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Species monitoring recommendations for Niumi Saloum National Park (the Gambia) and Delta du Saloum National Park (Senegal)

ENGLISH

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IUCN Global Species Programme

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Species monitoring recommendations for Niumi Saloum National Park (the Gambia) and Delta du Saloum National Park (Senegal), prepared by Jamie Carr, with funding from Global Environment Facility (GEF) via UNEP.

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Executive Summary

This report is one in a series of five, and presents recommendations for strategies to monitor the impacts of climate change on species at Niumi National Park and Delta du Saloum National Park, which are found in the Gambia and Senegal, respectively.

The development of these recommendations followed a three-step process:

1. The application of IUCN's climate change vulnerability assessment framework to all terrestrial and freshwater vertebrates of the West Africa region, to determine those species that are likely to be most vulnerable to climate change.
2. A GIS-based analysis, combining spatially explicit data on species' ranges (from the IUCN Red List) and protected areas (from the World Database of Protected Areas, or WDPA) to derive estimated species lists for the sites of interest.
3. A consultation with species experts with good knowledge of the site, wherein they were presented with the results from the above two steps and asked to provide specific monitoring recommendations based upon these.

The main recommendations given were as follows:

Being a predominantly coastal and estuarine site, no specific amphibian species were recommended for monitoring. Nevertheless, given that the site still supports some freshwater habitats (e.g. freshwater lagoons, freshwater marshes, seasonal marshes), and as amphibians are known to be excellent bio-indicators, it was suggested that some monitoring should occur, perhaps at the community level.

Bird species recommended for monitoring were *Haematopus ostralegus, Larus genei,* and multiple common seabirds and waterbirds (e.g. *Hydroprogne caspia*; *Larus cirrocephalus*; *L. genei*). There has been ongoing monitoring of the colonial breeding seabirds at these sites for nearly two decades, providing a great foundation for future monitoring. Moreover, the International Waterbird Census (IWC) is one of the longest-running biological monitoring programmes, and has been conducting fairly regular monitoring here for several years.

Fish species recommended for monitoring included *Pronothobranchius kiyawensi a*nd Grey Mullets (Family: Mugilidae), though the presence of Grey Mullets at the site require confirmation. Nevertheless, recommendations were generally for monitoring at the community level.

Mammal species suggested as candidates for monitoring included the West African Manatee (*Trichechus senegalensis*) and the bat species *Eidolon helvum*, *Hipposideros rubber* and *Lavia frons.*

For reptiles, it was recommendation to monitor the Green Turtle (*Chelonia mydas*).

Typically, recommendations for all groups included monitoring (in combination with the monitoring of relevant climatic factors) the availability (i.e. abundance and phenology) and quality of key habitats and microhabitats. As this site is predominantly coastal and estuarine in nature, the monitoring of factors such as salt intrusion and salinity levels of freshwater habitats is a priority.

For aquatic habitats and species, the monitoring of factors such as flow rates and dissolved oxygen was also recommended.

This report also provides some more generic recommendations on developing monitoring schemes, including on the setting of objectives, the monitoring of climatic factors, and consideration of the timescales required in order to identify species' population trends and to determine whether these are attributable to climatic factors or are simply natural fluctuations. We also urge those developing species monitoring schemes to consider other factors, such as whether there is already a monitoring scheme in place; whether it is better to monitor one, several or many species; whether there are confounding factors (e.g. human hunting) which may disguise or falsely implicate the impacts of climate change; and whether or not the species proposed for monitoring is sufficiently observable to detect a population trend. For those wishing to develop a monitoring scheme for one or more bird species, additional information on the practicalities of doing so, provided by BirdLife International, is presented as an appendix.

1. Introduction

This report presents recommendations for strategies to monitor the impacts of climate change on species at five transboundary pilot sites across the focal region of West Africa.

This report is one in a series of five, each considering one of the five focal transboundary sites. Here we specifically consider Niumi and Delta du Saloum National Parks (hereafter NDSNP), which are adjacent and occur in the Gambia and Senegal, respectively. The report contains information on the methods used to identify the species most vulnerable to climate change at both the regional and site scales, and presents results specific to the focal site. It also describes the methods and results of the consultation process used to identify species (or species groups) considered to be best suited and/or the greatest priorities for the monitoring of climate change impacts within NDSNP.

Prior to this, we present information on the importance of monitoring species in the context of climate change.

The importance and basics of species monitoring under climate change

It is now widely accepted that rapid, anthropogenic climate change is having, and will continue to have, impacts on biodiversity. Although in some cases certain (typically more generalist) species may benefit from climate change, for many other species climate change will present a new threat, which could either act alone or in combination with existing threats to increase the risk of local or global extinction (Urban 2015). The general consensus among experts and the relevant literature is that the impacts of climate change on biodiversity (and the societies that depend on it) will be predominantly negative (Bellard *et al.* 2012).

Within their current ranges, some species may experience one or more of the following as a result of climate change: changes to their habitats or microhabitats; changes of environmental factors beyond tolerable thresholds; disruptions to important interspecific interactions (e.g. the loss of an important prey item, pollinator etc.); the emergence or increase of novel, negative interspecific interactions (including by humans); the disruption of important environmental cues or triggers and/or increases in the frequency of localised extinctions due to stochastic events (Foden *et al.* 2013). Species that are sensitive to such changes (and are exposed to significant climatic change in the first place) might be expected to respond in one of two ways: (1) to disperse to areas where the environment is more suitable, or (2) to adapt to change *in-situ* through genetic or behavioural microevolution. Species that are unable to respond in such a way (e.g. due to low genetic variability, low reproductive output, the presence of barriers that prevent dispersal and/or a low intrinsic capacity for dispersal) are those species that are considered to be the most vulnerable to climate change (Foden *et al.* 2013).

Biodiversity monitoring is widely conducted across the world as a means to detect changes in natural systems, and to assess the requirements and effectiveness of management actions. There is now an increasingly urgent need to monitor the impacts of climate change on species, so that managers may respond to this emerging threat in the most timely and effective manner.

In many cases, the monitoring of climate change impacts on biodiversity (and particularly of individual species) can and should build upon existing monitoring schemes. Nevertheless, certain additional steps and considerations must be made when developing a monitoring strategy to specifically look at climate change impacts. Although it is beyond the scope of this report to lay out the specifics of a monitoring strategy (though suggestions for further reading on this topic are provided at the end of the document), here we remind the reader of a few additional key points that are specific to monitoring in a climate change context:

1) It is essential to monitor over a long time period (ideally spanning several decades) as effects may only be detectable over many years (Yoccoz *et al.* 2001).
2) In addition to monitoring biodiversity, it is essential to monitor the actual climate. In some cases such data may be available from long-term weather stations, although one must remain aware of the uncertainties associated with these data, and particularly when making inferences about trends at locations farther away and/or at finer scales (e.g. at the microhabitat level). The ideal protocol is to monitor weather and climate at the exact location where any biodiversity sampling takes place, although this will often be highly restricted by the availability of resources and expertise.
3) Any monitoring effort needs to set its objectives prior to developing the sampling protocol, as the former will greatly influence the latter. Similarly, the sampling protocol (and anticipated analyses) should be clearly stated so that they can be implemented consistently by multiple people, as will typically be required over such a long timeframe.
4) When selecting the species (or species groups) that will form the subject of the monitoring strategy, several key considerations should be borne in mind:
    a. Is there already a monitoring scheme in place, which could be adapted to consider climate change? Making use of long term data sets can provide indication of trends much more rapidly than when setting out anew. However, do take time to consider the sampling protocol used (and whether it is appropriate) as well the other points that follow in this section.
    b. Should I monitor one, several or many species? It is generally little more work, and much more powerful, to monitor all (sufficiently common) species using whichever technique is chosen, rather than a subset of pre-selected species. Moreover, we encourage a holistic assessment of biodiversity trends wherever possible.

Nevertheless, the following point describes why certain species could provide a misleading impression of how climate change is (or is not) having an impact. As such we do also recommend that specific attention is paid to species which are already suspected to be vulnerable to climate change, and for which there are no (or few) confounding factors (e.g. non-climatic threats) at work.

c. Are there any other factors at work that may disguise the impacts of climate change? For species that are already subject to ongoing, non-climatic pressures (e.g. human collection, pollution etc.), it may not be possible to determine the significance of additional pressures arising from climate change. As such, it is desirable to aim to monitor species that are otherwise unaffected. Where one wishes to focus upon a species that is already threatened, then it may be possible to focus efforts on a sub-population of the species which is stable and not subject to any other threats.

d. Is my focal species sufficiently observable to detect a population trend? Species that are not readily detected, perhaps because they are cryptic and/or rare, will not make good monitoring subjects as they will not provide sufficient data to detect a change in distribution or population. Managers should aim to focus on species that are sufficiently common and observable to provide a useful dataset.

2. Description of a transboundary site

Niumi National Park was established in 1986 and covers 7,758 ha from Barra at the mouth of the River Gambia. It encompasses Jinack Island and is a natural extension of the Saloum Delta National Park.

The Saloum Delta National Park was established in 1976. It is located in the central West of Senegal in the Sine Saloum natural region. It covers 76,000 ha and was established as a biosphere reserve in 1981 and recognized as a wetland of international importance (Ramsar site) in 1984.

The two national parks form a complex classified as a wetland of international importance since 2008. A protocol of agreement between The Gambia and Senegal for the transboundary management of protected areas, known as the Jinack Protocol, which specifically applies to the Niumi-Saloum transboundary site, was signed in 2001. A transboundary management plan for the Niumi-Saloum complex has also been created in October 2010 and will be updated as part of the PARCC project to take into account climate change aspects.

3. Traits-based vulnerability assessments

In a process led by the International Union for Conservation of Nature's Global Species Programme (IUCN-GSP), almost all terrestrial and freshwater vertebrates of the West Africa region were assessed in terms of their vulnerability to climate change (see Carr *et al.* 2014 for the full report). Through two expert workshops, remote consultations, and using data available from previous projects, biological and ecological trait data were collated for 183 amphibians, 1,172 birds, 517 freshwater fish, 405 mammals and 307 reptiles. These data were used to infer, for each individual species, 'sensitivity' and 'adaptive capacity' to climate change and its impacts. Species distribution polygons, collated through the process of assessing species for the IUCN Red List of Threatened Species™, were overlaid with future climate projections provided by the UK Met Office Hadley Centre to determine the changes in the means and variability of temperature and precipitation that each species may be exposed to. Species that are both sensitive and poorly able to adapt to climate change, and are among the most severely exposed to climatic changes are described as 'climate change vulnerable'.

These data were used to derive estimates of the levels of species vulnerability at each site (see Table 1), as well as to guide experts on the selection of species for the monitoring strategy, as described in section 5.

Results for NDSNP

Using species distribution polygons collected through the assessment process for IUCN's Red List, in combination with a polygon representing the geographic boundaries of NDSNP, it was possible to derive a list of species considered likely to occur at the site. It is important to note that this list, which is presented as Appendix 1 at the end of this report, is likely to both include and omit species that may or may not actually occur at the site, due to the imprecise nature of the input spatial data. Nevertheless, it was widely agreed that this method of deriving species lists for each site was the best approach available, given the poor availability of alternative data sources and/or methods, and the wide taxonomic scope that we wished to consider.

The total numbers of species from each of the five taxonomic groups estimated to occur at the NDSNP is presented in Table 1. This table also presents, for each taxon, the number of species considered to be climate change vulnerable, as well as the number of species deemed to be 'biologically susceptible' to climate change (i.e. considered both sensitive and poorly able to adapt to climate change, but not necessarily expected to be exposed to large changes). It is important to note that the measures of overall vulnerability presented in this table are relative to all other species considered in the wider, regional assessment, while measures of biological susceptibility are not.

Table 1. Numbers of species, including climate change vulnerable and biologically susceptible species, estimated to occur at NDSNP.

Taxon	Estimated number of species	Estimated number of climate change vulnerable species	Estimated number of biologically susceptible species
Amphibians	25	3	4
Birds	453	71	90
Freshwater Fish	51	8	15
Mammals	94	4	12
Reptiles	62	6	17

5. Expert consultations

In order to gather suggestions and recommendations for a climate change monitoring strategy, we consulted a wide range of local and international experts. More than 200 experts were approached, and a response rate of just over 10 percent was received (noting that some individuals) opted to provide feedback following internal, group consultations). Experts were provided with three documents (all prepared in both French and English):

- The original, regional assessment report (Carr *et al.* 2014), which provides background information on the methods used to assess climate change vulnerability at the regional level.
- Lists of species derived for each of the five pilot sites, including indication of the specific vulnerability traits relevant to each species.
- A form on which to provide suggestions of candidate species for monitoring, as well as other comments and suggestions. This form requested three main types of information:
    - The name of the species (or species group) proposed.
    - Justification of why the species (or group) is considered a good and/or important species for monitoring under climate change.
    - A brief description of how the monitoring should be conducted.

The remainder of this document provides a summary of the feedback received, which was either specific or relevant to the NDSNP.

6. Expert recommendations

Table 2 contains the species-specific monitoring recommendations provided by experts through our consultation process.

Table 2. Monitoring recommendations for the NDSNP gathered through expert consultations

Taxon	Species	Taxonomic notes	Monitoring recommendations
Amphibians	No specific species recommended	Although a predominantly coastal and estuarine site, amphibians are still found in the NDSNP's freshwater habitats (e.g. freshwater lagoons, freshwater marshes, seasonal marshes). Amphibians can provide good indication of the quality of the freshwater habitats of the site, particularly in terms of intrusion by saline waters as a result of storms and/or sea level rise.	Amphibian communities and populations within the site should be noted and monitored in terms of their location, community structure and species abundances. Monitoring should aim to assess whether the above factors are being affected by salt intrusion in freshwater habitats, which necessitates the recording of salinity levels. The monitoring of other factors relating to habitat quality (e.g. pollution) will help to partition the effects of other, possibly confounding, factors, and may also provide insights into other ways that climate change is impacting habitat quality.

Taxon	Species	Taxonomic notes	Monitoring recommendations
Birds	*Haematopus ostralegus, Larus genei*, and multiple common seabirds and waterbirds (e.g.*Hydroprogne caspia;Larus cirrocephalus; L. genei)*	This site is an important breeding area for a number of seabirds / waterbirds, and most of the monitoring recommendations relate to these. There has been ongoing monitoring of the colonial breeding seabirds at SDSNP for nearly two decades, providing a great foundation for future monitoring. Many of the tern and gull species present here depend on a network of uninhabited sandy islets, all of which are vulnerable to destruction by waves and, in particular, rising sea levels. The International Waterbird Census (IWC) is one of the longest-running biological monitoring programmes, and has been conducting fairly regular monitoring at NSDNP for several years. Data are managed by Wetlands International	Monitoring should aim to build upon the aforementioned existing schemes. Particular attention should be paid to the effects of rising sea levels and storm severity/frequency on the presence and quality of sandy islets and coastal mudflats, as well as on the effects of increased seawater intrusion into other estuarine and freshwater habitats. Some work has already been done on monitoring species' diets (e.g. by collecting and identifying fish otoliths from tern and gull 'nests'), which can provide an excellent indication of the changing availability of marine surface fishes. Continuation of this work is encouraged. Further general information on the practicalities of monitoring of birds under climate change is available in Appendix 2 (Guidance for monitoring birds in West African Protected Areas under Climate Change).
Fish	Estuarine and freshwater fish communities, with possible focus on *Pronothobranchius kiyawensis.* Grey mullets (Family: Mugilidae). Two species are thought to occur at the site: *Chelon labrosus* and *Liza saliens*.*	Estuarine and freshwater fish (and the aquatic systems that they inhabit) are believed to be highly sensitive to climate change, and although such sensitivity can vary between species, the group is typically better suited to monitoring at the community level, giving focus to key habitats. Nevertheless, *P. kiyawensis* is a climate change vulnerable species and should receive particular attention, as it is regularly seen during more	In combination with monitoring of climatic factors (temperature and precipitation), the availability (i.e. abundance) and quality of key habitats and microhabitats for fish should be monitored. The monitoring of additional variables, such as salinity and levels of dissolved oxygen, will also provide insights into the quality of aquatic habitats. Efforts should focus on key habitats and microhabitats, and areas that are susceptible to becoming intermittently dry, as well as shallow areas important

Taxon	Species	Taxonomic notes	Monitoring recommendations
	*As these species are considered predominantly marine, they were not included in our vulnerability analyses, nor in the lists provided to experts.	general freshwater surveys, and is easily identifiable.	for spawning and/or juvenile development, should form priorities for monitoring. Regular sampling at these locations should monitor the overall diversity of fish communities, as well as the relative abundances of the species present. The distribution of Grey Mullets should be monitored along the river course, as they are expected to move further up the river as salt water intrudes and conditions become more saline.
Mammals	*Trichechus senegalensis* Bats: *Eidolon helvum, Hipposideros ruber, Lavia frons*	The West African Manatee (*T. senegalensis*) is an iconic aquatic mammal, which is considered threatened on the IUCN Red List (Powell and Kouadio 2008). Threats include, among others, climate change in the form of droughts, temperature extremes, storms and flooding (which can leave the animals stranded). This species is also sensitive to increases in salinity, which can result in animals dispersing to new locations. Bats are good candidates for the monitoring of climate change impacts, particularly as they are often easily surveyed, sensitive to environmental change and typically subject to less additional pressures than other mammals. Of particular note is the ongoing activities of the Eidolon Monitoring Network, which has responded to suggestions of Newson et al. (2009) that *E.*	*T. senegalensis*: In combination with climatic and other environmental factors (e.g. salinity), the abundance of this species at the site should be monitored. Records should be kept of any strandings of this species to assess whether such events are becoming more frequent as a result of climate change. Bats: In combination with monitoring of climatic factors (temperature and precipitation), the availability (i.e. abundance) of habitats and microhabitats suitable for this species should be monitored, as should the abundance of the species within them. Across the site, habitat data should be collected in order to define present habitat types, as well as population trends. Records on the flowering and fruiting times of important food species should also be kept, as they may provide insights into the reason for any population or phenological trends observed. Implementers of the monitoring strategy are encouraged to liaise with the

Taxon	Species	Taxonomic notes	Monitoring recommendations
		helvum is an especially good indicator of the impacts of climate change on migratory species.	Eidolon Monitoring Network to develop a robust database.
Reptiles	*Chelonia mydas** *As this is a marine species, it was not included in our vulnerability analysis, nor in the lists provided to experts.	Marine turtles are among the most vulnerable animal groups to climate change. Rising sea levels could reduce the availability of their beach nesting habitats, while increased egg incubation temperature may influence population gender ratios (leading to increases in the proportion on males in the population).	In combination with the monitoring of sea levels, and intrusion of seawater, it is desirable to monitor the nesting activity and success of this species. If possible, it would also be desirable to monitor the male to female ratios of hatchlings of this species, to determine whether this is being impacted by rising temperatures.

7. Suggested additional reading

Bibby *et al.* (2000) Bird Census techniques (2nd ed). Academic Press, London.

Davies*et al.*(eds.) (2002) African Forest biodiversity: a field survey manual for vertebrates. Earthwatch Europe. [Available here]

Lepetz *al.* (2009) Biodiversity monitoring: some proposals to adequately study species' responses to climate change. *Biodiversity and Conservation*18 (12): 3185-3203. [Available here]

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Carr*et al.* (2014) A Climate Change Vulnerability Assessment of West African Species. UNEP-WCMC technical report.

Foden *et al.* (2013) Identifying the World's Most Climate Change Vulnerable Species: A Systematic Trait-Based Assessment of all Birds, Amphibians and Corals. *Plos One*. DOI: 10.1371/journal.pone.0065427

IUCN (2015) The IUCN Red List of Threatened Species. Version 2014.3.

Newson *et al.* (2009) Indicators of the impact of climate change on migratory species, Endangered species research 7 (2): 101-113.

Powell and Kouadio (2008) *Trichechus senegalensis*. The IUCN Red List of Threatened Species. Version 2015.1. <www.iucnredlist.org>.

Urban (2015) Accelerating extinction risk from climate change. *Science* 348 (6234): 571-573.

Yoccoz*et al.* (2001) Monitoring of biological diversity in space and time. *Trends in Ecology and Evolution* 16: 446–453.

Appendix 1. Species lists for Niumi and Delta du Saloum National Parks

The following tables present species lists derived for the NDSNP using IUCN Red List species distribution maps and digital boundaries of the site. Tables include information on the threat status of each species according to the IUCN Red List of Threatened Species (IUCN 2014) and information on the perceived climate change vulnerability of each species according to the biological traits presented in Carr *et al*. (2014). Empty cells infer that a species is not sensitive, climate change vulnerable etc. We encourage making reference to Carr *et al.* (2014) in order to gain further information on the species traits investigated, and to gain a full understanding of the assessments process applied. Note that a question mark in the final columns of any of the following tables indicates that this species has undergone a taxonomic change since the original assessment, meaning that trait data are either not available or no longer valid. Finally, it should be noted that these lists are estimates based on desk-based GIS analyses, and should not be considered as exhaustive or complete. At best, we hope that they provide a reasonable indication of the species that are likely to occur at the focal site.

Amphibians

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Afrixalus vittiger	LC	Yes	Yes	
Afrixalus weidholzi	LC	Yes	Yes	Yes
Amietophrynus regularis	LC	Yes		
Amietophrynus xeros	LC	Yes		
Bufo pentoni	LC	Yes		
Hemisus marmoratus	LC	Yes		

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Hildebrandtia ornata	LC	Yes		
Hoplobatrachus occipitalis	LC			
Hylarana galamensis	LC	Yes		
Hyperolius nitidulus	LC			
Hyperolius occidentalis	LC		Yes	
Kassina senegalensis	LC	Yes		
Leptopelis viridis	LC	Yes		
Phrynobatrachus francisci	LC	Yes	Yes	Yes
Phrynobatrachus latifrons	LC			
Phrynobatrachus natalensis	LC			
Phrynomantis microps	LC	Yes		
Ptychadena bibroni	LC	Yes		
Ptychadena oxyrhynchus	LC	Yes		
Ptychadena pumilio	LC	Yes		
Ptychadena schillukorum	LC	Yes		
Ptychadena tournieri	LC	Yes		
Ptychadena trinodis	LC	Yes	Yes	Yes
Tomopterna cryptotis	LC	Yes		
Xenopus tropicalis	LC			

Birds

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Accipiter badius	LC		Yes	
Accipiter erythropus	LC	Yes	Yes	Yes
Accipiter melanoleucus	LC		Yes	
Accipiter ovampensis	LC		Yes	
Acrocephalus arundinaceus	LC			
Acrocephalus schoenobaenus	LC	Yes		
Acrocephalus scirpaceus	LC	Yes		
Actitis hypoleucos	LC		Yes	
Actophilornis africanus	LC			
Alcedo quadribrachys	LC	Yes		
Alopochen aegyptiaca	LC		Yes	
Amadina fasciata	LC	Yes		
Amandava subflava	LC			
Anas acuta	LC	Yes	Yes	Yes
Anas crecca	LC	Yes	Yes	Yes
Andropadus virens	LC		Yes	
Anhinga rufa	LC		Yes	
Anthoscopus parvulus	LC		Yes	
Anthreptes collaris	LC			
Anthreptes gabonicus	LC	Yes	Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Anthreptes longuemarei	LC		Yes	
Anthreptes platurus	LC		Yes	
Anthus campestris	LC	Yes		
Anthus cervinus	LC		Yes	
Anthus leucophrys	LC			
Anthus trivialis	LC	Yes		
Apalis flavida	LC			
Apus affinis	LC		Yes	
Apus apus	LC	Yes	Yes	Yes
Apus caffer	LC		Yes	
Apus pallidus	LC	Yes	Yes	Yes
Aquila rapax	LC		Yes	
Aquila spilogaster	LC		Yes	
Ardea alba	LC		Yes	
Ardea cinerea	LC		Yes	
Ardea goliath	LC		Yes	
Ardea melanocephala	LC		Yes	
Ardea purpurea	LC		Yes	
Ardeola ralloides	LC		Yes	
Arenaria interpres	LC		Yes	
Asio capensis	LC		Yes	
Aviceda cuculoides	LC	Yes	Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Aythya ferina	LC	Yes	Yes	Yes
Aythya fuligula	LC	Yes	Yes	Yes
Aythya nyroca	NT	Yes	Yes	Yes
Balearica pavonina	VU (A4bcd)		Yes	
Batis senegalensis	LC		Yes	
Bostrychia hagedash	LC		Yes	
Botaurus stellaris	LC	Yes		
Bradornis pallidus	LC			
Bubalornis albirostris	LC			
Bubo lacteus	LC		Yes	
Bucorvus abyssinicus	LC	Yes	Yes	Yes
Bulweria bulwerii	LC		Yes	
Buphagus africanus	LC			
Burhinus capensis	LC		Yes	
Burhinus senegalensis	LC		Yes	
Butastur rufipennis	LC		Yes	
Buteo auguralis	LC	Yes	Yes	
Buteo buteo	LC	Yes	Yes	Yes
Butorides striata	LC			
Bycanistes fistulator	LC	Yes	Yes	Yes
Calherodius leuconotus	LC		Yes	
Calidris alba	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Calidris alpina	LC	Yes	Yes	Yes
Calidris canutus	LC		Yes	
Calidris ferruginea	LC		Yes	
Calidris minuta	LC		Yes	
Calidris pugnax	LC	Yes	Yes	
Calidris temminckii	LC		Yes	
Calonectris diomedea	LC		Yes	
Camaroptera brachyura	LC			
Camaroptera chloronota	LC	Yes	Yes	Yes
Campethera abingoni	LC			
Campethera maculosa	LC	Yes		
Campethera nivosa	LC	Yes	Yes	Yes
Campethera punctuligera	LC			
Caprimulgus climacurus	LC		Yes	
Caprimulgus europaeus	LC	Yes	Yes	Yes
Caprimulgus inornatus	LC		Yes	
Caprimulgus longipennis	LC		Yes	
Caprimulgus ruficollis	LC	Yes	Yes	Yes
Catharacta skua	LC		Yes	
Centropus senegalensis	LC			
Ceryle rudis	LC			
Charadrius alexandrinus	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Charadrius dubius	LC			
Charadrius hiaticula	LC	Yes	Yes	
Charadrius marginatus	LC		Yes	
Charadrius pecuarius	LC		Yes	
Chelictinia riocourii	LC	Yes	Yes	Yes
Chlidonias hybrida	LC		Yes	
Chlidonias leucopterus	LC		Yes	
Chlidonias niger	LC	Yes	Yes	Yes
Chlorocichla flavicollis	LC		Yes	
Chrysococcyx caprius	LC			
Chrysococcyx klaas	LC			
Ciconia abdimii	LC		Yes	
Ciconia ciconia	LC	Yes	Yes	Yes
Ciconia nigra	LC	Yes	Yes	Yes
Cinnyricinclus leucogaster	LC			
Circaetus beaudouini	VU (A2bcd+3bcd+4bcd;C1+2a (ii))	Yes	Yes	Yes
Circaetus cinerascens	LC		Yes	
Circaetus cinereus	LC		Yes	
Circaetus gallicus	LC	Yes	Yes	Yes
Circus aeruginosus	LC	Yes	Yes	Yes

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Circus macrourus	NT	Yes	Yes	Yes
Circus pygargus	LC	Yes	Yes	Yes
Cisticola aridulus	LC	Yes		
Cisticola brachypterus	LC			
Cisticola cantans	LC			
Cisticola erythrops	LC			
Cisticola galactotes	LC			
Cisticola guinea	LC			
Cisticola juncidis	LC			
Cisticola lateralis	LC	Yes		
Cisticola natalensis	LC			
Cisticola rufus	LC			
Clamator glandarius	LC			
Clamator jacobinus	LC			
Clamator levaillantii	LC			
Columba guinea	LC		Yes	
Columba livia	LC	Yes	Yes	
Coracias abyssinicus	LC			
Coracias cyanogaster	LC	Yes		
Coracias garrulus	NT	Yes		
Coracias naevius	LC			
Corvinella corvina	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Corvus albus	LC		Yes	
Cossypha albicapilla	LC		Yes	
Cossypha niveicapilla	LC			
Coturnix coturnix	LC	Yes		
Crex egregia	LC			
Crinifer piscator	LC			
Cuculus canorus	LC	Yes	Yes	Yes
Cuculus clamosus	LC		Yes	
Cuculus gularis	LC		Yes	
Cuculus solitarius	LC		Yes	
Cursorius temminckii	LC		Yes	
Cypsiurus parvus	LC		Yes	
Delichon urbicum	LC	Yes		
Dendrocygna bicolor	LC			
Dendrocygna viduata	LC	Yes		
Dendropicos fuscescens	LC	Yes		
Dendropicos goertae	LC	Yes		
Dendropicos obsoletus	LC		Yes	
Dicrurus adsimilis	LC			
Dicrurus ludwigii	LC			
Dryoscopus gambensis	LC		Yes	
Egretta ardesiaca	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Egretta garzetta	LC		Yes	
Egretta gularis	LC		Yes	
Elanus caeruleus	LC		Yes	
Elminia longicauda	LC	Yes	Yes	Yes
Emberiza affinis	LC			
Emberiza tahapisi	LC			
Ephippiorhynchus senegalensis	LC	Yes	Yes	
Eremomela icteropygialis	LC		Yes	
Eremomela pusilla	LC		Yes	
Eremopterix leucotis	LC		Yes	
Eremopterix nigriceps	LC	Yes		
Estrilda caerulescens	LC			
Estrilda melpoda	LC	Yes		
Estrilda troglodytes	LC			
Euplectes afer	LC			
Euplectes franciscanus	LC			
Euplectes hordeaceus	LC			
Euplectes macroura	LC			
Eupodotis senegalensis	LC		Yes	
Eurystomus glaucurus	LC	Yes		
Falco alopex	LC		Yes	Yes
Falco ardosiaceus	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Falco biarmicus	LC	Yes	Yes	
Falco cuvierii	LC	Yes	Yes	
Falco naumanni	LC			
Falco peregrinus	LC	Yes	Yes	Yes
Falco subbuteo	LC	Yes	Yes	Yes
Falco tinnunculus	LC	Yes		
Falco vespertinus	NT	Yes		
Ficedula hypoleuca	LC	Yes		
Galerida cristata	LC	Yes		
Gallinago gallinago	LC	Yes		
Gallinago media	NT	Yes		
Gallinula angulata	LC			
Gallinula chloropus	LC			
Gelochelidon nilotica	LC		Yes	
Glareola pratincola	LC		Yes	
Glaucidium perlatum	LC			
Gypohierax angolensis	LC		Yes	
Gyps africanus	EN (A2bcd+3bcd+4bcd)		Yes	
Gyps fulvus	LC	Yes	Yes	Yes

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Gyps rueppelli	EN (A2abcd+3bcd+4abcd)	Yes	Yes	Yes
Haematopus ostralegus	LC	Yes	Yes	Yes
Halcyon chelicuti	LC	Yes		
Halcyon leucocephala	LC			
Halcyon malimbica	LC	Yes		
Halcyon senegalensis	LC	Yes		
Haliaeetus vocifer	LC		Yes	
Heliolais erythropterus	LC			
Hieraaetus pennatus	LC	Yes	Yes	Yes
Hieraaetus wahlbergi	LC		Yes	
Himantopus himantopus	LC	Yes	Yes	Yes
Hippolais opaca	LC			
Hippolais pallida	LC			
Hippolais polyglotta	LC			
Hirundo daurica	LC			
Hirundo leucosoma	LC	Yes		
Hirundo lucida	LC			
Hirundo semirufa	LC			
Hirundo senegalensis	LC			
Hirundo smithii	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Hydrobates castro	LC		Yes	
Hydrobates leucorhous	LC		Yes	
Hydroprogne caspia	LC		Yes	
Hyliota flavigaster	LC		Yes	
Hypergerus atriceps	LC			
Illadopsis puveli	LC	Yes	Yes	
Indicator indicator	LC	Yes		
Indicator maculatus	LC	Yes		
Indicator minor	LC	Yes		
Ispidina picta	LC			
Ixobrychus minutus	LC	Yes		
Ixobrychus sturmii	LC			
Jynx torquilla	LC	Yes		
Kaupifalco monogrammicus	LC		Yes	
Lagonosticta senegala	LC		Yes	
Lamprotornis caudatus	LC			
Lamprotornis chalybaeus	LC			
Lamprotornis chloropterus	LC			
Lamprotornis pulcher	LC			
Lamprotornis purpureus	LC			
Lamprotornis splendidus	LC	Yes	Yes	Yes
Laniarius barbarus	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Lanius excubitor	LC	Yes		
Lanius isabellinus	LC			
Lanius senator	LC			
Larus audouinii	NT	Yes	Yes	Yes
Larus cirrocephalus	LC		Yes	
Larus fuscus	LC	Yes	Yes	
Larus genei	LC	Yes	Yes	Yes
Larus ridibundus	LC	Yes	Yes	Yes
Leptoptilos crumenifer	LC		Yes	
Limosa lapponica	LC		Yes	
Limosa limosa	NT		Yes	
Lissotis melanogaster	LC		Yes	
Lonchura cantans	LC	Yes		
Lonchura cucullata	LC			
Lophaetus occipitalis	LC		Yes	
Lophoceros nasutus	LC	Yes	Yes	Yes
Luscinia megarhynchos	LC	Yes		
Luscinia svecica	LC	Yes		
Lybius vieilloti	LC	Yes	Yes	Yes
Lymnocryptes minimus	LC	Yes	Yes	Yes
Macheiramphus alcinus	LC	Yes	Yes	
Macronyx croceus	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Malaconotus blanchoti	LC			
Megaceryle maxima	LC			
Melaenornis edolioides	LC			
Melierax metabates	LC		Yes	
Merops albicollis	LC		Yes	
Merops hirundineus	LC		Yes	
Merops nubicus	LC		Yes	
Merops persicus	LC		Yes	
Merops pusillus	LC		Yes	
Microcarbo africanus	LC		Yes	
Micronisus gabar	LC		Yes	
Milvus migrans	LC		Yes	
Mirafra rufocinnamomea	LC			
Monticola solitarius	LC			
Motacilla alba	LC	Yes		
Motacilla flava	LC	Yes		
Muscicapa aquatica	LC			
Muscicapa striata	LC	Yes		
Musophaga violacea	LC		Yes	
Mycteria ibis	LC		Yes	
Myioparus plumbeus	LC		Yes	
Myrmecocichla aethiops	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Myrmecocichla albifrons	LC			
Necrosyrtes monachus	EN (A2acd+3cd+4acd)		Yes	
Nectarinia chloropygia	LC	Yes	Yes	Yes
Nectarinia coccinigaster	LC	Yes	Yes	
Nectarinia cuprea	LC		Yes	
Nectarinia pulchella	LC		Yes	
Nectarinia senegalensis	LC		Yes	
Nectarinia venusta	LC		Yes	
Nectarinia verticalis	LC	Yes	Yes	Yes
Neophron percnopterus	EN (A2bcde+3bcde+4bcde)	Yes	Yes	Yes
Neotis denhami	NT		Yes	
Nesocharis capistrata	LC	Yes		
Nettapus auritus	LC	Yes	Yes	
Nicator chloris	LC	Yes	Yes	Yes
Nilaus afer	LC		Yes	
Numenius arquata	NT	Yes	Yes	Yes
Numenius phaeopus	LC		Yes	
Numida meleagris	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Nycticorax nycticorax	LC		Yes	
Oceanites oceanicus	LC		Yes	
Oena capensis	LC		Yes	
Oenanthe oenanthe	LC	Yes		
Onychoprion anaethetus	LC		Yes	
Onychoprion fuscatus	LC		Yes	
Oriolus auratus	LC		Yes	
Oriolus oriolus	LC	Yes		
Ortygospiza atricollis	LC			
Otus scops	LC	Yes		
Otus senegalensis	LC			
Pandion haliaetus	LC		Yes	
Passer domesticus	LC	Yes	Yes	Yes
Passer griseus	LC			
Pelagodroma marina	LC		Yes	
Pelecanus onocrotalus	LC	Yes	Yes	Yes
Pelecanus rufescens	LC		Yes	
Peliperdix albogularis	LC	Yes		
Pernis apivorus	LC	Yes	Yes	Yes
Petronia dentata	LC			
Phalacrocorax carbo	LC		Yes	
Phoeniconaias minor	NT		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Phoenicopterus roseus	LC		Yes	
Phoeniculus purpureus	LC	Yes	Yes	
Phoenicurus phoenicurus	LC	Yes		
Phylloscopus bonelli	LC	Yes		
Phylloscopus collybita	LC	Yes		
Phylloscopus ibericus	LC	Yes		
Phylloscopus sibilatrix	LC	Yes		
Phylloscopus trochilus	LC	Yes		
Platalea alba	LC		Yes	
Platalea leucorodia	LC		Yes	
Platysteira cyanea	LC		Yes	
Plectropterus gambensis	LC		Yes	
Plegadis falcinellus	LC		Yes	
Plocepasser superciliosus	LC			
Ploceus cucullatus	LC			
Ploceus heuglini	LC			
Ploceus luteolus	LC			
Ploceus melanocephalus	LC			
Ploceus nigerrimus	LC	Yes		
Ploceus nigricollis	LC			
Ploceus vitellinus	LC		Yes	
Pluvialis squatarola	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Pluvianus aegyptius	LC		Yes	
Podica senegalensis	LC		Yes	
Pogoniulus bilineatus	LC	Yes	Yes	Yes
Pogoniulus chrysoconus	LC	Yes	Yes	
Pogonornis dubius	LC	Yes	Yes	Yes
Poicephalus robustus	LC		Yes	
Poicephalus senegalus	LC		Yes	
Polemaetus bellicosus	NT		Yes	
Polyboroides typus	LC		Yes	
Porphyrio alleni	LC			
Porphyrio porphyrio	LC			
Prinia subflava	LC			
Prionops plumatus	LC		Yes	
Prodotiscus insignis	LC	Yes	Yes	Yes
Pseudhirundo griseopyga	LC			
Psittacula krameri	LC		Yes	
Pternistis bicalcaratus	LC			
Pterocles exustus	LC			
Pterocles quadricinctus	LC			
Ptilopachus petrosus	LC			
Ptilopsis leucotis	LC	?	?	?
Ptilostomus afer	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Puffinus lherminieri	LC		Yes	
Puffinus puffinus	LC	Yes	Yes	Yes
Pycnonotus barbatus	LC			
Pyrenestes sanguineus	LC			
Pyrrhurus scandens	LC	Yes		
Pytilia melba	LC	Yes		
Pytilia phoenicoptera	LC			
Quelea erythrops	LC			
Quelea quelea	LC			
Rallus caerulescens	LC			
Recurvirostra avosetta	LC	Yes	Yes	Yes
Rhinopomastus aterrimus	LC	Yes	Yes	Yes
Rhinoptilus chalcopterus	LC		Yes	
Riparia paludicola	LC			
Riparia riparia	LC	Yes		
Rissa tridactyla	LC	Yes	Yes	
Rostratula benghalensis	LC		Yes	
Rynchops flavirostris	NT		Yes	
Salpornis spilonotus	LC			
Sarkidiornis melanotos	LC			
Saxicola rubetra	LC	Yes		
Scopus umbretta	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Scotopelia peli	LC		Yes	
Serinus leucopygius	LC			
Serinus mozambicus	LC			
Spatula clypeata	LC	Yes	Yes	Yes
Spatula querquedula	LC	Yes	Yes	Yes
Spilopelia senegalensis	LC		Yes	
Sporopipes frontalis	LC			
Stephanoaetus coronatus	NT	Yes	Yes	
Stercorarius pomarinus	LC	Yes	Yes	Yes
Sterna dougallii	LC		Yes	
Sterna hirundo	LC	Yes	Yes	Yes
Sternula albifrons	LC		Yes	
Streptopelia decipiens	LC		Yes	
Streptopelia roseogrisea	LC	Yes	Yes	Yes
Streptopelia semitorquata	LC		Yes	
Streptopelia turtur	LC	Yes	Yes	Yes
Streptopelia vinacea	LC		Yes	
Strix woodfordii	LC		Yes	
Sula leucogaster	LC		Yes	
Sylvia atricapilla	LC	Yes		
Sylvia borin	LC	Yes		
Sylvia cantillans	LC	Yes		

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Sylvia communis	LC	Yes		
Sylvia hortensis	LC	Yes		
Sylvietta brachyura	LC		Yes	
Sylvietta denti	LC	Yes	Yes	Yes
Sylvietta virens	LC	Yes	Yes	Yes
Tachybaptus ruficollis	LC			
Tauraco persa	LC	Yes	Yes	Yes
Tchagra senegalus	LC			
Telacanthura ussheri	LC	Yes	Yes	Yes
Telophorus sulfureopectus	LC		Yes	
Terathopius ecaudatus	NT		Yes	
Terpsiphone rufiventer	LC			
Terpsiphone viridis	LC			
Thalasseus bengalensis	LC		Yes	
Thalasseus maximus	LC		Yes	
Thalasseus sandvicensis	LC		Yes	
Thalassornis leuconotus	LC		Yes	
Thescelocichla leucopleura	LC	Yes	Yes	Yes
Threskiornis aethiopicus	LC		Yes	
Torgos tracheliotos	VU (C2a(ii))	Yes	Yes	Yes
Treron calvus	LC		Yes	
Treron waalia	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Trigonoceps occipitalis	VU (C1+2a(ii))	Yes	Yes	
Tringa erythropus	LC	Yes	Yes	Yes
Tringa glareola	LC		Yes	
Tringa nebularia	LC		Yes	
Tringa ochropus	LC			
Tringa stagnatilis	LC	Yes		
Tringa totanus	LC	Yes	Yes	Yes
Turdoides plebejus	LC		Yes	
Turdoides reinwardii	LC		Yes	
Turdus pelios	LC		Yes	
Turnix sylvaticus	LC			
Turtur abyssinicus	LC		Yes	
Turtur afer	LC		Yes	
Tyto alba	LC		Yes	
Upupa epops	LC	Yes	Yes	Yes
Uraeginthus bengalus	LC			
Urocolius macrourus	LC	Yes		
Vanellus senegallus	LC		Yes	
Vanellus spinosus	LC		Yes	
Vanellus tectus	LC		Yes	
Vidua chalybeata	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Vidua macroura	LC			
Vidua nigeriae	LC			
Vidua paradisaea	LC			
Zapornia flavirostra	LC			
Zosterops senegalensis	LC			

Freshwater fish

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Alestes baremoze	LC	Yes		
Alestes dentex	LC	Yes		
Aplocheilichthys spilauchen	LC		Yes	
Auchenoglanis occidentalis	LC		Yes	
Barbus leonensis	LC		Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Bathygobius soporator	NE		Yes	
Bostrychus africanus	LC		Yes	
Brycinus nurse	LC		Yes	Yes
Chrysichthys johnelsi	LC	Yes	Yes	
Chrysichthys maurus	LC	Yes	Yes	
Chrysichthys nigrodigitatus	LC		Yes	
Clarias anguillaris	LC			
Clarias buettikoferi	LC			
Clarotes laticeps	LC		Yes	Yes
Ctenopoma kingsleyae	LC	Yes	Yes	Yes
Ctenopoma petherici	LC	Yes	Yes	
Dalophis boulengeri	LC		Yes	
Distichodus brevipinnis	LC		Yes	
Distichodus rostratus	LC		Yes	
Dormitator lebretonis	LC		Yes	
Eleotris daganensis	LC		Yes	
Eleotris senegalensis	LC		Yes	
Eleotris vittata	NE		Yes	
Epiplatys bifasciatus	LC	Yes	Yes	Yes
Epiplatys spilargyreius	LC	Yes	Yes	Yes
Gobioides sagitta	LC		Yes	
Hemichromis bimaculatus	LC	Yes	Yes	
Hemichromis fasciatus	LC	Yes	Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Hepsetus odoe	LC			
Heterobranchus longifilis	LC			
Hydrocynus brevis	LC		Yes	Yes
Labeo coubie	LC			
Labeo senegalensis	LC			
Laeviscutella dekimpei	LC			
Lates niloticus	LC			
Marcusenius mento	LC	Yes	Yes	
Mormyrops anguilloides	LC	Yes		
Nematogobius maindroni	NE		Yes	
Neolebias unifasciatus	LC		Yes	
Papyrocranus afer	LC			
Paradistichodus dimidiatus	LC		Yes	
Pellonula leonensis	NE		Yes	
Periophthalmus barbarus	LC		Yes	
Poropanchax normani	LC		Yes	
Pronothobranchius kiyawensis	NT	Yes	Yes	Yes
Protopterus annectens	LC	Yes		
Schilbe intermedius	LC	Yes		
Synodontis gambiensis	LC		Yes	
Synodontis schall	LC	Yes	Yes	Yes
Tilapia guineensis	LC	Yes	Yes	

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Yongeichthys thomasi	LC		Yes	

Mammals

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Aonyx capensis	LC			
Arvicanthis niloticus	LC	Yes		
Asellia tridens	LC	Yes		
Atelerix albiventris	LC	Yes		
Atilax paludinosus	LC			
Canis adustus	LC			
Caracal caracal	LC	Yes		
Cephalophus rufilatus	LC		Yes	
Chlorocebus sabaeus	LC		Yes	
Civettictis civetta	LC		Yes	
Cricetomys gambianus	LC			
Crocidura cinderella	LC	Yes		
Crocidura foxi	LC	Yes		
Crocidura fuscomurina	LC	Yes		
Crocidura lamottei	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Crocidura lusitania	LC	Yes		
Crocidura nanilla	LC			
Crocidura olivieri	LC	Yes		
Crocidura viaria	LC			
Crocuta crocuta	LC		Yes	
Eidolon helvum	NT	Yes	Yes	
Epomophorus gambianus	LC	Yes		
Erythrocebus patas	LC		Yes	
Felis silvestris	LC	Yes		
Galago senegalensis	LC	Yes		
Genetta genetta	LC	Yes		
Genetta pardina	LC			
Genetta thierryi	LC			
Gerbilliscus gambiana	LC		Yes	
Gerbilliscus guineae	LC		Yes	
Glauconycteris poensis	LC	Yes		
Glauconycteris variegata	LC	Yes	Yes	
Heliosciurus gambianus	LC			
Heliosciurus rufobrachium	LC			
Herpestes ichneumon	LC			
Herpestes sanguineus	LC			
Hipposideros caffer	LC	Yes	Yes	
Hipposideros gigas	LC	Yes	Yes	Yes

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Hipposideros ruber	LC	Yes	Yes	Yes
Hystrix cristata	LC			
Ichneumia albicauda	LC			
Ictonyx striatus	LC	Yes		
Lavia frons	LC	Yes	Yes	Yes
Lemniscomys zebra	LC			
Leptailurus serval	LC		Yes	
Lepus microtis	LC			
Mastomys erythroleucus	LC			
Mastomys huberti	LC			
Mellivora capensis	LC		Yes	
Micropteropus pusillus	LC	Yes		
Mungos gambianus	LC			
Mungos mungo	LC	Yes		
Mus haussa	LC			
Mus musculoides	LC			
Nandinia binotata	LC			
Nycteris gambiensis	LC	Yes		
Nycteris hispida	LC	Yes	Yes	
Nycteris macrotis	LC	Yes		
Nycteris thebaica	LC	Yes		
Orycteropus afer	LC	Yes		
Papio papio	NT	Yes	Yes	Yes

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Phacochoerus africanus	LC			
Philantomba maxwellii	LC		Yes	
Pipistrellus guineensis	LC	Yes		
Pipistrellus nanulus	LC	Yes		
Pipistrellus nanus	LC	Yes		
Pipistrellus rendalli	LC	Yes		
Pipistrellus rusticus	LC	Yes		
Praomys daltoni	LC			
Praomys tullbergi	LC			
Procavia capensis	LC	Yes		
Procolobus badius	EN (A2cd)	Yes	Yes	
Redunca redunca	LC		Yes	
Rhinolophus fumigatus	LC	Yes	Yes	
Rhinolophus landeri	LC	Yes		
Scotoecus albofuscus	DD	Yes		
Scotoecus hirundo	LC	Yes		
Scotophilus dinganii	LC	Yes		
Scotophilus leucogaster	LC	Yes		
Scotophilus viridis	LC	Yes		
Steatomys caurinus	LC	Yes		
Steatomys cuppedius	LC	Yes		
Sylvicapra grimmia	LC			

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Tadarida condylura	LC			
Tadarida pumila	LC			
Taphozous mauritianus	LC		Yes	
Taterillus gracilis	LC			
Taterillus pygargus	LC	Yes		
Thryonomys swinderianus	LC			
Tragelaphus scriptus	LC		Yes	
Tragelaphus spekii	LC		Yes	
Trichechus senegalensis	VU (A3cd; C1)	Yes	Yes	
Vulpes pallida	LC	Yes		
Xerus erythropus	LC			

Reptiles

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Acanthodactylus dumerilii	NE	Yes	Yes	Yes
Afronatrix anoscopus	NE	Yes		
Afrotyphlops lineolatus	NE	Yes	Yes	
Afrotyphlops punctatus	NE	Yes	Yes	
Agama agama	NE			
Agama sankaranica	NE			
Agama weidholzi	LC	Yes		
Amblyodipsas unicolor	NE			
Atractaspis aterrima	NE	Yes		
Atractaspis microlepidota	LC	Yes	Yes	Yes
Atractaspis micropholis	LC	Yes		
Bitis arietans	NE			
Boaedon fuliginosus	NE		Yes	
Boaedon lineatus	NE		Yes	
Causus maculatus	NE	Yes		
Chalcides armitagei	NT	Yes	Yes	Yes
Chamaeleo senegalensis	LC			
Crotaphopeltis hotamboeia	NE			
Cynisca feae	LC	Yes		
Dasypeltis confusa	NE			
Dasypeltis gansi	NE	Yes	Yes	Yes

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Dasypeltis sahelensis	NE		Yes	Yes
Dendroaspis polylepis	NE			
Dendroaspis viridis	LC	Yes		
Dispholidus typus	NE	Yes		
Echis leucogaster	LC	Yes		
Echis ocellatus	NE	Yes	Yes	
Elapsoidea semiannulata	NE			
Gongylophis muelleri	NE			
Grayia smithii	NE	Yes	Yes	
Grayia tholloni	NE	Yes		
Hemidactylus angulatus	NE			
Hemitheconyx caudicinctus	LC	Yes		
Latastia longicaudata	NE			
Lycophidion albomaculatum	LC			
Lycophidion semicinctum	NE			
Lygodactylus gutturalis	NE		Yes	
Meizodon coronatus	NE	Yes	Yes	
Mesalina olivieri	NE		Yes	
Myriopholis albiventer	LC	Yes		
Myriopholis boueti	LC	Yes	Yes	Yes
Naja katiensis	LC	Yes		
Naja melanoleuca	NE	Yes		

Species	Red List Category and Criteria	Sensitive?	Low adaptability?	Climate change vulnerable (baseline)?
Naja nigricollis	NE			
Naja senegalensis	LC	Yes		
Natriciteres olivacea	NE			
Panaspis nimbaensis	LC	Yes	Yes	
Prosymna meleagris	LC	Yes	Yes	
Psammophis elegans	NE			
Psammophis lineatus	NE			
Psammophis praeornatus	NE	Yes		
Python regius	NE			
Python sebae	NE	Yes		
Rhamphiophis oxyrhynchus	NE			
Tarentola parvicarinata	NE		Yes	
Tarentola senegambiae	LC		Yes	
Telescopus tripolitanus	NE	Yes		
Telescopus variegatus	NE			
Trachylepis affinis	NE		Yes	
Trachylepis perrotetii	NE	Yes	Yes	
Varanus exanthematicus	NE			
Varanus ornatus	NE			

Appendix 2. Guidance for monitoring birds in West African protected areas under climate change

Compiled by Stuart Butchart, BirdLife International, 2015

Summary

- Monitoring biodiversity is important in order to detect changes and assess the effectiveness of management actions. Monitoring is particularly important under climate change given the expected shifts in species' abundance and distribution, and the uncertainty over these.
- Birds are useful as indicators for biodiversity more broadly because they are relatively easy to observe, identify and count, widely distributed in most habitats, responsive to environmental change and popular (so there are many potential people available with the skills to monitor them).
- Establishing a monitoring scheme requires setting objectives, defining a sampling strategy, selecting appropriate techniques, training and motivating surveyors, analysing data and using the results. Guidance is provided here on each step.
- Sampling units are typical defined as 2x2 km or 10x10 km squares. Squares can be selected for surveying using a random sampling approach, regular sampling, or semi-random sampling, but free choice should be avoided as it introduces bias.
- Three main alternative survey techniques are described: line-transects, point counts and Timed Species Counts, which have different pros and cons and are suitable for different situations.
- It is generally little more work, and much more powerful, to monitor all (sufficiently common) species using whichever technique is chosen, rather than a subset of pre-selected species.
- Adequately training and motivating surveyors is essential to ensure accurate and consistent results.
- Population trend indictors can be relatively easily calculated from the data generated, and these can be used to meet the monitoring objectives by identifying species that are declining, assessing the accuracy of climate projections, informing management actions and assessing the effectiveness of adaptation responses.

1. Introduction

1.1 Why monitor biodiversity?

It is important to monitor the state of biodiversity in order to detect changes (e.g. increases or decreases in population abundance, species' distributions, community composition etc) and to determine the effectiveness of management actions (for example, aimed at increasing or decreasing the abundance of particular species or habitats). In protected areas, monitoring helps to establish if the biodiversity the area was designated to protect is being maintained, and to inform and track management interventions (e.g. those aimed at reducing poaching, or boosting numbers of a particular iconic species).

1.2 Monitoring under climate change

Under climate change, monitoring is particularly important, because substantial shifts are expected in the species for which individual sites are likely to support suitable habitat in future, owing to changing climatic conditions. For example, in West Africa, many species currently occurring in particular protected areas are not expected to persist in future because of projected changes in the climatic conditions within them. By contrast, other species of conservation concern are expected to colonise particular protected areas in future. Management of individual sites will therefore need to be adjusted through the coming decades. Monitoring will be critical to: (a) detect if projected changes in species' abundance and occurrence happen (and within the projected time-frames), (b) detect if any unexpected shifts in species abundance and distribution occur, and (c) determine if the adaptation actions and management interventions implemented are effective.

1.3 Why monitor birds?

Monitoring all types of wildlife would be extremely expensive and is impractical for a range of reasons. Fortunately, birds are often useful indicators of trends in the state of nature, and thus of the sustainability of human use of landscapes and resources. This is because they are relatively conspicuous, easy to identify, sufficiently diverse yet not overwhelmingly speciose in any particular location, widely distributed, occur in most habitats but with many species being quite specialised in their requirements, responsive to environmental change and popular (so there are many potential people available with the skills to monitor them). It is therefore often feasible and affordable to monitor birds, and valid to use the results to infer trends in the broader environment.

1.4 The guidelines

To facilitate monitoring of birds in West African protected areas under climate change, guidance is provided here on the following topics:

- Setting objectives for monitoring

- Sampling design
- Survey techniques
- Training and motivating surveyors
- Analysing data and using the results
- Additional sources of information

The guidance builds on the extensive experience of BirdLife Partners, their collaborators, and on-going monitoring efforts in Africa, Europe, North America and elsewhere, and draws heavily on Senyata (2007). Note that there is no blue-print for monitoring, and approaches will need to be tailored for the local context, taking into account the resources available, habitats, bird abundance, infrastructure, management structures and monitoring objectives.

2. Setting objectives

The first step in establishing monitoring efforts is to determine the objectives of the monitoring, as it will be impossible to design a scheme or determine its effectiveness unless the objectives it is trying to achieve are clear.

Examples of questions that could potentially be answered or informed by monitoring include:

- Are the species in a particular protected area being impacted by climate change?
- How are species being impacted?
- Which species are most severely impacted?
- Which are benefitting from climate change? Which are negatively impacted?
- Are the ranges and abundance of species shifting as predicted by climate change vulnerability assessments (e.g. species distribution models, or trait-based assessments of climate change vulnerability), in terms of the magnitude, rate, timing, and relative impacts across species
- How should management of the protected area change?
- Are climate change adaptation efforts effective?

The objectives chosen will then determine what sort of data needs to be collected, how much of it, how often and so on.

3. Sampling Design

Once it is clear what the objectives of monitoring are, it is important to design a monitoring scheme systematically. Resources rarely allow all individuals of all species to be counted throughout a particular protected area. However, a systematic sampling approach can require vastly less effort and cost, yet provide data that can be taken as representative of the protected area as a whole. It necessitates pre-determining the locations within the protected area where data will be collected, and the timing and frequency of data collection.

The basic principle is for the same set of locations, ideally spread throughout protected area, to be surveyed on a regular basis, preferably each year. As it is difficult to predict the future, and because there is considerably uncertainty associated with projected impacts of climate change on species, it generally makes sense to collect data on all bird species recorded (or at least all common species). It is also important to use a standardised methodology (see below), preferably implemented by the same observers between years (with repeated training to ensure consistency within and between observers; see below). Trends in the abundance of each species may then be calculated by assessing changes between years in counts at each survey location.

3.1 Defining and selecting sampling units

It is important to standardize the 'sampling units', i.e. locations from which data will be collected. The best approach is to divide the entire protected area into grid squares of a standard size, for example, 2x2 km or 10x10 km squares, rather than using irregularly shaped areas such as wetlands or particular patches of forest.

Then a sample of these squares needs to be selected at which data will be collected. It is extremely important, as much as is practicable, to avoid bias in the selection of sampling units. Such bias might arise from choosing only squares that contain particular habitat types (e.g. wetlands and forest, but not agricultural land or urban areas), or only areas that are known to be good for birds, or only areas with a geographical bias (e.g. from the north of a protected area, or from close to the park headquarters). One approach that should be avoided, if at all possible, is that of 'free choice'. Allowing observers to decide where they survey is almost certain to result in a biased sample. These locations will not be representative of the protected area as a whole, and counts and trends of birds from them will not necessarily be indicative of trends in species across the protected area.

Instead, it is better to select squares through random or regular sampling. The former involves selecting squares entirely at random from the entire sample, whereas the latter involves selecting every 10th, or 20th, or 100th square to ensure an even spread of survey squares across the protected area (with the interval and hence total number of squares being determined by the resources available and heterogeneity of the habitats in the protected area). Both approaches should help to ensure an unbiased and hence representative sample.

In reality, it may not be possible to use a fully random or regular sampling design if the number of potential surveyors is few, the sites too distant, remote, difficult or unsafe to access, or for other practical reasons. In such cases, it is better to adopt a more pragmatic, semi-random approach which allows potential surveyors to define the general area that it is practical to survey within (encouraging this to be set as large as possible). The survey squares are then selected at random from within this area. This ensures that while there may be some biases at a large spatial scale, at a smaller scale the squares selected should be unbiased.

3.2 Dealing with imperfect sampling

Often, for the reasons already outlined, the sample of squares surveyed may be unrepresentative of the entire protected area. However, some major sources of bias can be controlled for when analysing the results by weighting the trends obtained from individual sites. The two most obvious ways to do this are by region, to account for a greater density of survey sites in some parts of the protected area than others, or by habitat, to correct for unrepresentative sampling of habitats. The latter requires at least a basic assessment of habitat within survey squares, and knowledge of habitat cover over the protected area as a whole.

3.3 Setting the number of samples

The number of samples (i.e. squares surveyed) will, to a large extent, depend on both the availability of surveyors, and the method used. As a general rule it is desirable to have as many samples as possible, e.g. ten counts made at two different sites will be preferable to twenty counts made at one site. Similarly, many samples taken using a simpler method are preferable to few samples with more detailed and time-consuming methods.

4. Survey techniques

After deciding the sampling design and where to monitor birds, the next step is to decide the method to be used. There are a number of publications that describe in detail the different techniques that can be used to survey birds (see below). Considering the likely resources available for monitoring biodiversity in West African Protected Areas, three alternative approaches are recommended here: line transects, point counts and timed species counts, which are described in turn below.

4.1 Line transects

This method involves counting birds along a predefined route within a predefined sampling square. A regular approach to placement of the route within the square is best: most schemes use straight transects that run north-south, or east-west, through the centre of a square. In reality, certain land uses (roads, watercourses etc.) might limit access, resulting in modifications to the ideal routes. It is important to document or demarcate the route so that exactly the same one can be used in repeat surveys in future.

At its simplest, the technique involves walking along the transect and recording all individual birds (seen or heard) within a fixed distance on either side of the observer. For analysis purposes, it is crucial to decide several factors before starting, such as a) if recording will be done in units (i.e. counting in sections, such as 200 m lengths) rather than totals for the whole transect, b) when and how to score habitat condition (which allows comparisons of bird numbers to changes in the habitat available to them), c) if there is any distance beyond which birds should not be counted and d) the speed with which the transects will be walked, which is often dictated by the terrain, the number of birds present, and any difficulties in recording these birds. All these should be standardised.

The length of the transect requires consideration of total bird abundance and diversity, the degree to which bird activity is dependent on the time of day, and the degree to which data quality will decline with observer fatigue. If transects are walked, remember that observers will usually want to end up near where they started, for practical reasons, so a transect in one direction followed by another, returning on a parallel route (but far enough away to avoid double-counting) is a sensible approach.

4.2 Point transects

This technique involves standing still at a pre-determined point and recording all birds heard or seen from it. A point count approach is often preferable when counting less mobile species, and in closed habitats (e.g. forests), where observer mobility is more limited. As with line transects, once the sampling unit (square) has been randomly chosen, it is not necessary for the census stations to be randomly selected; if possible, a regular approach that ensures the entire sampling unit is covered is preferable. Compared to line transects, point counts may be easier where access is an issue, as the series of points can be accessed by whatever route is most convenient, rather than having to follow a set route.

The number of point counts to use within a sampling square depends primarily on the size of the square, although most schemes aim for 10-20 points per square, noting that the precision of the counts at points can be increased by repeating them, but at the detriment of total area surveyed. This balance also has implications for how long the count periods at each point should be: periods of 5-10 minutes are widely used. In addition, it is a good idea to have an initial 'settling in' period before counting (usually 2 minutes). It will also need to be decided whether all birds seen or heard from a count station will be recorded, or only those within a fixed radius (e.g. 100 m, 200 m) of the point.

Table 1 summarizes some of the main issues to consider when choosing between line transects and point counts, relating to effectiveness (i.e. which best provides answers for the questions posed), efficiency (which provides the required data most cost-effectively) and appropriateness for the surveyors available.

Table 1. Advantages and disadvantages of line and point transects

Line transect	Point transect
Relatively efficient at low bird densities and in species-poor habitats (e.g. deserts, farmlands etc.)	More suitable at high bird densities, especially in species-rich habitats (e.g. forests)
Good for open habitats	Suits dense habitats
Suitable for large and conspicuous species	Suitable for skulking or cryptic species
Suitable for easily accessible areas	Suitable in areas where accessibility is poor

4.3 Timed Species Counts

Timed Species Counts (TSCs) are lists of the species seen within a particular habitat (habitats are not mixed, as these usually have obviously different bird communities), recording the time when a species is first recorded. Thus a one hour-long survey may be divided into ten-minute blocks, and for each species, the block in which it was first recorded is noted. A score of 6 is given to any species first recorded in the first 10 minutes, a score of 5 to any species first recorded in the second 10 minutes, a score of 4 to any species recorded in the third 10 minutes etc. and so on, with a score of 0 given to all species not recorded within that hour.

These TSCs are then repeated as many times and as widely as is possible within the habitat, and for each species the mean score across all 1-hour counts gives a relative measure of abundance. The assumption is that the more common species will be recorded more frequently and quickly, and so would have a higher cumulative score. Often, surveyors are allowed to wander everywhere, but it is also possible to designate a fixed route (randomly selected), which may be more useful in terms of repeated observations along a specific stretch of a particular habitat. Consequently, if habitat conditions along that stretch are also recorded, the TSC scores could then be correlated to any observed habitat changes.

However, the results of TSC should be interpreted with caution, because the scores of each TSC event (i.e. a score 6, 5, 4, 3, 2, 1, or 0) measure relative abundance of a species at that time, and a cumulative score of these over several sites and deduction of trends from these indices over years (or repeated counts) is not simply the arithmetic sum.

Table 2. Suitability of point counts, line transects and Timed Species Counts for various bird groups. Adapted from Gibbons and Gregory (2005). Two asterisks indicate greater suitability.

Method	Waterbirds	Raptors	Gamebirds	Passerines
Point count	*	*	*	**
Line transect	**	**	**	**
Timed Species Count	*	**	**	**

4.4 Overarching considerations

It is important to note that all three techniques are highly influenced by detectability: counts will be a lot lower for small, cryptic, quiet species than for large obvious vocal species present at a similar density. Similarly, habitat will also have an impact on the numbers detected (higher in more open habitats, lower in denser habitats). However, this may not be problematic, given that monitoring should be repeated (ideally annually) at the same sites and using the same methods, so relative change between counts is unbiased. The difficulty in detecting some species may mean, however, that they are recorded insufficiently frequently for adequate data to be collected to monitor trends.

These techniques also permit the estimation of population densities (and therefore population size estimates), if the distance from the observer to each bird is recorded, and if detectability of birds decline with distance (section below for references on ‘distance sampling’). Although ‘distance sampling’ is relevant for population estimates, it is not required for trend analyses. However, if surveyors can handle the added complexity of recording the distance (in bands) to each bird recorded, this maximises the utility of the data collected.

It is important to highlight that once a technique (line transects, point transects or TSCs) has been selected, it should not be changed over time, in order to ensure comparability. Further issues to consider include the following:

- How often to do counts? For points and transects, multiple visits are desirable, as it is easy to miss species or obtain unusually high or low counts on a single visit. Many schemes use two visits per year, and take the highest count from either visit for each species for analytical purposes. TSCs are far less robust, and so more counts would be needed.
- What time of year to count? This will depend on the time of year when breeding activity peaks or when birds are most readily detected. For some tropical countries, it may be best for counts to be spread across the whole year (e.g. 2 counts 6 months apart, 3 counts 4 months apart, or 4 counts 3 months apart).

- What time of day to count? Early morning is always best because of higher bird activity, but this requirement may have to be relaxed given travel times to some sites.
- Whether to count all species, or fixed subset? The latter is not desirable because it restricts the scope of the monitoring, loses data and is not future-proof (we do not know which species it may be important to monitor in future, so may not have an adequate baseline if we decide to add additional species in future). However, monitoring a subset of species may make a monitoring scheme more accessible, feasible and practical for specific audiences, depending on their capabilities, the intended use of the data etc.

5. Training and motivating surveyors

Once the sample design and survey techniques have been defined, careful consideration has to be made of the practical considerations of implementing the monitoring. This may be done by protected area staff (e.g. park rangers) and/or volunteer observers (e.g. from conservation NGOs). Hence it is vital that good management practices are employed to recruit, train and retain participants by ensuring their involvement with the scheme is enjoyable and rewarding. In addition, it is important to ensure that there is sufficient support, guidance and training so that the data collected is robust, reliable and consistent.

Training

Good training is an essential component of successful monitoring, in order to build capacity for designing surveys, managing surveyor networks, analysing data, communicating results and using them to inform management and decision-making. This is likely to involve both face-to-face training (e.g. through workshops) and the dissemination of training materials.

Training workshops should aim to:

- Describe the rationale behind establishing monitoring, and its value for a protected area
- Give a basic grounding in survey design and methods
- Fully describe the survey method to be used
- Include sessions on identification, filling in forms correctly, health and safety issues
- Use a mixture of practical and theoretical sessions, and opportunity for participants to exchange experience and opinions.

As well as a detailed workshop at the initiation of monitoring, repeat training should be held when needed (and at least annually).

Providing supporting materials

To maximise participation, accuracy and consistency in the data collected, some or all of the following materials may be produced:

- Data capture forms – which should be easy to read and allow for all the required data to be recorded on them in the field
- Survey protocols – which should describe in detail the methods to be used so that everyone understands what is to be done, and data collection is consistent
- Field guides – if these are too expensive then modified identification kits illustrating only the species most likely to be encountered can be considered
- Posters, leaflets, brochures etc – to provide appropriate information for the surveyors and other stakeholders involved

Incentives

Recruitment, retention and maintained motivation of surveyors may be greatly helped by offering incentives (noting that long-term sustainability is also critical). These might include recognition (e.g. named awards), prizes (e.g. a free field guide, or binoculars), additional training, or travel opportunities. If volunteers are involved in monitoring, then regular personal contact is important, or at least regular communications.

The results of monitoring should be reported to surveyors as promptly as possible, for example through newsletters, websites, annual reports, brochures etc. This enables surveyors to see the results of their efforts and hence helps to maintain motivation.

6. Analysing the data and using the results

Before launching a monitoring scheme, it is important to consider how the data collected will be analysed. Rules may be needed for identifying, checking and if necessary, removing erroneous records (e.g. likely misidentifications, vagrants, implausibly high counts etc). Data need to be entered into a spreadsheet or appropriate database, and then analyses conducted. In the first year of a scheme, these will be simple descriptive statistics such as the number of species, and their relative abundance. After three or four consecutive years, it will be appropriate to develop species trends for those more frequently recorded species for which there is sufficient data. The production of trends requires analysing changes in counts at each site between years, and can be achieved by a number of modelling approaches. A recommended approach is to use the freely available bespoke analysis software TRIM (Trends and Indices for Monitoring data: www.ebcc.info/trim.html).

Population trend indices can be calculated for individual species (e.g. iconic species or those of conservation concern for which a protected area has been designated), suites of similar species (e.g.

vultures, waterbirds), sets of species characteristic of particular habitats within a protected area (e.g. forest species, savannah species), those species projected to be negatively impacted by climate change, or those species targeted by management actions (including adaptation interventions).

These can help diagnose a problem (through identifying a suite of species that are declining), assess the accuracy of climate projections (in terms of the species projected to decline or shift their distributions, or the timing of such changes), inform management actions and assess the effectiveness of responses.

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