batteries.

There are four primary means through which data may be retrieved from GPS tags: recovery of archival tags, transmission over the cellular telephone network, remote download to a base station, or transmission via satellite (see 4.3). These are briefly described below.

4.5.1 Archival

The use of archival tags means that individuals must be recaptured in order to recover the data collected or that the tag should be dropped from the bird and subsequently retrieved. As a consequence, the use of these devices is restricted to situations where either birds can be reliably recaptured, often on the same site, for example breeding grounds (Eberhart-Hertel et al. 2025). In

some situations, for example in the case of colonial breeding seabirds, this may mean deployments are restricted to only a few days (Wakefield et al. 2017). However, where devices are lightweight and can be deployed using harnesses, or other long-term attachment methods, longer deployments are possible as long as birds can feasibly be recaptured at the end of the deployment (Eberhart-Hertel et al. 2025). The other application is through a deployment method that causes the tag to fall off from the bird after a limited amount of time – often glueing to the back or tail – after which the tag switches on a beacon which allows it to be traced and found. Despite the use of a beacon function, tracing and finding such tags can be difficult and usually only works when the tag is dropped in a predictable range (e.g. breeding grounds).

4.5.2 Cellular Phone Network GSM(2G)/3G/4G/5G

To avoid the difficult step of recapturing a bird to retrieve a tag, or having to find a dropped tag, many tags can transmit data to the cellular phone network (Figure 12). The need to transmit data increases battery consumption of the tag, meaning that transmitting tags are typically heavier than archival tags. Whilst less restrictive in terms of data retrieval than is the case for archival tags, it is important to note that it is dependent on a strong enough network connection. There are several websites that can be used to investigate likely network coverage in the Philippines (e.g. <https://www.nperf.com/en/map/PH/-/1999180.SmartSunTNT-Mobile/signal?ll=20&lg=0&zoom=3>). When using these resources, consideration should be given as to whether tags transmit over the 2G (GSM), 3G, 4G or 5G networks, and coverage of these networks should be checked. However, in all circumstances, the projected network should be confirmed in the field noting the potential for local landscape features to negatively influence it.

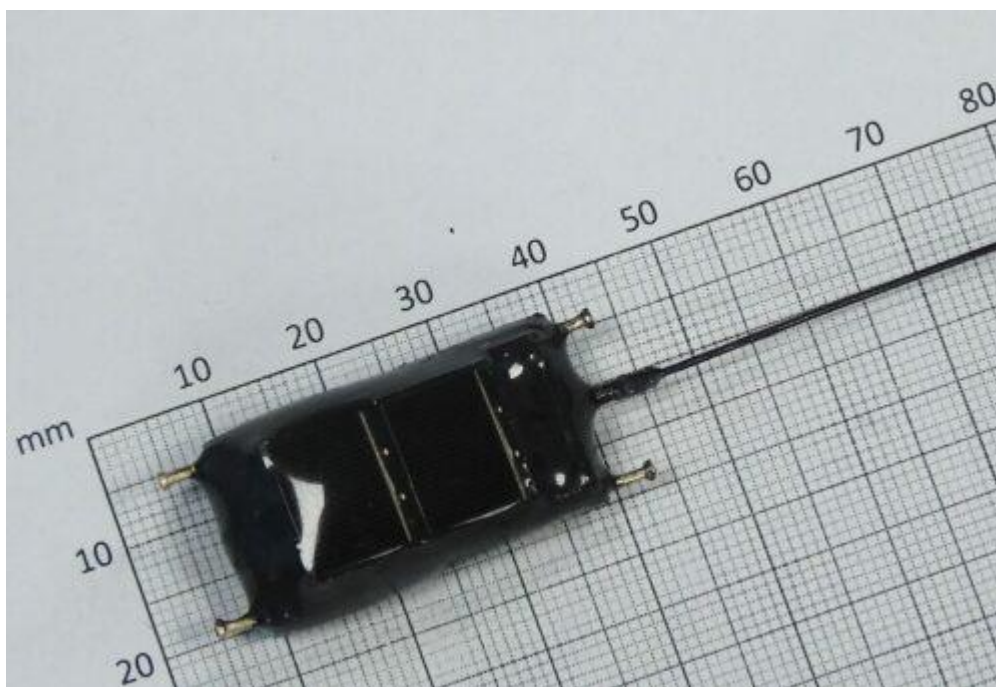


Figure 12. An example of a GPS tag (a NanoFix GPS tag from Pathtrack) with capability to download over the cellular phone network suitable for use on a shorebird.

4.5.3 Remote Download

Remote download of data means that the tag (Figure 13) transmits the data to a dedicated receiver station (Figure 14), which in turn sends the data to the cellular phone network. This means the tag itself does not need cellular phone connectivity technology and can therefore be lighter. The dedicated Bluetooth or VHF technology for the remote download requires much less weight, meaning these remote download tags to be amongst the lightest on the market. Transmission to base stations can typically happen within a range of 1.5 km. Transmission often also works when birds fly over the station, although connection time may not be long enough to share all data stored in the tag, and repeated connection is needed. This can be especially true after longer periods with contact. Ensuring that base stations are in an elevated position relative to the birds can aid with this. This may be achieved by deploying base stations on nearby buildings, identifying elevated positions in the landscape (e.g., nearby hilltops), or using fence posts or scaffolding. In positioning base stations, careful consideration must be given to the potential for loss or damage due to theft, vandalism, or environmental conditions (e.g., rising tides or flooding). Typically base stations contain whitelists of tags they can receive data from (part of the same project). However, base stations can also be programmed (in 'Super Mode') to receive data from all tags that come into their range, even if these tags do not belong to the same project, or even the same researcher. The base station will transmit the data to the cellular network and to the database that can be accessed by the researcher the tag belongs to. The base station owner does not get to see those data. If many users put their base stations in Super Mode, that creates a network of receiving base stations, with opportunities to transmit data sometimes far away from the deployment site. For example, tags deployed in Manila Bay have been transmitting data to base stations in Bohai Bay in China. Remote base stations can also send information to tags, e.g. to enforce new settings for data fix frequency. This only works for tags in the whitelist of the station.

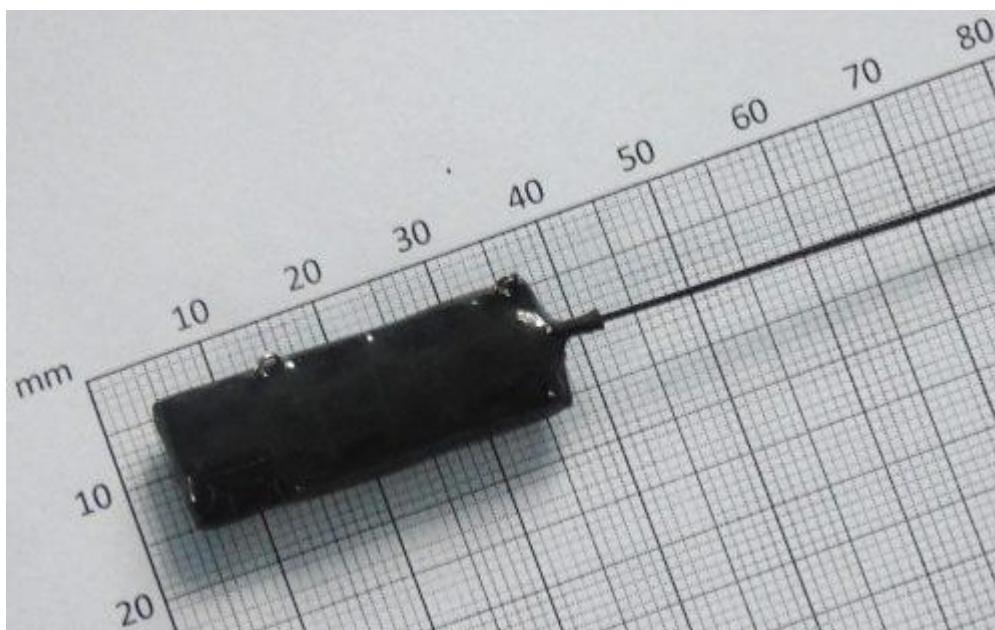


Figure 13. An example of a remote download GPS tag (a Mini GPS tag from Pathtrack) suitable for use on a shorebird.



Figure 14, A base station for collecting data from a remote download GPS tag

5 Capture Methodologies

A wide range of methods have been developed and used over time to catch birds, often in the context of hunting. Many of these have been modified and adapted to suit the requirements of trapping birds for research, banding and tagging and of those several can be applied to catch shorebirds as well (Davis 1981; McClure 1984). A good overview can be found in Howes & Bakewell 1989. Experimenting with these techniques to find the most suitable one for a specific situation and to gain experience can be useful but must be approached with caution to avoid harm to birds and people, and always done in possession of permits for catching birds – including for the use of specific methods - and permission for access to sites. It is recommended to seek advice from experienced bird banders or, if these are unavailable in the country or internationally, trappers. However, it is recommended to thoroughly assess whether engaging with trappers is a suitable option given the local context as this may create additional risks, and in general, trappers do not have the health of the birds in mind when developing and applying a trapping method. A non-inclusive list of shorebird trapping methods includes:

- Mist Nets
- Cannon Nets/ Phut Nets
- Whoosh Nets
- Clap Nets
- Pull Traps
- Drop Traps
- Walk-in Traps
- Dazzling
- Leg nooses
- Other methods used by local bird trappers.

Here we concentrate on a selection of those, which are conventionally used in the EAAF.

Besides obviously being species-dependent, trapping methods are also highly site dependent, meaning that not every method is equally suitable for any site, and vice versa. Species dependent means that in general, smaller species can be caught with mist nets and larger species with other nets, like whoosh– or cannon nets. This is just a general indication however, and other factors coming into play include, for example, flocking behaviour and option to attract by feeding. Before any trapping is attempted, the site and wider area should be evaluated, from maps and on the ground. Often a reconnaissance is necessary to assess the site and decide on the approach to take and preparations necessary. The monitoring team must allow sufficient time between reconnaissance and planned trapping to facilitate possible preparatory work, ranging from obtaining permits to obtaining materials and fine-tuning to local conditions and ensuring safety requirements are met. The monitoring team must also remember that trapping often happens at night, which comes with additional safety considerations.

The use of mist nets is generally the most applied method for catching shorebirds in the Philippines. In the mist net section below the process of catching is described in detail. This contains details that are also relevant to other catching techniques and are not all repeated there. So, it is recommended to at least read the mist net section, even if another catching method is

envisaged.

5.1 Mist Nets

Mist nets can be used in intertidal zones to capture shorebirds (Spencer 1984). Nets are positioned across areas where birds may commute and consist of fine mesh, erected vertically between poles. The nets create a barrier with a series of longitudinal, loose pockets that catch and entangle birds without harm. It is beyond the scope of this protocol to provide a full description of how to run a mist-netting session (setting up of nets, opening nets, furling nets, maintaining nets) successfully and responsibly, and a range of literature is available on this (e.g. Redfern & Clark 2001; Busse & Meissner 2015). However, some key points and considerations are set out below.

Mist-netting targets flying birds and the positioning and timing of operation of mist nets needs to take that into account. In the case of catching shorebirds in intertidal areas, predictable movements of birds triggered by the tidal cycle – birds flying between feeding and roosting areas – or by sleep-migration are events to target. Birds have great eyesight and generally mist-netting needs to therefore be done at night, to avoid birds seeing the net and evading it. Even moonlight can negatively influence the effectiveness of mist-netting, so periods with dark nights – around New Moon – are advised. Thick cloud cover can facilitate mist-netting during other parts of the lunar cycle.

This method is non-selective and likely to catch anything that passes the trajectory of the nets, including non-target bird species, bats, and even large insects. Nets should be checked regularly at intervals of not more than 1 hour, to ensure trapped birds are not left in circumstances that are harmful or influence their survival. During periods of cold and wet conditions, or high temperatures, careful consideration needs to be given to such risks, and if necessary, the frequency of checking nets needs to be increased, or nets closed all together.

Whilst non-selective, different sizes of mist nets are available, suitable for catching different types of shorebirds. This relates to mesh size, length of the net, height of the net, and number of shelves. The material from which the mesh is produced varies, which results in differences in visibility, strength, durability and, importantly, also in risk of injury to birds. Strong mesh (72 denier, 3 ply) is recommended in most cases. Mono-filament mesh is generally less suitable and more prone to ‘cutting’ the birds, causing injuries, especially during periods of strong wind.

Selection of correct mesh size is important. Small birds in large mesh size can cause problematic entanglement of wings and head, which takes time to undo and may result in higher chance of injury, especially in combination with wind-pull. Just always going for small mesh size is also not the solution, as it reduces the chances of catching bigger birds, which more easily escape from small mesh size nets. In general 30mm mesh size nets (often called ‘wader nets’) are suitable for mid-size shorebirds. It requires assessment of the specific situation at the potential catching sites by experienced field people, to decide what mesh size and dimensions of net to use, and this is part of what the reconnaissance visit should look into. Risk of bycatch of small species, for example, may lead to choosing smaller mesh size (e.g. 20mm), to avoid harming these small birds (even though that may be at the expense of effectiveness for the bigger birds).

Long nets are generally preferred for shorebird catching (12-18m), and often these are used in long lines of linked nets. The tension needed to properly set such long lines of nets requires the use of very strong poles, especially the outer ones, and mostly three tension lines anchored with long pegs, to account for soft sediments, at both ends. Each 'linking pole' in the line in general requires two tension lines perpendicular to the net direction, to prevent the net from falling over under the load of many birds coming in or strong winds (even when furled).

The selected netting area should experience shorebirds flying low over the catching area (the area should be selected for that). In open areas and when catching at night, four shelf nets, erected in long lines, are often used. Smaller, two or even single shelf nets can be used for easier handling and reduced visibility when operating at night with back-lit environments (cities or harbours in the background) or even for catching at daylight where they can be set against a background that hides them or across depressions in the landscape (gulleys). In the latter case, make sure that the gully is not so deep that birds caught over the deep part cannot be extracted.

Operating mist nets in open coastal areas means there is often full exposure to wind. Strong winds should be avoided for catching because it pulls on the nets, creating dangerous conditions for birds entangled in the net.

Working in intertidal areas brings the specific risk of rising tides reaching the nets and wetting or even drowning birds in nets. Special attention needs to be given to the tension of the net-lines and the required minimum level of the lower shelves, to avoid that the nets sag into the water when large numbers of birds are caught. Although both rising as well as falling tides bring about movements of birds and are therefore in principle useful times to target for catching, mist-netting is preferably done at falling tides to reduce above mentioned wetting risks. When operating with rising tides, operators should reduce the checking interval, to minimise drowning risks to the minimum. Operators must be aware that water levels do not always rise linearly with time and sometimes seem to 'jump up'.

The successful positioning of the nets requires experience. Some essential considerations include:

- Assessing risks to the fieldworkers and take necessary safety measures;
- Securing good access for setting up and extracting birds in changing water conditions (tide);
- Avoiding placing nets over deep water (gulleys, creeks, channels) because extraction will be problematic;
- Considering the effect of repeated visits to the nets on the sediment/substrate the nets are placed on, as it. It may become inaccessible. Mud is hard to walk on/in and may present the risk of sinking away;
- Always avoid going alone when checking nets, especially in the dark;
- Avoiding light backgrounds as the birds will see the nets.
- Being aware (and avoiding as much as possible) the risk of catching bats. These animals

are vulnerable, will most likely damage the nets, and represent a significant risk of being bitten, presenting a risk of transmission of zoonotic diseases such as rabies. Given this risk, fieldworkers should be encouraged to get vaccinated against rabies, and a protocol should be put in place in case of bites.

In general, be aware there may be a ‘surprise effect’ in the catching, in the sense that the first catch, if positioned well, can yield relatively more than follow-up catches at the same position, due to the fact that birds have become aware of the risk. Consider changing net positioning if feasible, to create multiple surprise effects and minimise net avoidance.

5.2 “Whoosh” Nets / Cannon Nets

Both whoosh and cannon nets are widely used to capture birds on the ground, and both operate by launching a net over a target area either using bungees or projectiles fired from cannons with explosive black powder, respectively. These methods are effective for shorebirds as they can be placed along the shore and remotely triggered at the optimal moment as the rising tide pushes foraging shorebirds towards the nets. The catch can be somewhat selective as deployment can be timed as groups of shorebirds enter the target zone allowing the bander to select their species of choice. Whilst groups of birds can be targeted to some extent, the size of the catch varies, and a large team is necessary to process all birds swiftly. The use of these methods and any additional permissions (e.g., use of black powder) should be investigated well in advance of any project in the Philippines. Additional training will be required for the lead bander in the safe and proper use of black powder and projectiles. Cannon netting should only be done by banders with the necessary licenses and training.

5.3 Walk-In Traps

Walk-in traps are typically cages, placed on the ground, that birds cannot escape once they have entered. They are commonly used for shorebirds. The catch is selective and works best for small tactile feeders. Long-legged species and shorebirds with visual foraging techniques are less easily caught this way. Walk-in traps are safer for shorebirds than mist-nets. Birds inside the trap are often unaware of being caught until people approach, and the use of the traps is almost independent of weather conditions. However, great care needs to be taken to changing water levels as birds may drown in the cages if the water gets too high. Walk-in traps can be placed in a range of habitats e.g. on sandy seashore, but also at small, shallow muddy habitats, salt pans, sewage farms, and wet saltmarshes or meadows. They can be convenient in areas with regular tides, where birds can be driven into the direction of, and into, the traps, though it is important to be aware of drowning risks in these situations. Walk-in traps can be made in a range of designs, with different shapes, dimensions, localisation of capture chamber, types of entrance and material used for their construction (wire netting, thick fish netting or metal mesh), sometimes with a closing door, and with mesh fences to guide birds towards the traps. Operators must be aware that the closing door is a secure way of preventing escape but also limits further entrance of birds. Furthermore, some species may be more cautious around novel structures on the shore and wary of entering walk-in traps. More details on the design of walk-in traps is available in Howes & Bakewell (1989) and Busse & Meissner (2015).

5.4 Dazzling / Lamping

Dazzling, in the context of catching birds at night, involves using a bright light to momentarily disorient or "dazzle" birds, making them freeze and easier to catch with a handheld net at close proximity. Dazzling can be an effective method of capture for shorebirds, mostly for single individuals or very small groups, in open habitats, such as mudflats, beaches, or wetlands. This method is highly selective, cheap (not requiring additional kit beyond a spotlight and a long-handle hand-held net) and, if done carefully, causes minimal disturbance. Only a very small team is required as birds will be captured and processed one by one. There are limitations to the method as well: although the birds 'freeze,' they still react to sounds, so the approach needs to be done in silence, which can be very difficult in some habitats. Also, if the birds occur in groups, only birds that stay in the light beam remain dazzled. If others that are outside of the beam fly off, they often cause the dazzled bird to flush as well. In summary the method works best for single birds in habitat that allow a silent approach. Beware of flashing around with the spotlight beam as this may cause disturbance if hitting a roost or other group of birds.

6 Tag Attachment Methodologies

Tag attachment methods aim at fixing a localisation device to a bird in a way that it functions properly and does not impact behaviour or survival and well-being of the bird or does so in a minimal way. The choice of attachment method depends on a range of factors, which are partly determined by the research questions, and also by the species and its ecology, the environment it lives in, and energy considerations. Infrastructure technology, permitting and regulatory issues can also play a role.

In general, deploying tags is to be considered a relatively ‘invasive’ intervention. The welfare of the birds is of paramount importance here, both to avoid unnecessary or unacceptable stress or even harm to the bird, and to avoid that the method influences the study results. Generally, deploying a tag on a bird should be done by a team of at least two people, one person holding the bird, the other deploying the tag. Both the holding of the bird, fixing it for easy deployment, and the actual handling of the bird for deployment, making it go through involuntarily and ‘counter-natural’ movements, should be considered stressful. It is therefore important that this is only done by very experienced people, with the right skillset, materials, and tools, reducing the handling time to the minimum. Holding the bird in the right position is very important and makes a lot of difference for how well the deployment can be delivered. In several countries special permits are required for practitioners of these techniques, only to be obtained after dedicated training and examination and repeated certification.

A number of attachment techniques are discussed below.

6.1 Harnesses

Harness is a term used for various arrangements of strings of a range of materials around parts of the body of a bird. A body harness, also called full body harness, goes around the head and wings. A leg-loop harness goes around the legs of the birds. In both cases the tag sits on the back of the bird.

6.1.1 Body Harness

Body harnesses are regularly used for terrestrial species including raptors and gulls, as well as shorebirds (Chan *et al.* 2016; Figure 15; Scarpignato *et al.* 2016). They have the advantage that they allow year-round or multiple year tracking from the same individual. Harnesses have traditionally mostly been constructed from a low abrasion Teflon ribbon material. In recent years, the use of silicon tubing (silastic), which is flexible (as opposed to non-flexible Teflon ribbon) has become more popular.

Such harnesses, made entirely of Teflon or silicone tubing, are in principle designed to stay on the bird for the rest of its life. The transmitters often do not last that long, due to a range of possible technical issues, including battery failure, antenna failure etc. Depending on the research question, in cases where the data need is limited in time, the current recommendation in the UK is therefore to use a ‘weak-link design’ where the harness is held together by a single component designed to break over time, allowing the harness to detach from the bird without the need for recapture. The duration of deployment will depend on the weak-link material used and can vary

from months to four years or more. Once the link breaks, the harness is not closed anymore and will come off. As this happens in an un-controlled way, there is some risk for entanglement, but this seems to be minimal (especially when using leg-loop harness designs, see next paragraph). Very few literature references or experience could be found at this stage to assess such risks.

A disadvantage of this method is in the increased handling time required to ensure a safe fit (as compared with leg-loop harnessing). Typical attachment times for experienced fieldworkers are 10-15 minutes for Teflon harnesses. With silicone tubing this can be reduced to a few minutes. With the use of weak-link designs this will be longer, possibly 15-20 minutes. There are options to reduce fitting time, for example using a 4-point device housing designed to accommodate the weak-link harness design specifically, but it is considered that c.10 minutes will be the minimum for this method.

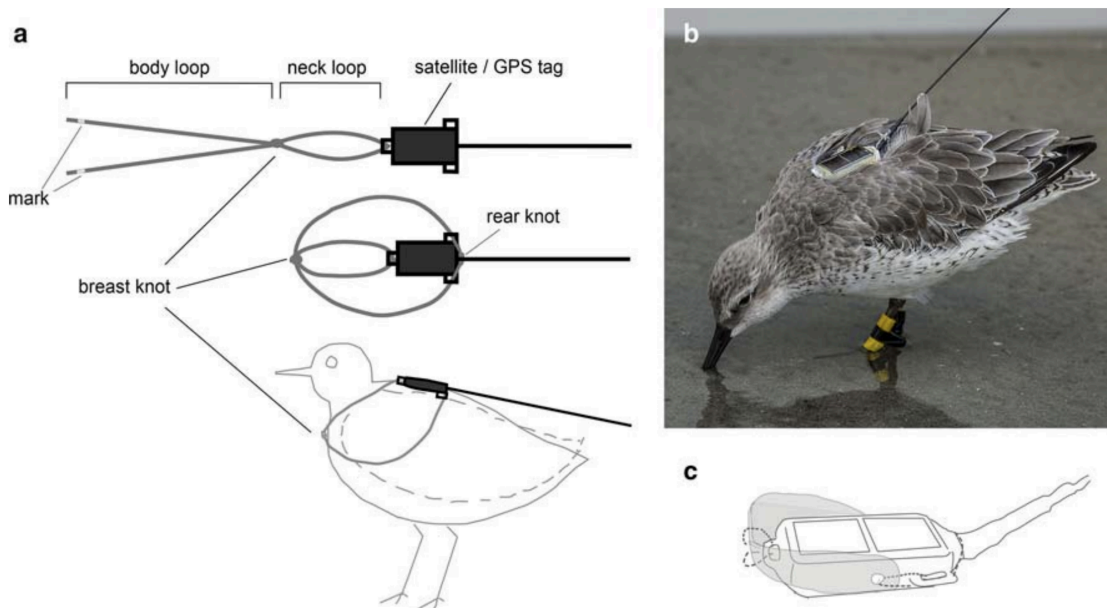


Figure 15. A loose neck-body loop harness (also called full-body harness) attached to a Red Knot (*Calidris canutus*) (Chan et al. 2016).

6.1.2 Leg Loop Harness

Leg-loop harnesses are an alternative design of harness that is positioned around the knee-joint⁶ and the thigh in the inguinal region⁷ at the top of each leg, often hidden in the feathers. This places the device in the centre of the lower back of the bird with optimal exposure to sunlight for charging (Figure 16 & Figure 17). This position avoids feather abrasion at the base of the wings for rapid flying species and has lower risk of impacts such as entanglement than the full body harness, also when a weak-link design is used. There are an increasing number of waterbird species being successfully tracked using leg-loop harnesses, which are constructed from different materials including silastic, a mix of silicon and plastic. This method works best for species where the knee joint protrudes more prominently from the body.

⁶ It is important not to confuse the knee joint – which is located much higher up the leg, close to the body and usually hidden by feathers. – with the joint that is prominently visible and bends backward (which most people commonly mistake for the knee), which is actually the bird's ankle or heel joint. Birds effectively walk on their toes. The knee joint is the articulation between the femur and the tibiotarsus, which bends in the same forward direction as a human knee.

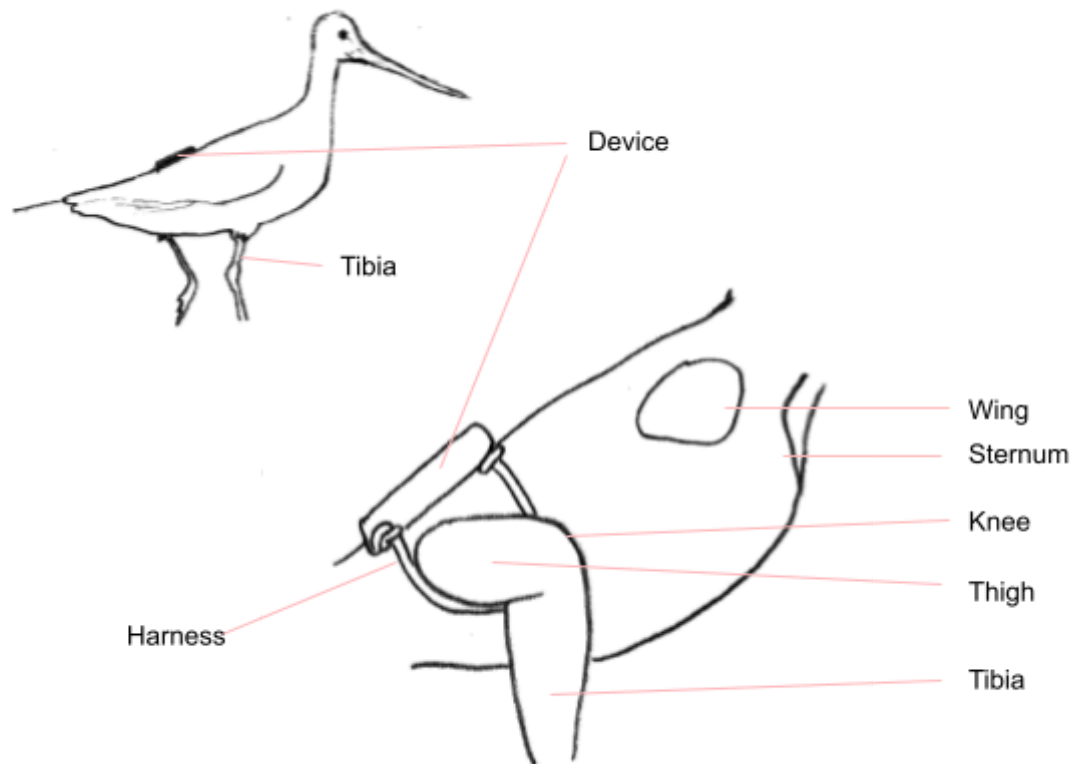


Figure 16. A leg-loop harness attached to a shorebird, drawing by Ward Hagemeijer

It takes experience to carefully deploy the leg-loops, to ensure that the tension and fit of the harness is correct, minimising the likelihood of impacts directly from the harness itself. The deployment of leg-loop harnesses typically takes less time than is the case for full-body harnesses. Typical fitting times for experienced fieldworkers may be c. 10 minutes, though this may be reduced towards a few minutes only if using 'pre-sized' silastic harnesses, meaning that different sizes of harnesses have been prepared from which the best fit can be chosen and little to no size adjustment is required. However, the pre-sizing and choice of the best fit also require experience.

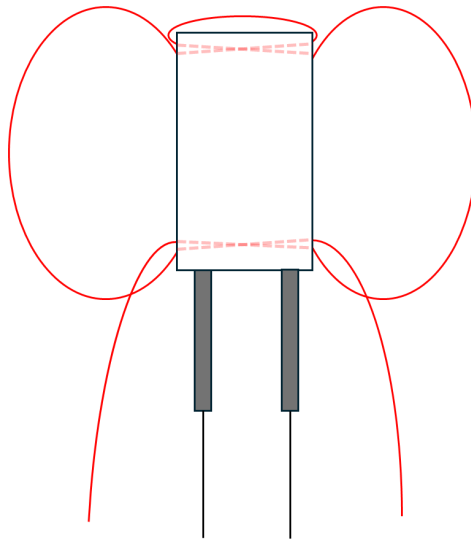


Figure 17. Schematic representation of a leg-loop harness construction on a small tag with tubular connection system, like a 2024 generation Druid Ultra P1 tag. Harness material shown in red.

Different types of knots are being used by different experts, depending on the material used for the harness and personal preference. It is important to make a non-sliding knot that holds well and does not negatively affect the strength of the material. When using Teflon, glue can be used to fix the knot. When using silicone tubing, no glue should be used, as it damages the material. Either a Types of knot used are the square knot (Figure 18) or a single knot of both ends together may be used. As these knots are supposed to be permanent, they should be closed very tightly, ensuring they do not come loose. If a harness is to be taken off a bird, the harness should be cut.

Figure 18. Example of a square knot, a non-sliding knot which can be used when fitting a harness see



<https://www.animatedknots.com/square-knot> for example



Figure 19. Upland Sandpipers (*Bartramia longicauda*) with tracking tags attached with an elastic leg-loop harness; solar-powered Argos Platform Transmitter Terminals (5 g PTT, Microwave Telemetry, USA, Top) and battery-powered PinPoint Argos-GPS tags (4 g, Lotek Wireless, Canada, Bottom) (Hill *et al.* 2019).

6.2 Glue Mounting

Devices may be attached to the back of a bird using glue, most commonly superglue (cyanoacrylate). This method has been used for manual radio-tracking studies, and more recently for attaching GPS devices as part of studies on a variety of shorebirds in the Wadden Sea (Bijleveld *et al.* 2022) with typical deployment durations from 2-3 weeks up to several months depending on the specific attachment protocol and stage of moult of the bird. Attachment time for this method takes c. 10 minutes to ensure the device is fitted correctly, which will help maximise attachment duration as poorly fitted devices are likely to induce extra preening and removal of the device by the bird.

An area of feathers is trimmed on the back as a basis for attachment by glueing, which may interrupt waterproofing if not covered adequately by the device and/or a section of fabric on the device base used to form the attachment surface. The growth of feathers as part of moult will cause the tag to fall off.

Tags used for glueing are sometimes not fitted with a solar panel because a fixed battery may last for the planned duration of deployment, if the fixed frequency is accordingly programmed. This saves weight. Also, in some cases no transmission technique is used during the operation of the tag on the bird. When the tag falls off, a beacon signal can be activated which may facilitate retrieval of the tag, after which the data can be downloaded (see also section 4.5.1).

6.3 Tape Mounting

The most suitable and commonly used method to attach devices to species such as auks and Gannet is to tape-mount. Strong adhesive tape, often produced by Tesa (Hamburg, Germany), is used to secure the device to several feathers either on the back or central tail. This may be further reinforced with super glue or cable or similar ties to help increase deployment duration. Tape-mounting is a short-term method with devices attached typically for several days up to a week before being shed. It has the advantage of fitting times being typically c. 5 minutes or less. Similar to glue mounting, transmission of data can be in various ways (see above).

6.4 Leg Band / Flag Mounting

Long-term deployment of devices is also possible by fitting to plastic leg bands or flags (Figure 20). These may be secured to the band with small cable ties and remain attached for several years or more. However, this is currently most suitable for very light devices, such as geolocators, or those which don't require a good solar recharging position. The 'tag-band' can be prefabricated, reducing deployment time in the field to just fitting that additional leg band, making this method very quick to use (~ 1 minute or less). However, due to the limitations of suitable devices this method has mostly been restricted to collecting data with a low spatial and temporal resolution. Additionally, devices fitted to leg bands are not typically capable of transmitting data and require that the individual is recaptured again to retrieve data. Hence, there is an increased amount of fieldwork needed and some attrition of loggers as not all birds return or can be recaptured. A pilot study on Norwegian Greater Black-backed Gulls in the framework of windfarm studies, generated useful information but resulted in the conclusion that leg-loop mounting of the GPS device would not be used for further work, mainly due to battery recharging issue (Madden et al. 2024).



Figure 20. Geolocator mounted on leg band or closely trimmed leg flag, parallel to leg on a Semipalmated Sandpiper (*Calidris pusilla*, left) and Red Knot (*Calidris canutus*, right) (Weiser et al. 2016)

7 Tagging Study Timelines and Planning

7.1 Identification of a Suitable Field Site

One of the first steps in planning a tagging study is to identify a suitable field site. There are several steps to this, first and foremost of which is identifying sites at which the species of interest is present. Survey data may exist in the framework of national or international programs like the International Waterbird Census (Wetlands International, <https://iwc.wetlands.org/>) or tools like the Critical Site Network tool (<https://criticalsites.wetlands.org/en>). Furthermore, there are significant amounts of information of bird distribution available through citizen science initiatives and tools like eBird⁷ or Observation.org (<https://observation.org/>). If local bird groups are active, they are almost certainly a very good source of information. Having identified sites where the species is present, it is then necessary to assess how feasible it may be to capture sufficient numbers of birds to meet the needs of the study, noting any requirements in relation to a sample of control birds to assess tag effects, e.g. through colour-banding (see Section 1.4.1). All of this scoping should be done with consideration of the methodologies set out in Section 4. Finally, consideration should be given as to how any data will be retrieved (see Section 3):

- If archival tags (e.g. Geolocators) are used, will it be feasible to recapture birds?
- If remote download tags are used, are there locations where a base station, or base stations, can be positioned as described in section 4.5.3, that are safe and secure from theft and damage whether accidental, deliberate or due to adverse weather conditions and tides?
- If cellular network GPS tags are used, is there adequate cellphone coverage to transmit data?

7.2 Planning

Carrying out an effective tagging study can be logistically challenging. Consequently, careful planning is required to ensure that all tasks are carried out in a timely manner. Sufficient time needs to be allowed for ordering tags, obtaining all necessary licences and permissions, and to safely deploy tags and monitor any potential tag effects. The exact timing of any tag deployment will depend on the species concerned and the attachment method used. It is impractical to give an indication of time it takes to start a tagging study. This will differ a lot between countries, with permitting being one of the longest-lasting steps (e.g. see suggested lead-in times for permitting in the Philippines in section 7.2.2). Outside of permitting, and if no preparatory steps have already been taken, it is realistic to assume that deployment fieldwork can start not earlier than 3 (very fast processes) to 6 months or even a year after defining the research question.

7.2.1 Tag Orders

A variety of tag types are available (see section 4 for descriptions of these), with different capabilities in relation to the types of data that can be collected, battery life, deployment duration,

⁷ <https://ebird.org/>

and data recovery. These tags are generally manufactured to order, with peaks in demand occurring during the northern hemisphere summer, coinciding with the breeding season, when it is most straightforward to catch many species. As a consequence, a lead time of two months and sometimes in excess of six months is required in order to secure tags and longer may be required for larger orders. Sorting out tags and procurement options is one of the first steps to take after defining the research question.

In addition to the standard delivery times, it is important to be aware of any customs restrictions, and budget for the customs duties associated with the import of any devices. Any tax waivers should be applied for well in advance in order to allow time for these to be processed. A failure to take customs procedures into account may lead to a delay in the release of the devices, with potential consequences for project timelines. It may also result in increased costs if expedited services are needed or if tax-exemptions are missed because of shortage of time.

It is important to consider the storage and maintenance of tags. In some instances, for example with geolocators, battery life is limited. Consequently, to prolong the life of these tags, and maximise the value of any data collected, these should be kept cool if not being deployed. In other circumstances, for example with solar powered tags, it is important to ensure that tags are sufficiently charged prior to deployment. In general this means that, even though the tags are delivered charged from the seller, it is necessary to check and charge the tags before deployment. If tags are not used immediately after this check, regular re-charging is recommended. When storing tags for a longer time period, recharging is recommended at monthly intervals. This can be a cumbersome task. Deep depletion of batteries needs to be avoided as it reduces the life of the battery and may result in batteries not waking up again. In addition to pre-deployment storage, these factors need to be considered in relation to the customs procedures highlighted above.

7.2.2 Philippines Permitting System

At present, the marking of birds in the Philippines is covered under DENR Administrative Order 54 of 1989⁸, which sets out to establish a national bird banding scheme. This policy is currently being updated and revised in order to better reflect current approaches and technologies. The status of this updated document should be confirmed, and engagement with DENR should be required prior to planning any tagging study.

In addition to following national policies directly relevant to bird banding, wildlife research studies should be designed to adhere to wildlife protection, prevent overcollection and unnecessary harm to wildlife, safeguard local knowledge and resources against biopiracy, and protect the rights of local communities. To ensure adherence to research standards and ethics, wildlife studies are governed by national laws such as the Wildlife Act (Republic Act 9147), Enhanced National Integrated Protected Areas System or E-NIPAS Act (Republic Act 7586), the Indigenous Peoples Rights Act or IPRA Law (Republic Act 8371), Strategic Environmental Plan (SEP) for Palawan Act (Republic Act 7611), and the Animal Welfare Act (Republic Act 8485 as amended Republic Act RA 10631). Studies involving ethnography, wildlife diseases, and domesticated animals will have different guidelines.

⁸ <https://elibrary.bmb.gov.ph/elibrary/wp-content/uploads/2023/05/DAO1989-54.pdf>

As bird tagging requires handling of wildlife, researchers must first secure a Gratuitous Permit (GP) from the DENR. A GP is a permit issued to any individual or organisation that is engaged in a non-commercial scientific or educational undertaking to collect wildlife. The process for securing a GP varies depending on the location, scale of the research work, and methodologies involved. Depending on the complexity of the project, up to a year may be required to obtain a GP (e.g., for a large, multi-site study).

7.2.2.1 General Requirements for Gratuitous Permit

In general, all researchers, regardless of whether they plan to collect or handle wildlife, should first coordinate with the local municipal or city government and the nearest DENR office before starting fieldwork. This step is essential to ensure the safety of all personnel and field staff. In certain regions of the Philippines, it may also be necessary to liaise with the local Philippine National Police (PNP), Armed Forces of the Philippines (AFP), or Coast Guard detachment. Conducting local coordination and reconnaissance surveys can further help identify any additional coordination and document requirements.

In cases where a GP needs to be secured, the following documents must be prepared:

- Letter of intent and the research proposal detailing the project description, methodology, project site, species to be collected or handled, number of specimens to be collected (if any), and repository of collection (if collecting specimens). The research proposal should also include a list of researchers involved in the project. Foreign students and institutions, as well as Filipino researchers affiliated with a foreign institution, are required to have a local institutional collaborator.
- Endorsement letter from adviser and dean if the lead researcher is a student. In the case of an individual researcher, an endorsement letter may come from an expert in the field, or the head of a research institution, or a conservation organisation.
- Prior Clearances or Prior Informed Consent (PIC)
- Prior Clearance issued by Municipal Mayor (for study areas within public lands outside Protected areas), secured through the Municipal Office.
- Prior Clearance issued by the Protected Area Superintendent for sites within Protected Areas, issued by the Protected Area Management Office. Securing the Prior Clearance or endorsement would require the research proponents to present the research during a scheduled Protected Area Management Board (PAMB) meeting. Prior coordination with the Protected Area Management Office is necessary.
- Certificate of Precondition (CP) upon securing the Free and Prior Informed Consent (FPIC) from Indigenous communities for sites within ancestral lands, issued by the National Commission on Indigenous Peoples (NCIP). The FPIC is given by the concerned Indigenous Peoples following the customary laws of the community, obtained upon the signing of a MOA containing the benefits, conditions, requirements, and penalties as basis for the consent. NCIP Administrative Order No. 1 and 3 series of 2012 and AO No. 1 series of 2006 provides the steps and provisions for securing certification from NCIP. Coordinate with the regional NCIP office for specific requirements. A research proposal

presentation may be required.

- Clearance from private landowner/s, for sites within privately owned lands.
- Foreign institutions must first have an approved Memorandum of Agreement (MOA) with the DENR or the Palawan Council for Sustainable Development (PCSD). Foreign institutions must also provide a letter of acceptance from their local collaborators. Filipino collaborators may be academic institutions, conservation organisations, or researchers in the Philippines. A MOA may also be required for local institutions with project sites that cover several regions.
- Additional requirements for studies conducted in Palawan:
 - Application of Authorization for the Conduct of Scientific Procedures Using Animals, issued by the Department of Agriculture – Bureau of Animal Industry (BAI) upon the issuance of an Institutional Animal Care and Use Committee (IACUC) permit, for studies focusing on vertebrate taxa by an academic or research institution.
 - Barangay resolution/endorsement
 - City Environment and Natural Resources (City ENRO) clearance, if study site is within Puerto Princesa
 - For large-scale studies: Prior Informed Consent (PIC) from municipal or provincial local government unit
 - Strategic Environmental Plan (SEP) project endorsement or Gratuitous Permit (if with specimen collection) from Palawan Council for Sustainable Development (PCSD)
 - Presentation to and endorsement from Protected Area Management Board (PAMB) if study site is within a Protected Area.
 - For sites within an ancestral domain, a Certification Precondition (CP) from the National Commission on Indigenous Peoples (NCIP) upon securing the Free Prior Informed Consent (FPIC) of the Indigenous community and signing of Memorandum of Agreement (MOA) between parties.

7.2.2.2 Where to Apply for a Gratuitous Permit

Complete documents should be submitted to the DENR Regional Office in the region where your project site is located. For projects involving multiple regions, the document must be submitted to the DENR-Biodiversity Management Bureau.

For a more technical description of obtaining a Gratuitous Permit in the Philippines, refer to the Department Administrative Order 2004-55 (Streamlining/ Procedural Guidelines Pursuant to the Joint DA-DENR-PCSD Administrative Order. DENR A.O. 2016-07 (Manual of Authorities on Technical Matters). The Citizen's Charter No. BMB-WRD-03 entitled Processing, Approval of Request and Issuance of Wildlife Gratuitous Permit (GP) to collect Wildlife for Scientific Research, provides streamlined guidelines, accessible through:

https://bmb.gov.ph/downloads/BPKMD/citizenscharter/2019/3wrd-application_for_gp.pdf

7.2.3 Site Reconnaissance

At least one and, ideally more, reconnaissance visits should be undertaken to understand practicalities of working at the site. The first visit would be undertaken early on in the project to assess where the birds are distributed and potential banding sites, identify any access issues and consider possible locations for base stations. Given fieldwork is likely to take place in tidal locations, during this visit it will be important to confirm the accuracy of tidal information (for example, using the NAMRIA PH Tides App <https://namria.gov.ph/PhTides.aspx#gsc.tab=0>) both to identify the optimal times and locations for capturing birds, and to ensure the health and safety of fieldworks by ensuring they do not get trapped by rising tides. Special consideration should be given during these visits to the potential presence of dangerous animals, for example, crocodiles or venomous snakes.

During the first visit, consideration should also be given in relation to the provision of shelter for both the field team and birds. It is important to provide shelter from adverse weather conditions including both heat and rainfall. This shelter may be in the form of nearby buildings or other structures, or temporary structures (e.g. tents or gazebos) deployed by the field team. Such shelter should also be able to serve as the 'banding station' to work from, which puts additional conditions in for selecting or creating such a place.

It is important to engage with local authorities (including barangays), communities and other stakeholders, including local bird clubs, other NGOs, and site managers, at an early stage, and this first reconnaissance visit offers an excellent opportunity for this. This serves several purposes. Firstly, it alerts them to the work that will be undertaken, reducing the potential for misunderstanding about the work that is being undertaken (for example, ensuring that it is not misinterpreted as poaching). It also offers an excellent opportunity to access local knowledge about species present, their behaviours, and challenges of working in the local environment. They may also be able to facilitate contact with local landowners and make suggestions for locations in which equipment, such as base stations could be deployed. If local preparatory works are needed, like cutting a trail or building a shelter and/or banding station, or when local transport is to be arranged (e.g. boats), local craftsmen can be engaged at this stage. Finally, it offers an excellent opportunity for education, particularly if researchers re-visit the area on completion of the work to present the findings of the study. This may provide opportunities for additional local support, including with the monitoring of potential device impacts, notification of when birds depart and return on migration and, potentially, future capacity development through the training of suitably skilled, and interested people. Where local stakeholders provide support to the project, an honorarium should be considered, if culturally appropriate. If any volunteers assist with the tagging, they should be asked to complete risk assessments.

The second reconnaissance visit should be undertaken shortly before the planned fieldwork. It should be used to confirm the locations of target species and finalise plans and arrangements for capturing them. Location of banding stations, where the birds will be processed can be identified and preparations agreed. If data are to be obtained through remote download to base stations, consideration should be given to the locations of these, noting the need for direct line of sight between the base station and the locations used by the birds. This may involve talking to local

landowners or householders and obtaining permission to place base stations on their land. Ideally, tags will have been delivered by the time of this visit, in which case, they should be carried in order to check functionality, and, if appropriate, inform deployment of base stations.

7.2.4 Logistics

The logistics involved in planning and successfully delivering a tagging project should not be under-estimated. Noting that fieldwork may take place in a remote location, or close to tourist destinations, maybe during peak holiday season, accommodation should be booked at an early stage. Ideally, this accommodation should be close (e.g. within 30 minutes' drive) to the field site, with sufficient parking for all project vehicles, and space for staff to relax at the end of a busy day in the field. Additionally, the availability of food, local shops and restaurants should be determined to inform plans of how any additional food, or other resources should be provisioned. In remote areas, where the team will have to work without daily access to all the services mentioned above, a detailed field plan is required. Depending on the scale of the project, it may be advisable to have a dedicated person responsible for the logistics, including safety arrangements.

The availability of suitable vehicles to transport personnel should be confirmed. This should include consideration of how the field site will be accessed, for example, whether boat access is required. Where boat access is required, discussion with fishermen and/or other local operators should take place at an early stage (during the reconnaissance visits for example) to set up a transport system and set maximum durations for any fieldwork. These discussions would also be valuable to gain insight into tidal movements within the area. Given the unpredictable nature of fieldwork, flexibility in timing is crucial. Noting the challenges and risks associated with working in remote locations, this should include establishing procedures for emergency, medical evacuation.

At an early stage in the planning process, the availability of field staff, and appropriate back-ups, should be confirmed. A pre-field project meeting should be held to outline plans for the field season. At this meeting, the experience of the banding team would be discussed (e.g. numbers and species of bird handled, experience of capturing birds), opportunities for capacity building and upskilling of field team members should be identified, alongside any other training requirements (e.g. associated with working safely on mud flats). Any personal field equipment needs (e.g. suitable clothing and footwear) should also be identified. Risk assessments should be prepared and completed. These assessments should be kept under review in the event of circumstances changing closer to the field project.

An equipment inventory should be completed. This should cover all field equipment including banding kits, reference books, and documents, a first aid kit, harness material, and optics (e.g. binoculars and/or telescopes) to be used for monitoring, and bird guides for reference and to help build the confidence of fieldworkers inexperienced in bird identification. Any additional equipment required should be ordered at as early a stage as possible. This should include ensuring that there is a backup phone for use in the field in case batteries run out, and mobile internet dongle (if using a base station to download data over the internet). Personal Protective Equipment (PPE) requirements should be checked and confirmed. Mobile phone coverage should be checked prior to the start of any fieldwork, and, in situations where coverage is very limited, or non-existent, alternative options, for example satellite phones, should be considered to ensure the safety of field workers. Any need for lone working (e.g. during post-deployment monitoring visits) should be

identified at this stage and appropriate protocols should be agreed and put in place.

Immediately prior to deployment, the duty cycles and settings for the tags should be finalised. This should include discussions in relation to the trade-offs between battery life and the types of data that can be recorded (e.g. complete tracks vs. high temporal resolution positional data). Fieldwork information sheets (key contacts, site information, medical details) and data collection sheets (e.g. for banding details and tag settings) should be printed, and care should be taken to ensure suitable vehicles are available for the fieldwork. In the case of a multi-site study, involving multiple research institutes, ideally a shared field protocol would be agreed in advance in order to maximise the value of any data collected, particularly in relation to the monitoring of device effects.

7.2.5 Identifying the Field Team

The complex set of activities that need to be delivered for processing of a bird up to a successful release of a tagged bird, means that the level of expertise and experience in the team should be sufficient to guarantee successful, responsible and safe (for people and birds) implementation of the catching, extraction, transport, banding (including identification of species, sex, age), colour-banding, tagging, photographing and release. This includes skills in identifying species, age and life-cycle stage of birds, sex of birds, moult, assessing condition of birds and ability to take firm and informed decisions (including go/no-go) about catching, handling, banding, tagging, and releasing birds. Assigning clear roles and responsibility is good practice. It should be clear where the final decision lies during the fieldwork.

The size of the team should be sufficient to deal with all these activities, preferably in parallel operating dedicated workflow teams of at least two people (experienced expert and an assistant, sometimes also doubling as scribe). In case of the possibility of large catches (high numbers of target species), additional capacity is needed, starting with extraction and transport, but also in banding.

In operating nets, the number of open nets should be adapted to the capacity available in the rest of the processing team. Be ready to unexpectedly catch peak numbers and if necessary, release (or band if that is possible) birds directly at the net. In particular, it is important to think about capacity to transport birds from catch to processing station, ensure appropriate containers are available to do so, sufficient personnel are available to watch the stored birds before processing and observe recovery after handling prior to release.

7.3 Delivery

7.3.1 General Considerations

Ahead of every day of catching, banding and tag deployment, a short briefing should be held for all field staff involved. Key expectations should be confirmed, and all staff should be clear about their roles and responsibilities in the field. During tagging sessions, all hygiene requirements should be followed, including cleaning and disinfecting kit when moving between sites to minimise the risk of disease transmission. There should be consideration about the organisation of food-logistics for field sessions that last longer than a few hours, with all food consumed away from areas in which field work is undertaken.

The primary objective of the field work in a tagging project is to tag the desired number of individuals of the target species and birds are captured to that purpose. It is good practice not to capture birds ‘for nothing’ and therefore, as a minimum, all caught birds should be banded. Furthermore, all tagged birds should also be fitted with colour bands or flags to identify individuals from a distance. It is strongly suggested to consider also colour-banding all other individuals from the target species for tagging, following the agreed colour schemes for colour-banding. Photographs of birds being fitted with tags should be recorded to demonstrate the techniques and condition of the birds before release and will be useful as a secondary record and check of colour-band data.

Given that in the Philippines, in the short-medium term tagging projects are likely to rely on expertise from outside the country, whilst acknowledging that bird welfare must be the primary concern, all projects should include a capacity building plan with measurable outputs. Depending on the existing skills and experience of local researchers, such a plan may include:

- Training in the management and processing of data.
- Training in the safe handling of birds.
- Training in the safe extraction of birds from mist nets.
- Supervised deployment of tags.
- Local co-leadership of field activities.

It should not be assumed that all of these capacity building measures can be applied in every study, and it must be the decision of the field lead as to whether any local researchers and fieldworkers are able to safely, and with due concern for bird welfare, apply these skills. Furthermore, there should be an expectation that some fieldworkers and researchers will develop these skills more naturally, and therefore, more quickly, than others.

Methods for capturing birds are set out in section 5, above. Once captured, birds must be transported to a processing station, where they are stored prior to banding and tagging. The steps necessary for these processes are set out below.

7.3.2 Catching Birds

In section 5, several methods for catching birds have been mentioned with some of the important considerations coming with each method. In the implementation phase of the tagging study, all preparations should provide the starting point for an appropriate net set up at a suitable location and a proper team in place to execute the necessary steps. In this section it is further assumed that the catching is done with mist nets.

Once opened, the nets should be left alone to allow birds to fly in. Every 45 minutes a round should be done to check the nets for birds, and caught birds should be extracted (See section 5 for additional considerations that may lead to the decision to check the nets more frequently).

Checking the nets should be done in a way that it is safe for the fieldworkers and causes minimal disturbance, to avoid reducing capture likelihoods. This means:

- Communicate each time that a round is done, so that the team leader is aware that a team is out and who is in that team.
- Going with at least two people (never go alone out of sight of others), but with a group that is as small as possible to do a proper check of the nets.
- Being silent when approaching and being near the nets and not talking unless necessary.
- Not using light during the entire round. If necessary, red light may be used; the use of white light is to be avoided, in the approach as well as at the nets.
- Ensuring the safety of fieldworkers (e.g. when in water, only going with people who can swim).

The use of a thermal imaging camera may help to assess the situation at the nets.

7.3.3 Extracting Birds

Extracting shorebirds from mist nets without harming the birds requires practice. Mist nets are meant to entangle birds to prevent escape. This entanglement can seem unresolvable to inexperienced people but understanding how the birds come in and may get stuck with legs, wings and head, helps to extract them smoothly and quickly, without causing harm. This requires experience, particularly in dark conditions. It is strongly preferred to minimise the use of light at the nets, so extraction should be done largely by feeling. When necessary, red light may be used. Use of white light is to be avoided. Time is of the essence in extracting as large numbers of birds may be trapped so a long per-bird extraction time adds up to long presence at the net. This causes stress to the birds, the team and reduces the time the net is in a state of readiness for catching. Therefore, team members should be trained in the safe and efficient extraction of birds from mist nets before engaging in shorebird extraction at night.

When approaching an animal in the net in darkness, operators must be careful and mindful of the option of it being a bat that may bite or a bird that may strike with beak or claws.

7.3.4 Transport to Processing Station

Once caught in the nets and subsequently extracted, birds need to be processed, as in banded and tagged. This is done in a processing (or banding-) station, away from the nets, so that nets can be left alone and catching can continue.

In some instances it may be appropriate to band birds at the net or trap or even release birds immediately without further handling. This may be the case for long-legged birds (e.g. curlews *Numenius* spp.), which are particularly prone to “leg cramp” (capture myopathy) during capture, captivity, and handling. See section 7.3.4.1 for more information about this important topic.

The other occasion at which birds may be banded at the net or even released without further handling, is when the number of non-target birds caught is high and no measurements are needed⁹ or when the total number of birds caught is so high that it will put undue pressure on the capacity of the team to ensure proper processing of the target species and other birds brought in for processing. In such circumstances the well-being of the birds is reason to decide to immediate release of (part of) the catch or to release after only banding¹⁰.

⁹ (noting that not measuring and banding by-caught birds is not considered best practice and it is recommended to measure and band all caught birds).

¹⁰ Minimum information to be taken is the species for each band that is deployed.

For transport to the processing station, birds are put in crates or boxes, where the birds can stand. This is particularly important for long-legged shorebirds. Smaller, short-legged shorebirds can also be transported in bird-bags. Long-legged birds are not to be transported in bird-bags. If no crates are available, cardboard boxes may be used as a temporary alternative for the transport of long-legged birds, to avoid transporting or storing birds in bags. If no cardboard boxes are available birds may be carried by hand (one at a time) if distance is short or, if the bird does not need to be tagged, it may be banded at the net as mentioned above.

Transport of the birds from extraction to place of processing (banding and tagging) is an essential step in the whole process and needs to be carefully considered and planned, especially with longer distances between the catching location and the processing camp. Good transport materials are essential.

Upon arrival at the processing site, birds need to be handled immediately or stored in conditions that guarantee their well-being. Long-legged shorebirds should only be kept in crates, cages, or tents where they can stand and stretch their legs, and not in bird bags.

If the distance between catching and processing is long or cannot be covered on foot, operators must carefully consider how the birds will be transported (in boat or car for example). Bird bags (small birds only) need to hang (may never be stacked) with sufficient breathing space. Where catching operations are sizable, a dedicated transport team will be required.

7.3.4.1 Avoiding Leg Cramp

Leg cramp is a form of severe muscle trauma, and this condition is a serious, potentially fatal syndrome resulting from the stress and physical exertion of being captured and handled. For bird banders, preventing capture myopathy is the primary goal by minimising handling time and using appropriate holding conditions. In the unfortunate circumstance that a bird develops severe symptoms, rehabilitation is difficult. It may involve providing quiet, dark, and undisturbed conditions for recovery, which can take several days or even up to two weeks. Sometimes it requires additional interventions like suspending the bird in a sling so its feet can touch the ground in a normal standing position, allowing gradual weight bearing as it recovers. Rehabilitated birds have shown comparable survival rates to un-cramped banded birds after release, suggesting that successful recovery is possible with proper care.

If long-legged shorebirds like curlew species are amongst the target species, it may be appropriate to have a dedicated person tasked with avoiding leg cramp situations and nursing sensitive birds throughout the processing cycle, up to release.

7.3.5 Processing Station

The handling of birds to apply metal bands, take measurements, apply colour-bands, and deploy trackers needs to happen in a suitable environment. Such a processing station may be a permanent building, or a temporarily set up location (e.g. a gazebo), that provides shelter from wind, rain, and light (exiting). Bands, tags, tools, and other materials need to be organised in a way that facilitates coordinated working, seated at tables, and flawless administration of results, either on paper or in digital format.

As different work streams (banding and taking measurements, colour banding, taking samples,

tagging) may be happening, the work needs to be well-coordinated, with teams taking on specific responsibilities. Banding (metal band) should be done first and ensures that a unique number is assigned to a bird, acting as an 'index' that all other data can then be linked to. Recording of information should be a dedicated task (scribe). Often, each workflow has its own scribe. The role of the scribe is not to be underestimated, as large amounts of information are being transferred by several people (possibly in foreign languages), under hectic conditions, sometime simultaneously. It is recommended that a scribe always provides verbal feedback about what she/he has heard and recorded, to get confirmation from the sender, and avoid misunderstanding.

Documenting processed individual birds of target species with a visible colour band combination is recommended. Since the colour band combination to be used on a bird often determines the position of the metal band, close coordination between the bird bander and the colour-bander is essential.

Operators must think ahead of the right conditions for good pictures, like a standard grey background, an appropriate camera and lens (macro lens for example) and good light conditions (flash). Pictures should be standardised; try to standardise the pictures as much as possible and make sure to be able to link each picture to an individual bird, based on the band number.

The number of tasks and the number of birds to be processed determines the minimum size of the team, necessary to run a processing station.

7.3.6 Storing birds

The processing of birds should be done by an experienced and well-coordinated team, to create a smooth flow of birds, thus reducing handling times, which is critical for the health of the birds. With large catches the need to store birds before they can be processed cannot always be avoided. It is important to anticipate this and have facilities, like holding tents, to store the birds safely and comfortably. Shorebirds should not be stored in transport bags. For passerines (songbirds) this is often not a problem, but for shorebirds this should absolutely be avoided.

Good keeping tents, cages, or boxes can avoid such problems (e.g. Figure 21). These keeping tents or boxes can also be used for observing the behaviour of a shorebird after tag deployment, before release.

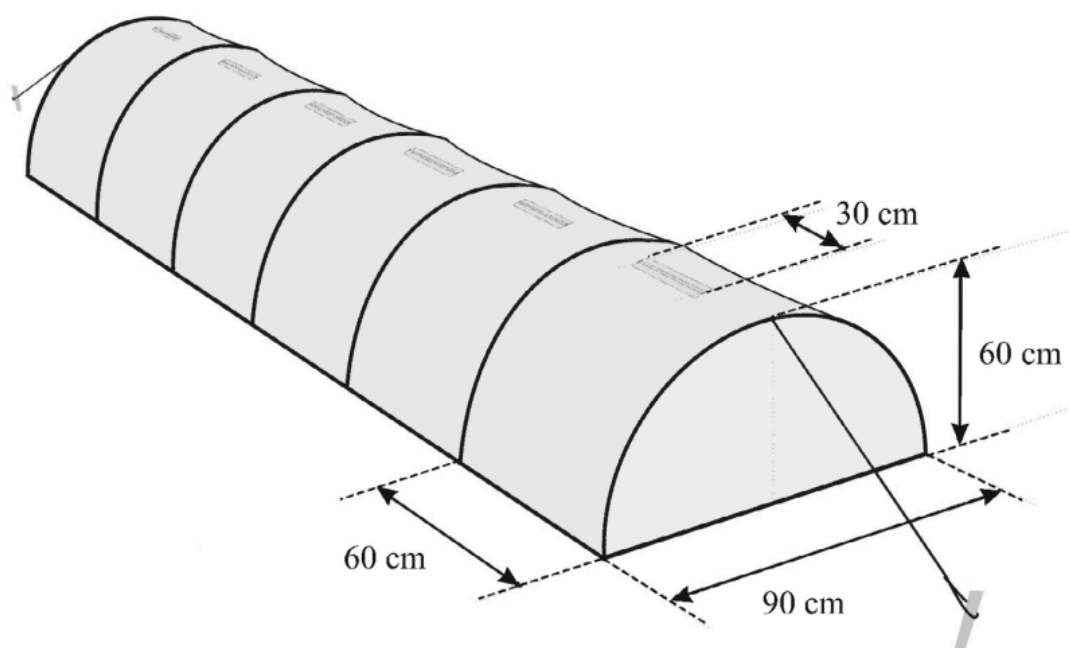


Figure 21. An example of a keeping tent for shorebirds (after Clark, 1986).

7.3.7 Banding

Banding (sometimes also referred to as ringing) is often the first action when a bird is being processed, as it establishes a unique identifier that all other actions can be linked to and all components of administration should therefore as a minimum capture the band number of the bird.

A metal bird band contains a unique number. Established banding schemes around the world provide bands with such numbers. Many countries have their own banding schemes, especially in Europe, the Americas, and a range of countries in the East Asian-Australasian Flyway. Many other countries however, including the Philippines, do not have their own banding scheme. In such countries it is best to use bands of one of the established schemes, after permission for such international use has been obtained. Looking for such a scheme in the direct range of countries around the planned banding projects is often most logical, although in some cases established relationships and research traditions may provide other solutions.

Metal bands can be obtained in various materials. Each material comes with its own advantages and disadvantages. For shorebirds hard-wearing materials are needed because of the conditions the birds live in. Usually aluminium bands (the standard in passerines) are too soft for use in shorebirds. Typically, incoloy (a hard-wearing nickel-chromium alloy) or stainless-steel bands are used on shorebirds. Disadvantages are that these hard bands are more difficult to deploy correctly, requiring more force and experience.

An established banding scheme does not only provide bands, it also provides the critically important administration of the banding information and provides the option for receiving banding recoveries. This is a critically important role, and it is better to use an existing banding scheme

rather than to just make or order dedicated bands for a stand-alone banding (or tagging) project, without ensuring the guaranteed and lasting service of administration of banding and recovery data.

Once the processing of a caught bird starts, the bander determines the species (and population if appropriate), the sex and the age, and fits a metal band that is suitable in size and position for that species. Where necessary, field guides should be referred to confirm the species, and where possible, the sex and age of a bird. If a bird cannot be confidently identified to species level, it should not be banded. The bander then takes measurements as agreed beforehand.

If the sex of the bird cannot be determined in the hand, it is recorded as 'unknown.' For birds that are tagged, it is recommended to take a feather sample to allow retrospective determination of sex through DNA analysis, as the sex of the bird may be important when interpreting the tagging data.

A few standard measurements are universally taken of any banded bird, and additional measurements can be taken, depending on the need of the study. These measurements may include:

- Wing length
- Tarsus
- Tarsus-toe
- Bill to feathers
- Total head (bill+head)
- Body mass
- The moult of the flight feathers (moult score)

Please refer to literature (e.g. Busse and Meissner 2015) for correct ways of taking these biometric measurements. Such measurements have been taken by banders around the world for decades and provide a sound basis for establishing populations the bird belongs to. The body-mass is a critical parameter in determining the condition of the bird and in deciding whether it can be tagged or not and with what kind of tag.

The moult of the flight feathers informs about age, sex and life-cycle stage and is scored in a standardised way. Moult is a complex process and specialist knowledge is needed to be able to interpret moult patterns. Shorebirds differ in the way they moult over the year and how they manage their moult in relation to other energy demanding processes like migration. Shorebirds, and especially also terns, can have multiple generations of feathers as a result of arrested or suspended moult. There is a body of literature that describes this and much of the knowledge on this is still developing. The International Wader Study Group has a series of species monographs on ageing and sexing of shorebirds, and it is strongly recommended to refer to these¹¹.

The accurate and organised recording of all these parameters and values requires a carefully developed data plan and agreed data storage approaches, either on paper (preferably using standard forms) or directly into a digital format on laptop or phone. This recording is best allocated to a dedicated 'scribe' or a number of scribes, often one scribe per workflow. If data are

¹¹ <https://www.waderstudygroup.org/wader-study/ageing-and-sexing-series/>

recorded on paper, photographs of these forms should be taken at the end of each session to minimise the risk of losing important data before it can be digitised.

If colour bands and/or flags are being applied, this often dictates the position where the metal band needs to be. The metal band is often part of the combination of colours a bird gets, so the position is very important. This may result in different species or even individuals within a species getting the metal band on different positions on the legs (tibia or tarsus, left or right). This needs to be agreed beforehand and the bander needs to pay careful attention to this. Once fitted, it may be difficult or even impossible to remove the band and change its position. There is risk of damaging the leg of the bird in doing this, so this should be avoided as much as possible. Steel bands in particular should not be opened once applied to a bird, as these are much harder than aluminium bands or bands made of other alloys, like incoloy. If the steel band is placed in the wrong position, it is preferable to not colour band the bird, rather trying to change the position of the steel band.

7.3.8 Colour Marking

A metal band provides a bird with a unique identification number, but this number can only be read with the bird in the hand (or sometimes from extreme close-up photography). Adding colour bands or engraved flags to a bird makes it possible to identify a bird down to the level of the individual in the field – without catching it - often from considerable distance, using appropriate optical equipment (telescope) or photography.

The use of colour bands can only be usefully done if the combinations are carefully administered with the metal band number, and if coordination ensures that the same colour combination is not used on different birds of the same species. The same applies for colour flags. A coloured flag or set of flags can indicate a country of origin and a possible engraving of a flag can indicate the individual. Sometimes both colour bands and colour flags are applied on a bird. The colour bands often allow 'reading' from larger distances and in more difficult angles, where the engraving on the flag is not readable.

A coordination mechanism for assessing and approving the international use of colour schemes in the EAAF appears to be missing. In the African Eurasian Flyway this is successfully done through the European Colour-band birding initiative: <https://cr-birding.org/>. In the EAAF, there is a coordinated scheme for country codes in colour flags. The code for the Philippines is a set of two flags with a black flag over a blue flag. An example of a colour-flagged Spotted Greenshank (*Tringa guttifer*) with colour bands (and a GPS GSM tracker) is shown in Figure 22. This was tagged in February 2024 in Manila Bay.

Smooth deployment of the right colour band and flag code on high numbers of caught shorebirds requires careful preparation of codes, pre-printing of recording forms, special tools and especially experience in applying. Usually, a target subset of banded shorebirds is fitted with colour bands. However, colour bands and flags only generate information if they are being recorded and reported. The resighting rate strongly depends on the availability of observers that are able and willing to record re-sightings and report them. Furthermore, an easily accessible reporting mechanism is necessary. In the EAAF volunteers maintain a very active Facebook group on [Shorebird leg-flag sightings in the EAAF](#), which links re-sightings back to banders.



Figure 22. A Spotted Greenshank with GPS GSM tag, colour bands, and leg flags. Note the black above blue flags on the right thigh, reflecting the EAAF colour code for the Philippines.

7.3.9 Tagging

Tagging here means deploying a tracker, also called a tag, on a bird. The tag is deployed on the bird in a way that it does not impact the behaviour of the bird and stays on the bird long enough to meet the specific target of the tagging. A range of techniques of deployment can be used. See section 6, above, for more information.

Tagging is considered a relatively invasive technique (more than bird banding) and is often considered an animal experiment. In several countries with advanced permitting systems, tagging requires a special permit for which certification needs to be obtained as a special addition to the banding license. While this may not be the case in the Philippines, this does indicate that special expertise and experience is needed to be able to tag birds without negatively impacting its behaviour and survival. Avoiding such impact is necessary for both ethical reasons as well as for reasons for not wanting to influence the results that are being obtained through the tagging. If time and the project allows, training in the fitting of tags to birds may be offered to suitably experienced personnel, with a view to establishing local capacity for future tagging studies. However, bird welfare must always be the primary consideration.

The tagging expert needs to be able to:

- Assess the condition of the bird as suitable for tagging;
- Direct an assistant in holding the bird according to welfare standards;
- Position and deploy the tag without harming the bird;

- Finalise the tagging within acceptable time, to avoid unnecessary stress in the bird;
- Use correct and lasting knots and fixation techniques (if and when appropriate);
- Assess and evaluate the correct connection with the bird after the deployment is finished. In case of a harness assess whether the tension (tightness) of the harness is correct when the tagging is finalised;
- Before release, appropriately store the bird to allow it to get used to the tag and to be observed to assess whether it shows normal behaviour;
- Decide whether the bird is fit to be released with the tag, or if the bird does not seem to get used to the tag, shows signs of discomfort or otherwise not normal behaviour, decide that the tag needs to be removed again;
- Release the bird in a safe way and in a safe environment. In daylight, make sure that no predators are in the immediate vicinity that may detect the bird being released and predate on it;
- Assess whether the bird successfully takes off into the wild. If not, recapture the bird for further care (including possibly removing the tag);

Alongside tagged birds, a control sample, at least equal to the number of tagged birds, should also be fitted with colour bands and flags for the purposes of monitoring potential tag effects. Where possible (e.g. for remote download GPS tags), as tags are deployed, the data obtained should be checked to ensure it is delivering as expected, and updates should be offered to project funders, and other interested stakeholders (if appropriate).

7.3.10 Photo Documentation

As mentioned above, it is important to document every tagged bird with a picture, with colour bands, flags, and tags visible. Metadata of the picture should include time and location. Make sure the pictures are taken in a standardised manner, preferably with a standard grey background.

7.3.11 Additional Research Activities

Depending on the objectives of the study that is undertaken, next to the 'standard' activities described above, it may be useful to undertake additional activities. This may for example include sampling for zoonoses (swabbing or taking blood), taking of feathers or blood for DNA analysis (e.g. to determine the sex of the bird – it is recommended to do this for all tagged birds), taking of feathers or blood for other specific analyses (e.g. the taking of primary coverts for analysis of mercury or other heavy metals). Special protocols, materials, tools and storage techniques are often needed for such additional activities. Additional permits will be required for such sample collection, and, if samples are to be moved from one region to another, also for transport. In these instances, a Wildlife Local Transport Permit, or equivalent authorisation, must be secured from the DENR Regional Office with jurisdiction over the collection site prior to transport.

7.3.12 Biosecurity and Disease Transmission

Biosecurity is an important aspect of bird banding. Additional mortality resulting from banding-induced diseases is a pressure that may drive additional declines in populations of threatened shorebirds. Any benefits related to informing wind farm development do not negate

impacts due to disease. Consequently, biosecurity protocols should be rigorously implemented as standard practice.

Catching and handling birds is a potential pathway for increased disease transmission within and between species. Diseases, such as Avian Influenza (HPAI) can be transmitted between birds via bodily secretions and faeces and banders' hands and / or equipment can potentially increase pathways for transmission from an infected to uninfected birds, or from site to site.

Banders should implement protocols to reduce the risk of transmission via two key approaches:

- Reducing the potential for banders to come into contact with infected individuals, and therefore potentially spread the virus further;
- Minimising the risk of transmission via hands, clothing, or equipment.

Fieldwork should not take place if symptomatic live birds, or abnormally high numbers of dead birds, are observed before or during a banding session. Activity should not be resumed at that site until a subsequent recce visit finds no further evidence of disease. On no account should fieldworkers handle or attempt to collect dead birds. These should be reported to the relevant authorities and, if appropriate, collected by trained individuals wearing full Personal Protective Equipment (PPE).

Fieldworkers must disinfect clothing, boots, hands, and equipment at appropriate intervals, using products known to be effective against HPAI. Regular use of alcohol-based hand gel or wipes is recommended. All hands, clothing or equipment that may have come into contact with a diseased bird must be sanitised immediately. Bird bags used to transport birds or hold caught birds in a dark environment to reduce stress prior to being banded, must only be used once during each banding session, and must be washed at a high temperature before they can be reused. Crates, cages and keeping tents should be given a floor lining of paper or plant material, which is to be renewed every session. The tents, crates and cages are to be cleaned as well.

7.3.13 Monitoring

Following tag deployment, all projects should conduct structured post-tagging and post-release monitoring. The protocols for this should be agreed in advance with DENR-BMB and be sufficient to assess short-term effects such as abnormal movement, reduced foraging, and any signs of distress. Any tag-related injuries, behavioural changes, tag loss, or mortalities should be documented and reported to DENR-BMB to support national records and guide future tagging work.

Should this monitoring involve any periods of lone fieldwork (e.g. for making observations of tagged birds in the field), lone fieldworker protocols must be put in place and followed, at a minimum, these should include leaving details of the timing and location of the fieldwork with a third party, and agreed check-in times with the rest of the project team. Where possible, birds should be observed immediately following release with a view to identifying any unusual behaviour (e.g. excessive preening of the area around the tag). Whilst birds are present at a site, periodic surveys should be undertaken with a view to detecting marked individuals, and comparing the number of tagged and control birds present, noting that the low sample sizes

involved mean that statistical power to detect meaningful effects is likely to be limited in all but the most extreme cases (Cleasby *et al.* 2021). Over an equivalent period the following year, additional surveys should be undertaken with a view to assessing the return rates of tagged and untagged individuals. Resightings for colour banded birds may help to interpret loss of signal from a tracker.

7.4 Post-Fieldwork

7.4.1 Kit Maintenance

Following the completion of the fieldwork, all data collected should be cleaned and backed up. The field kit should be sorted, cleaned, and stored, with any broken or missing items noted, and replaced or repaired as required. Where data collection will continue through other seasons, and settings can be altered remotely, settings should be adjusted to facilitate prolonged data collection whilst preserving battery life.

Where archival loggers (e.g. geolocators) have been deployed, plans should be made to retrieve these the following season.

7.4.2 Data Archiving

In line with DENR Administrative Order 54, published in 1989, it is important to maximise the value of all data collected, and to promote international cooperation. With this in mind, as a starting point, all banding and resighting data collected directly, or indirectly, as part of a tagging study should be reported to the “Shorebird Leg-Flag Sightings in the East Asian–Australasian Flyway (EAAF)” Facebook group or at <https://flagsightings.wordpress.com>. On retrieval of tagging data, these should be uploaded to an online repository, such as Movebank¹². These repositories often give users the option to make their data public or private, and researchers should use repositories which have such controlled access settings. Raw and high-resolution tracking data remain non-public by default, especially for threatened species. DENR-BMB should have access to all raw and processed datasets, and access to these data for research or planning processes should be through BMB. Data storage and access should be discussed at the outset of the project and agreed with DENR and other relevant stakeholders.

In addition to submission to an online repository, a clear data management protocol should be agreed with DENR-BMB at the outset of the project and should prioritise species protection and national data security. This should include, as a minimum:

- Standardised meta-data fields.
- Submission of cleaned datasets and GIS-compatible outputs to DENR-BMB.
- A post-study technical report template.
- Guidance on the sensitivity of data collected for threatened species or vulnerable sites.
- Timelines for repository submission and stakeholder feedback.

¹² <https://www.movebank.org/cms/movebank-main>

Once data has been collected and processed, feedback in relation to the movements of birds and any other relevant information should be provided to funders and other key stakeholders who have supported the work, for example landowners, local officials and local ornithology and wildlife groups. This will help to demonstrate the value of the studies and help build support for future work.

Publication of results to inform the wider community interested in the information may be considered.

7.5 Summary

Whilst the duration of fieldwork associated with any tagging project may be relatively short and intensive, up to, and sometimes in excess of, 2 years may be required to deliver a successful project (Figure 23). Consequently, given the proposed speed of development in the Philippines, for tagging projects to generate evidence to support offshore wind, these projects would need to start imminently. As set out above, there are several steps associated with the successful delivery of a tagging project, and it is important to consider the length of time involved in each and plan accordingly (Figure 23), especially given that many steps need to be sequenced. Furthermore, site permissions and obtaining the necessary permits may require several months for processing, and tag orders must be submitted in good time to allow them to be built and delivered. Whilst it would be possible to order tags whilst site permissions are being considered, and prior to obtaining the necessary research permits, this may carry a substantial financial risk if these permissions and permits are not approved. For these reasons, it is advisable to start planning any tagging study at least a year in advance of any fieldwork (Figure 23).

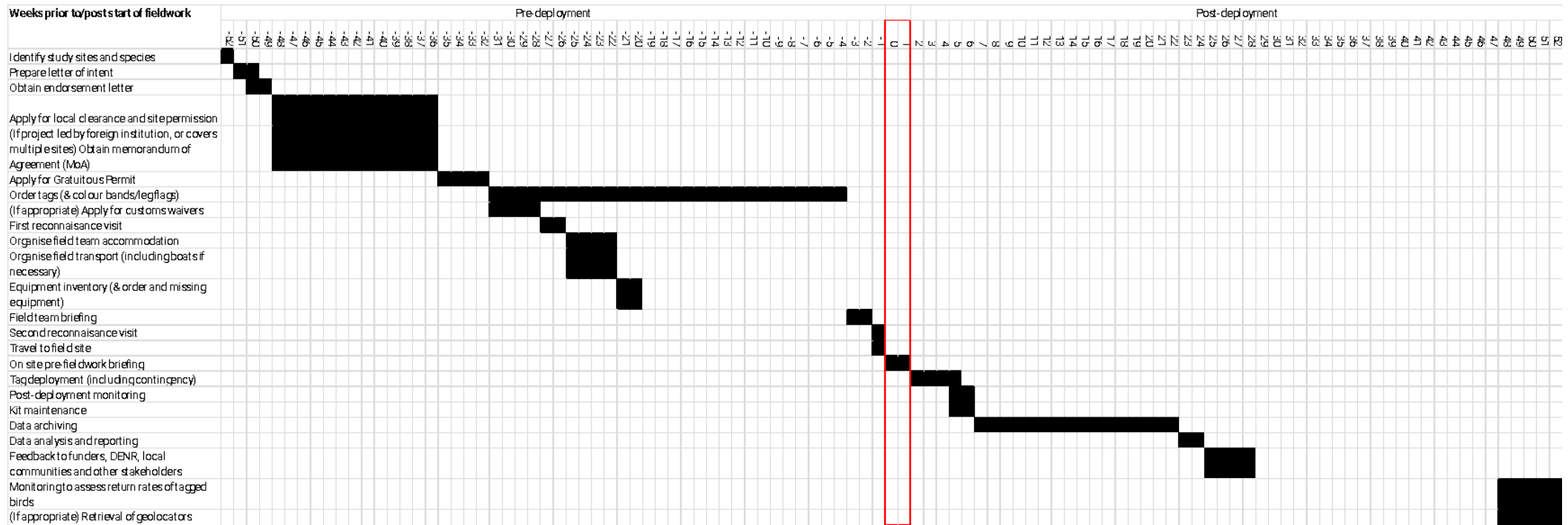


Figure 23. Gantt chart for successful delivery of shorebird tagging project, with tagging period highlighted in red.

8 Conclusions and Recommendations

8.1 Conclusions

Any shorebird tagging project must be tailored towards the research question concerned. In relation to migratory shorebirds and offshore wind farms, research questions may include:

- To what extent are birds on migration likely to be exposed to offshore wind farms?
- Are the local movements of a bird (e.g. when present at a stopover or wintering sites) likely to bring it into contact with an offshore wind farm and/or its associated onshore infrastructure?
- Do birds fly at an altitude whereby they are likely to be at risk of collision with turbine blades?

Each of these questions will require a different type of data to address and hence, are likely to involve different types of tags. For example, a study focused on local movements will require that data is collected at a finer spatial and temporal scale than a study focused on broader scale migratory movements. Similarly, the need for flight height data will necessitate the use of a tag capable of pinpointing the three-dimensional location of a bird, either using GPS or through the use of a barometric pressure sensor. As bird welfare must be a primary concern, the selection of a suitable tag must take into account its size, and how it will be deployed on the bird, in addition to the data that will be collected.

The time required to successfully plan and execute a shorebird tagging project should not be underestimated. We describe the necessary steps above, and summarise these in Figure 18, below. In particular, a substantial amount of time must be allowed both to secure permission to deploy tags, and to order these tags (see Figure 17). Whilst the two steps may occur in parallel, this comes at a substantial financial risk to the project funder should permission to proceed with the study be refused.

Shorebird tagging is a highly specialised skill. In the short-medium term, any tagging projects in the Philippines are likely to require the involvement of international partners, with the appropriate skills. The East Asian-Australasian Flyway Partnership, one of the objectives of which is to “enhance flyway research and monitoring activities, build knowledge and promote exchange of information on waterbirds and their habitats”, offers a valuable network from which to identify suitable partners. Over time, as projects proceed and opportunities present themselves, in-country expertise to carry out shorebird tagging studies must be developed.

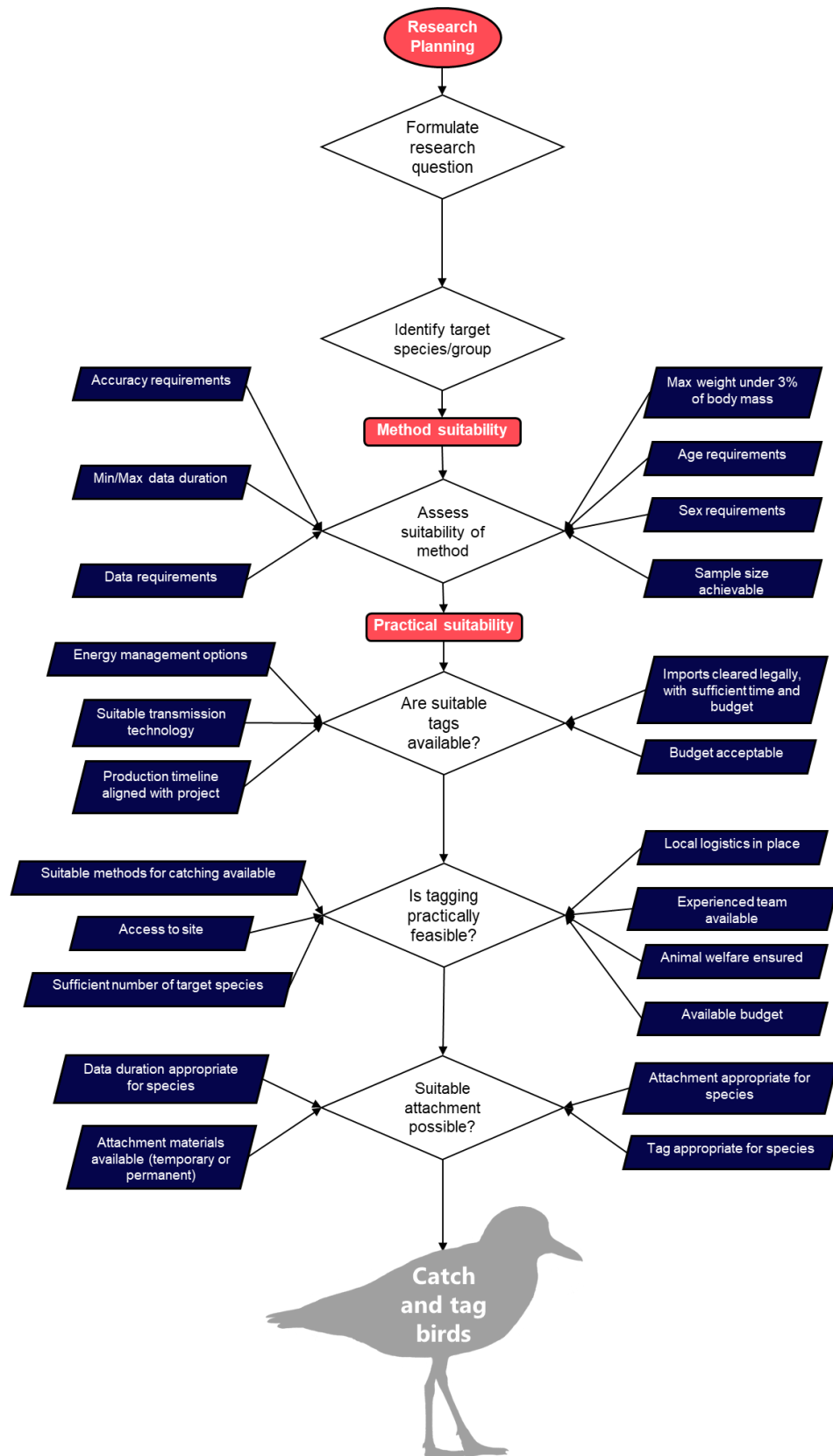


Figure 18 Steps to be taken when planning a shorebird tagging project.

8.2 Recommendations

- Research questions for tagging studies in the Philippines should be clearly defined and co-developed with funders and other key stakeholders (e.g., DENR Biodiversity Management Bureau, DENR Ecosystems Research and Development Bureau, Department of Energy, NGOs) to ensure clear expectations are set, and to foster collaboration.
- Planning for tagging studies should begin at least six months, and ideally 12 months, prior to any fieldwork taking place to ensure sufficient time to secure all necessary permits and order tags.
- The specialised skills required for safely capturing birds and deploying tags means that, in the short-medium term, these studies will require the involvement of international experts. As a priority, all tagging studies in the Philippines should include requirements for the training of national researchers to increase capacity in the country and reduce reliance on international experts.
- The Philippines is a key point on the East Asian-Australasian Flyway. To maximise the value of any studies and data collected, projects should seek to engage with the flyway partnership for collaboration and technical support.
- All tagged birds should also be colour-marked following EAAF protocol (including Black over Blue flags for the Philippines). Efforts should be made to promote colour-band resighting in the Philippines to improve understanding of movements across the flyway.
- To maximise the value of studies, all tagging data should be archived in online repositories, such as Movebank, with colour-banding and resighting data shared via EAAF platforms.
- On completion of tagging studies, in addition to the reporting of results to funders and any scientific publications, feedback on the results of the work should be provided to other stakeholders, including local communities, who facilitated the work both to provide insights and education about the connectivity of birds across the flyway, and to increase trust in researchers and build support for future studies. As the volume of data increases, it may be possible to use shorebird tracking information to inform smart curtailment decisions as a measure to mitigate the impact of offshore wind (e.g. Bradarić et al. 2024).

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[The Biodiversity Consultancy](#) exists to make positive biodiversity impact second nature for business. We help companies turn nature ambition into action, making the journey toward nature positive goals practical, achievable, and valuable.

We combine scientific expertise with commercial insight to deliver measurable outcomes that strengthen both business performance and biodiversity resilience. Having partnered with over 300 leading global corporations, we guide, support, and inspire our clients to navigate complexity, mitigate risk, meet strategic goals, and unlock value through the business–nature relationship.

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