Technical Document No. 1

Americas Flyway Initiative Site Selection Framework[1]

Background

The Americas Flyway Initiative (AFI) aims to Enhance the resilience of the Americas Flyways by protecting, restoring and managing the sites needed to secure 10% of the population of representative migratory birds by 2050, across their full annual cycle. Projects funded through AFI will deliver identified, measurable co-benefits including ecosystem services, economic development and climate change mitigation and adaptation.

To identify the sites eligible for the development of projects under the AFI, a Site Selection Task Team (SSTT) - with members from BirdLife International, National Audubon Society and CAF (Appendix 1) – and support from regional shorebird conservation partnerships (e.g., Pacific Shorebird Conservation Initiative, Midcontinent Shorebird Conservation Initiative, Atlantic Flyway Shorebird Initiative, Western Hemisphere Shorebird Reserve Network) – was established to develop a Site Selection Framework that outlines the site prioritization methodology, taking as a start point the site selection methodology developed for the East Asian Australasian Flyway project. Using this framework, we identified an initial portfolio of sites of importance for the connectivity and conservation of migratory shorebirds and landbirds across the Americas that would allow securing 10% of the global or hemispheric population of prioritized AFI species. We also developed a "consolidated score" to provide a consistent metric of importance for comparison among eligible sites. Finally, we assessed the site potential for the implementation of different types of "project investment concepts", based on the threats and species present at eligible sites. All project results were integrated into a single geographic database which is visible here.

Figure 1. Pacific, Midcontinent and Atlantic Flyways. Source: https://shorebirdflyways.org/

Site selection framework - Shorebirds

[1] Cite as: Velásquez-Tibatá, J., Linero-Triana, D., Valdes, J., Seavy, N. E., Gates, R., Michel, N., DeLuca, W.B., Toscano, G., Davidson, I., Crowe, O., Seager, M., Jones, V., Velásquez, M., Carrillo, J.C., Aparicio, S. 2024. *Americas Flyway Initiative Site Selection Framework*, Technical Document No. 1. National Audubon Society, BirdLife International & CAF. Retrieved [date], from https://nationalaudubon.box.com/s/m5ssvmh46gkht8cpal9idlicqt15mgym

We followed a 3-phase approach to site selection and prioritization. Phase 1 identified *candidate* sites for inclusion in the AFI portfolio. Phase 2 identified *eligible* sites by establishing prioritization criteria to score sites according to their importance for shorebirds and landbird populations. Phase 3 assessed natural assets, threats and opportunities for conservation at eligible sites. See glossary at the end of the document for definitions.

Phase 1: Identification of candidate sites

We proposed a four-step hierarchical process for identifying eligible sites for conservation investments. This process was designed to incorporate bird population data from the hemisphere down to local site conditions to arrive at a set of sites that provide the greatest value to migratory birds, following the framework of DeLuca et al. (2023).

Step 1. Identification of priority regions for migratory birds across the Western Hemisphere

We used existing spatial prioritizations for migratory bird species that breed in six major habitat types across North America as a coarse filter for site selection. These full annual cycle (FAC) prioritizations integrate tracking, banding, occurrence, and migratory connectivity data to identify broad regions of high conservation value (DeLuca et al. 2023). For shorebirds, we used the FAC prioritization developed for North American migratory waterbirds, which includes 54% of AFI trigger species (Figure 2). For landbirds, we used an integrated prioritization for 5 bird groups (boreal, eastern forest, western forest, grasslands, aridlands) which include 38% of AFI trigger species (DeLuca et al. 2023). For waterbirds, we retained the 70th percentile of the FAC prioritization and for landbirds a consensus prioritization was developed by retaining the 70th percentile of prioritizations for the 5 bird groups and taking the maximum across them.

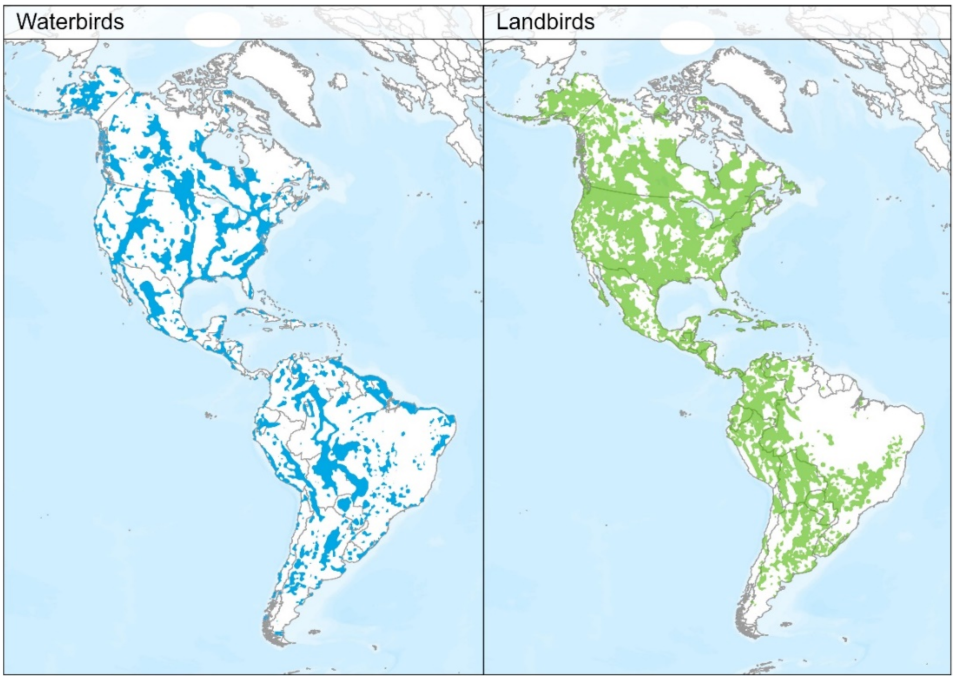

Figure 2. Full annual cycle prioritization for North American migratory waterbirds and landbirds (70th percentile).

Step 2a. Identification of candidate sites from existing network designations of important sites for shorebirds

Because many shorebirds concentrate in larger numbers during migration and the stationary non-breeding season, there has been a significant effort to identify places where the congregate. To incorporate this information into our process, we developed a unified and standardized geodatabase of candidate sites for shorebirds by compiling geographic data for the following conservation designations:

- Important Bird Areas (IBAs) with geographic data in the Key Biodiversity Areas (KBAs) dataset.
- Western Hemisphere Shorebird Reserve Network (WHSRN) sites.
- Potential WHSRN sites (sites meeting WHSRN criteria, not yet approved).
- Pacific Shorebird Conservation Strategy (PSCS) sites
- Atlantic Flyway Shorebird Initiative (AFSI) sites
- Midcontinent Shorebird Conservation Initiative sites (MSCI).
- RAMSAR sites.

Table 1. Criteria for conservation designations for shorebirds considered in the Americas Flyways Initiative.

Portfolio	Category	Criterion
IBAs	Global IBA for threatened species	The site holds significant numbers of globally threatened species.
IBAs	Global IBA for congregations	The site supports seasonal congregations of more than 1% of the global population of one or more species.
IBAs	Regional IBA for species of conservation concern	The site contains a significant number of Near Threatened species or species with an unfavourable regional conservation status.
IBAs	Regional IBA for congregations	The site supports more than 1% of the biogeographic population of a species or holds more than 20,000 waterbirds.
WHSRN	Site of hemispheric importance	The site presents at least 500,000 shorebirds annually or at least 30% of the biogeographic population for a shorebird species.
WHSRN	Site of international importance	The site present at least 100,000 shorebirds annually or at least 10% of the biogeographic population for a shorebird species.
WHSRN	Site of regional importance	The site presents at least 20,000 shorebirds annually or at least 1% of the biogeographic population for a shorebird species.
RAMSAR	Site of international importance for waterbirds	A site that supports at least 20,000 wetland-dependent birds or holds at least 1% of the population of a waterbird species or subspecies.

Since there is overlap in the prioritization criteria from different conservation designations, sites often belong to more than one of them (Table 1). For example, flyway strategies (PSCS, AFSI) use the same criteria as the WHSRN to identify sites of conservation importance, refined to include only the target species of each initiative. MSCI sites include all potential WHSRN within the midcontinent flyway. By meeting additional criteria, all these sites could be officially designated as IBAs or RAMSAR sites.

To overcome spatial issues with overlapping conservation designations, we performed an integration process for the initiative's priority countries in Latin America: Costa Rica, Panama, Colombia, Ecuador, and Chile. With this process, we were able to integrate sites from multiple designations (e.g. a site could be identified as RAMSAR and WHSRN) and assigned spatial boundaries to sites that only had central coordinates. The integration was carried out by manually reviewing all sites in ArcGIS Pro. If two or more sites with the same name overlapped, we integrated them into a single polygon. When the correspondence of overlapping sites was unclear, we retained the boundaries of all designations for future inspection. During this process, we also used the World Database on Protected Areas (WDPA) as it includes the spatial boundaries of various RAMSAR sites.

This process resulted in an integrated geodatabase consisting of 4,682 sites that belong to any of the above conservation designations. Except for prioritized countries, a site could be counted more than once if it's included in more than one network. The geodatabase was filtered to keep only the sites that intersect with the waterbirds FAC prioritization (Step 1). This procedure yielded a total of 2,389 candidate sites for shorebirds.

Step 2b. Identification of candidate sites for landbirds

Unlike shorebirds, most migratory landbirds don't congregate in large groups during the non-breeding season and these species are not well-covered by flyway-based conservation initiatives (Runge et al. 2015). Instead, most landbirds are widespread and migrate across a broad-front, such that managing for these species requires a landscape approach (Runge et al. 2015). Within these landscapes, conservation actions can be designed to abate threats and promote the habitat conditions that provide high-value habitat (Runge et al. 2015, Guo et al. 2024). To operationalize a landscape approach for migratory landbird site prioritization, we developed a geodatabase of sites for landbirds by dividing the FAC prioritization into 2,741 hexagonal cells of ca. 20,000 km^2 (hexses). Hexes that overlapped more than 25% with the landbird prioritization were considered candidate sites for AFI. This procedure resulted in 1,418 candidate hexes.

Step 3. Narrow the list of candidate sites using a list of migratory trigger species (AFI trigger species)

Since the focus of the Americas Flyways Initiative is the conservation of sites important for migratory birds across the Americas, we focused our species selection on species of conservation concern with medium and long-distance migration. We reviewed several continental bird conservation initiatives to compile a list of candidate shorebird and landbird species. Then we assessed their conservation status on lists from Road to Recovery, USFWS Birds of Conservation Concern, Partners in Flight Landbird Conservation Plan and the IUCN Red List. Finally, we assessed their migratory behavior. This procedure yielded a list of 51 trigger shorebird species (Appendix 2) and 61 trigger landbird species (Appendix 3). Detailed methods are in Appendix 4.

For both shorebird and landbirds, we compiled species population data of trigger species for each site (see Phase 2). Sites without reported occurrences of trigger species were removed from the list of eligible sites. 2,127 sites remained for shorebirds after the species filter was implemented (Figure 3). Site filtering for landbirds resulted in 1,375 hexes being selected. Results of Phase 1 are shown in a webmap to interactively access site and trigger species' population data.

Considering that austral species were not included in DeLucca et al. (2023) FAC prioritizations, we decided to add back all sites hosting austral species from our trigger species list, regardless of whether they were part of the FAC prioritizations or not. This added a total of 145 sites for shorebirds and 21 hexes for landbirds, for a total of 2,272 shorebird sites and 1,396 landbird sites.

Phase 2: Biological site prioritization

In Phase 1, we defined the conservation features (species) that our prioritization will be based on, as well as the pool of eligible sites for conservation work. Phase 2 consisted of the following steps:

Step 1. Compilation of population data

We used various sources of information to compile census or count data of the focal species at candidate sites. For count data we used eBird (Cornell Lab of Ornithology, 2022), the Global Biodiversity Information Facility (GBIF), BirdLife's World Bird Database (WBDB), Manomet's database on important shorebird sites in the Americas (Lesterhuis et al., 2022), as well as published counts (Appendix 5). We retrieved all occurrences of the focal species at candidate sites reported in these information sources up to December 31, 2022, regardless of the year they were recorded in. Subsequently, we performed a simple cleaning protocol for records derived from the open data platforms of GBIF and eBird. We eliminated duplicates and only included records approved and taken under area, stationary, traveling, and International Shorebird Survey (ISS) protocol types. Due to the considerable number of resulting records, we summarized the information by calculating the maximum counts per species, year, and site. Additionally, we considered all WBDB records on yearly or multi-year population estimates reported for candidate IBAs and all records compiled by Lesterhuis et al. (2022) to identify candidate potential WHSRN sites. All the resulting records were aggregated into a single table and associated with a candidate site so that each site had population estimates of AFI priority species.

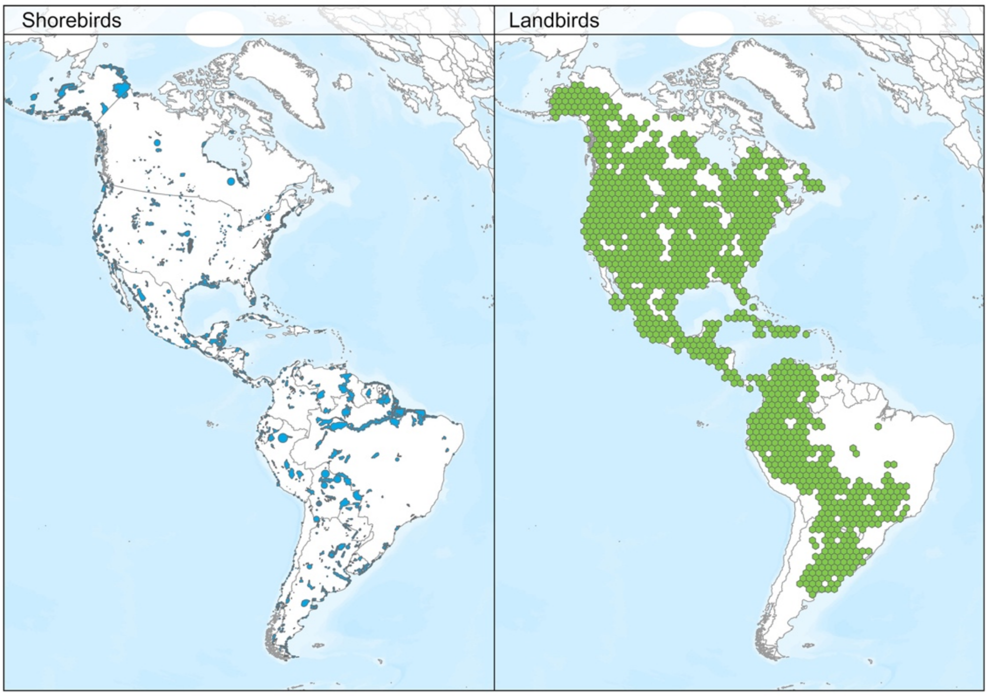

Figure 3. Sites with reported occurrences of shorebird and landbird trigger species that overlap with the full annual cycle prioritizations or include austral species.

To complement raw counts, we used 2021 data from the eBird Status and Trends models (ebirdst; Fink et al. 2021). We used 3km weekly raster files that were summarized to represent the percentage of the global population per pixel. We converted these values to population size by multiplying each sites' population percentages by the corresponding population size of each species using global population estimates from Andres et al. (2012), Rosenberg et al. (2019), and Wetlands International (2023; Appendix 6).

For the prioritization analyses, each shorebird site was assigned a single population estimate per species by taking the maximum across all available population estimates. Each estimate was assigned an annual cycle season (breeding, nonbreeding and passage) based on the site's location using BirdLife International range maps (BirdLife International and Handbook of the Birds of the World, 2021). For landbird hexes, we derived seasonal population estimates using the date ranges available in eBird for breeding, nonbreeding and passage (postbreeding and prebreeding migration). For the breeding and nonbreeding seasons, we took the maximum population size across each season for each pixel in ebirdst. For the passage season, we assumed a complete population turnover every two weeks and therefore summed population sizes every two weeks for the prebreeding and postbreeding migration periods for each pixel. We summed population estimates for all pixels within a hexscape to obtain species-season population estimates.

Since some bird populations maybe year-round residents, while other migratory (e.g. the Scissor-tailed Kite has year-round resident populations in South America while the northern populations are migratory), we removed population estimates for trigger species falling within or near each species' year-round populations. We used the bird species distribution maps of the world to perform this analysis (BirdLife International and Handbook of the Birds of the World, 2021). Hence, only migratory populations were considered for site prioritizations.

<u>Step 2. Site prioritization</u>

Following on the East Asian-Australasian Flyway Project, we implemented their three prioritization criteria (PC) to assess the condition and importance of eligible sites for bird conservation. We added irreplaceability as a fourth PC based on KBA criteria (IUCN, 2016).

PC1: Sum of population percentages. Corresponds to the sum of the percentwise global/hemispheric populations for all trigger species at a site (Eq. 1). When dealing with species having global distributions beyond the western hemisphere, we used total hemispheric population estimates to compute these percentages. The hemispheric population figures were obtained from Andres et al. (2012), Lanctot et al. (2010), and Morrison et al. (2006; Appendix 6).

$$PC_1 = \sum_i^N P_i \text{ (Equation 1)}$$

Where N is the total number of species and P is the percent of the global/hemispheric population of species i.

PC2: Number of species exceeding 1% global or hemispheric population thresholds (Eq. 2).

$$PC_2 = \sum_i^N (P_i > 1) \text{ (Equation 2)}$$

PC3: Number of threatened (critically endangered, endangered, and vulnerable) and near-threatened species.

PC4: Irreplaceability: the purpose of including irreplaceability as a prioritization criterion was to assess the complementarity of each site to achieve representation targets. A completely irreplaceable site (score = 100) will be always needed as part of a conservation portfolio that meets species representation targets, whereas sites with low irreplaceability (score = 0) can be easily replaced by others. We established a 10% representation target for all species in each season.

To compute irreplaceability, we used Marxan 2.43 (Ball et al. 2009). Marxan is a widely used systematic conservation planning software that allows users to solve the minimum set coverage problem, that is, to identify the set of areas needed to meet representation targets at the lowest cost. We used area as a proxy of cost but did not consider the status of each site (protected or unprotected) as AFI projects may include protected sites as part of its portfolio, for example, by improving management. Irreplaceability was calculated as the number of Marxan runs including a site, from a total of 100 runs.

Each PC was reclassified into three importance categories. For PC1-PC3, the low category is defined as values below the median (excluding 0), the medium category encompassed values between the median and the 90th percentile, and the high category includes values above the 90th percentile. PC4 was reclassified as low for values below 50, medium for values between 50-89, and high for values between 90 and 100.

After manual inspection of results, the SSTT established by consensus PC2 and PC4 as the key criteria for calculating an importance score for each site in the geodatabase. This score was determined by selecting the highest importance category between PC2 and PC4. As a result, an importance score was calculated for 1,368 shorebird sites and 1,264 landbird sites (Figure 4, Table 2).

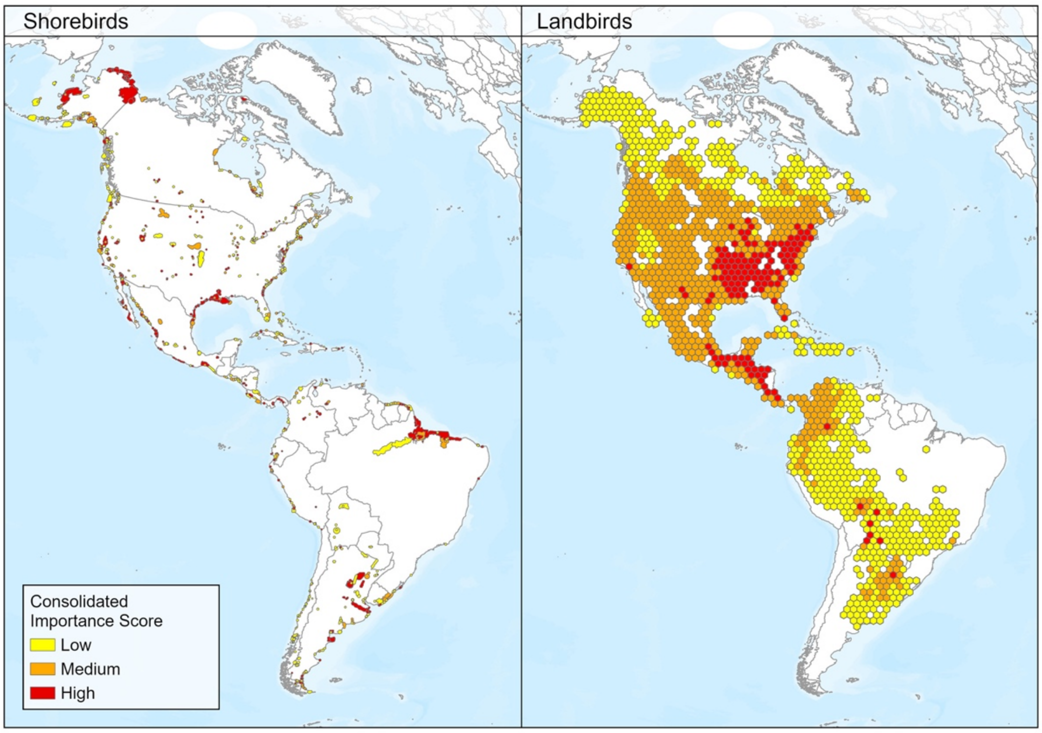

Figure 4. Consolidated Importance Score for shorebirds and landbirds.

Table 2. Criteria for conservation designations for shorebirds considered in the Americas Flyways Initiative.

	Prioritization criteria	Number of sites in low category	Number of sites in medium category	Number of sites in high category
Shorebirds	**PC1**	1,136	908	228
	PC2	548	271	173
	PC3	454	1,039	93
	PC4	394	126	219
	Consolidated Importance Score	670	322	376
Landbirds	**PC1**	698	558	140
	PC2	604	537	123
	PC3	725	350	132
	PC4	495	43	14
	Consolidated Importance Score	582	547	135

<u>Step 3. Initial AFI Site Conservation Portfolio</u>

To scope how many sites would be needed to meet the 10% species-season targets, we selected the Marxan run with the least cost for both shorebirds and landbirds. This was done to provide an estimation on the number of sites/areas needed to meet the targets as well as to explore emerging geographic patterns. We found that for shorebirds, 218 sites totaling 185,185 km^2 would be needed to meet the 10% target while for landbirds, 105 hexes totaling 2’045.985 km^2 would be needed (Figure 5).

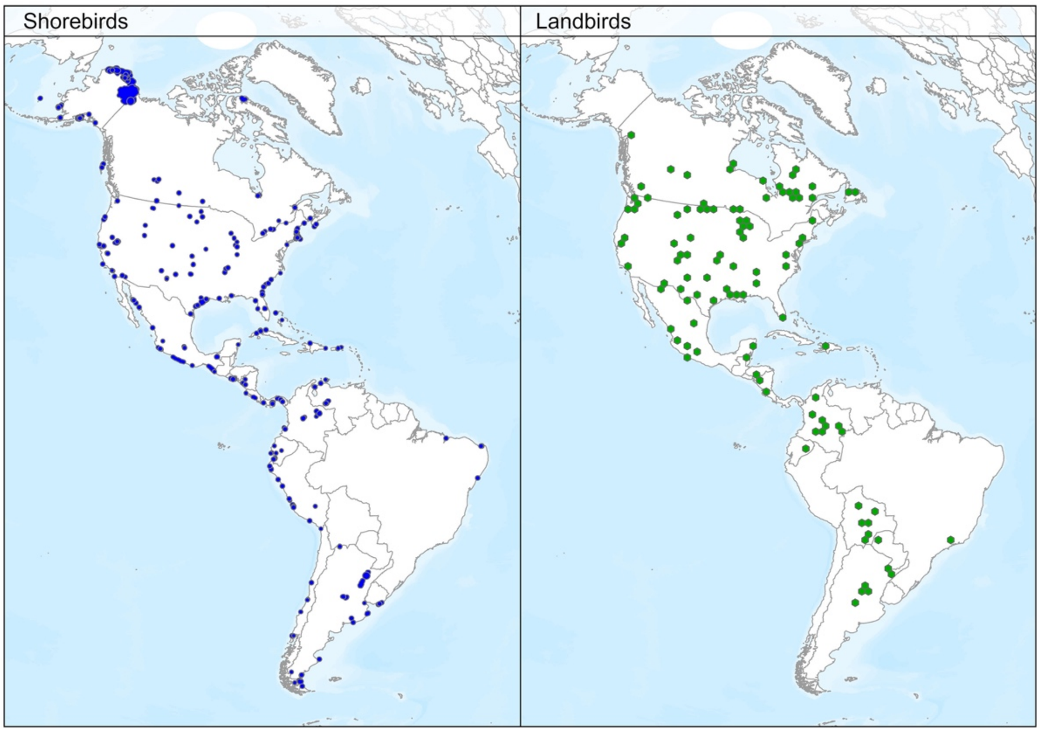

Figure 5. Initial AFI site portfolio for shorebirds and landbirds.

Phase 3: Threat assessment and project investment scoping

For the AFI, two main project types have been devised: bird-friendly infrastructure and nature-based solutions. To determine the potential project types and concepts for eligible sites, we assessed their existing and anticipated threats using global or regional GIS data. The following associations were considered in identifying potential project concepts (Table 3).

Table 3. Potential projects investment concepts according to threats.

Project type	Project investment concept	Threats (IUCN scheme)	GIS datasets
Bird friendly infrastructure	Linear infrastructure	4.1. Roads and railroads 4.2. Utility and service lines	• Highways, primary and secondary roads (Meijer et al., 2018). • Powerlines (Arderne et al., 2020). • Oil and gas pipelines (Homeland Infrastructure Foundation-Level Database, 2019; Sabbatino, 2018).
	Urban infrastructure	1. Residential and commercial development	• Built-up land cover (Zanaga et al., 2022). • Light pollution (Elvidge et al., 2021).

	Safe access to water, sanitation and irrigation	7.2. Dams and water management/use 9.1. Domestic and urban waste water 9.3. Agricultural and forestry effluents	• Low water quality (Vörösmarty et al., 2010). • Surface water management (Grill & Lehner, 2019; Vörösmarty et al., 2010).
	Green energy	3.3 Renewable energy	• Current solar farms (Global Energy Monitor, 2023). • Current wind turbines (Dunnett et al., 2020; Hoen et al., 2018). • Susceptibility to future solar and wind renewable energy development (Oakleaf et al., 2020).
Nature based solutions	Coastal management for resilience	11.1 Habitat shifting & alteration 11.4 Storms & flooding	• Coastal disturbance (Smith et al., 2022). • Coastal modification (Smith et al., 2022; Venter et al., 2018). • Sea level rise (Smith et al., 2022).
	Habitat protection under potential crop expansion	2.1 Annual & perennial non-timber crops	• Susceptibility to future agricultural development (Oakleaf et al., 2020).
	Improved management or restoration within protected areas	2.1 Annual & perennial non-timber crops 2.3 Livestock farming & ranching	• Agricultural and grassland covers (Zanaga et al., 2022).
	Potential for restoration outside protected areas	2.1 Annual & perennial non-timber crops 2.3 Livestock farming & ranching	• Agricultural and grassland covers (Zanaga et al., 2022).
	Conservation of natural habitats outside protected areas		• Forest, herbaceous wetland and mangrove land cover (Zanaga et al., 2022).
	Sustainable agriculture	2.1 Annual & perennial non-timber crops	• Agricultural cover (Zanaga et al., 2022).
	Sustainable aquaculture	2.4 Marine & freshwater aquaculture	• Aquaculture in Brazil, Ecuador, El Salvador, Honduras, Mexico, and Nicaragua (Clark Labs, 2022).
	Sustainable cattle ranching	2.3 Livestock farming & ranching	• Rangeland cover (Zanaga et al., 2022).

Based on the information in this table, we recommend implementing project investment concepts at each site, taking into account the various threats to birds. For each site, we measured the presence and exposure (percentage of the site area impacted) of agriculture, aquaculture, built-up areas, rangelands, and roads. All other threats were assessed solely in terms of presence/absence due to the resolution of existing hemispheric GIS datasets. In this analysis, it is crucial to note that we considered rangelands as a potential threat associated with cattle ranching, with some of these being natural native grasslands and others being modified ecosystems. This was a conservative approach to ensure that all livestock management areas were included. However, to mitigate the overestimation of rangelands in tundra ecosystems across Canada, Alaska, and Greenland, we excluded the grassland area that was not included in the livestock management map produced by Smith et al. (2022). Finally, to incorporate species-specific data into this assessment, we gathered information on threats affecting the AFI trigger species (Appendix 7) from the IUCN Red List assessments, Smith et al. (2022) and Birds of the World (2022). For each site, we only considered threats that impacted AFI trigger species.

According to the presence analysis, the most frequent threats are built-up areas, roads, and rangelands, being present in 86%, 81%, and 80% of the eligible sites, respectively (Figure 6). In contrast, solar farms, coastal modification, and aquaculture were the threats with the lowest presence percentage in eligible sites (31%, 23%, and 3%). Note that our estimation of prevalence of aquaculture in eligible sites is limited by the fact that we only had geographic information for 6 countries. Regarding exposure, we estimated that rangelands cover approximately 18% of the area of eligible sites, while croplands cover around 10% (Figure 6). As a result, and considering the alignment between threats and project concepts, bird-friendly infrastructure, sustainable cattle ranching, and restoration of rangelands emerge as the predominant potential investments in our analysis.

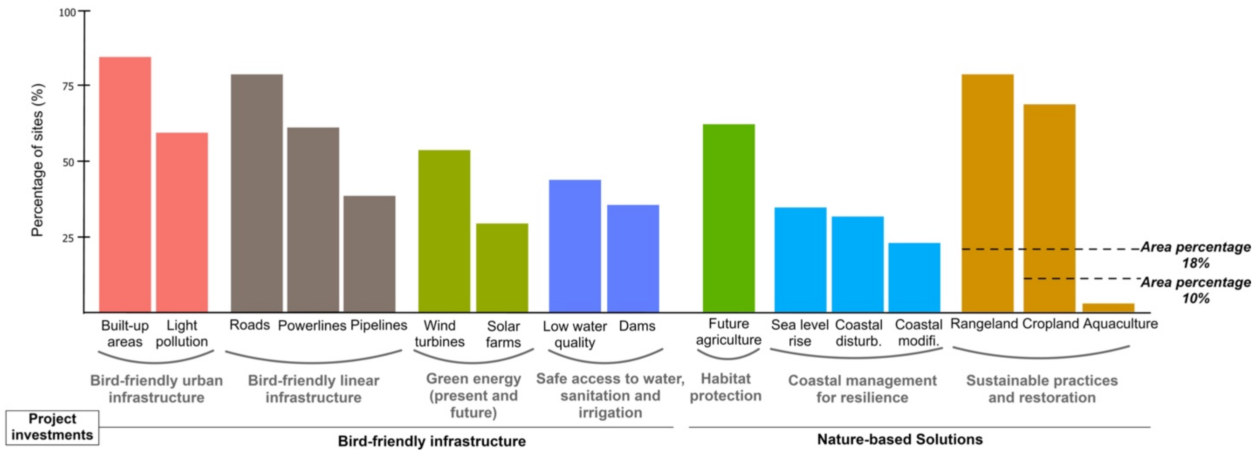

Figure 6. Threat presence and exposure in eligible sites for shorebirds and landbirds.

AFI site selection and assessment tool

We developed an online mapping application that allows users to easily access and visualize the results of the analysis. The application features two tabs, one for shorebirds and the other for landbirds. Each tab includes a dashboard with general information, such as the number of eligible sites and their distribution across different importance categories or countries. The tabs also feature an interactive map showcasing all sites (candidate, eligible, initial portfolio) with tools for searching specific locations, toggling layers, and adding user polygons without saving them online. Users can select a site on the map to query related tables, including:

- Site information: Site ID or name, country, count of AFI trigger species, area, and conservation designation (for shorebirds).

- Species: List of AFI trigger species recorded along with their highest counts, percentage of global population, and data source.
- Threats: List of threats impacting AFI species, assessed by exposure or presence (Table 3).
- Potential project investments: Suggested project investment concepts based on the threats impacting AFI species (Table 3).
- Other threatened biodiversity: List of vulnerable, endangered, or critically endangered mammals, amphibians, reptiles, and non-AFI priority birds, determined using IUCN species distributions (IUCN, 2023).
- Carbon stocks: Aboveground and belowground carbon stocks obtained from Spawn & Gibbs (2020).
- Additional comparisons: Spatial relationship with present and future climate strongholds in the US (Bateman et al., 2021), protected areas (UNEP-WCMC & IUCN, 2023), Important Bird Areas (IBAs; BirdLife International, 2022), indigenous and community lands (LandMark, 2017), and the relative deprivation index (CIESIN, 2022).
- Land cover: Distribution of land cover at the site based on Zanaga et al. (2022).

Glossary

Candidate sites: for shorebirds, these are sites that fall under any of the conservation designations in Table 1 and that either 1) overlap with FAC priorities for waterbirds (DeLuca et al. 2023) and have at least 1 AFI trigger boreal species or 2) have at least 1 austral AFI species. For landbirds, these are hexes that either 1) overlap with FAC priorities for waterbirds (DeLuca et al. 2023) and have at least 1 AFI trigger boreal species or 2) have at least 1 austral AFI species.

Eligible sites: are sites that meet the conditions for being candidate sites and whose PC2 or PC4 score is greater than 0.

Initial portfolio: is the set of eligible sites that would meet the 10% global population representation target for AFI species at the minimum cost, using area as the cost unit. Shorebirds and landbirds have separate initial portfolios.

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