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Guidelines on Sustainable Harvest of Migratory Waterbirds




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These AEWA Conservation Guidelines represent a full revision of, and supersede the 2005 version (AEWA Technical Series No. 19).

Contents

Preface

These guidelines have been prepared in response to recommendations made by AEWA Contracting Parties, the AEWA Technical Committee and international organisations that requested an update and widening of the scope of the original version of the Guidelines on Sustainable Harvest of Migratory Waterbirds (AEWA Conservation Guidelines No. 5; Beintema *et al.* 2005). The intention has been to take a broader perspective, addressing the variety of modes and motivations for harvesting found throughout the AEWA region and the implications they have for the management of sustainable waterbird harvests.

These guidelines show that effective flyway-wide management can be achieved, as demonstrated by the success of the first examples of adaptive management of migratory waterbirds that have recently been implemented in the AEWA region, which highlight new opportunities for coordinated management. Finally, there has been a wish for guidance on specific issues related to waterbird harvest that were not covered in the first set of guidelines.

The Waterbird Harvest Specialist Group of Wetlands International (WHSG) was chosen by the UNEP/AEWA Secretariat to conduct the task of compiling the revised guidelines. The WHSG consists of experts in waterbird ecology and harvest management as well as the socio-economic aspects of waterbird harvest. The group has a Northern Hemisphere focus; however, several participants have insight into waterbird ecology and harvesting across the AEWA region, including Africa, the Arctic and western Asia.

Nevertheless, the guidelines are, for various reasons, not least due to the availability of data, largely European in focus. This, however, does not preclude them from being applicable throughout the AEWA region and it is expected that future iterations will further elaborate on the commonalities and differences that are identified here. The themes that are dealt with in these guidelines vary in their degree of detail, depending on the existing information and guidance provided elsewhere. Furthermore, for some of the themes, existing knowledge gaps do not currently allow for very precise guidance. Readers can therefore select themes of special relevance to their purposes and use these guidelines to identify underlying principles, best practice, and other sources of relevant information.

The harvesting of waterbirds in all its modes and motivations can provide both threats and opportunities for the conservation of waterbirds. These guidelines are not intended to be exhaustive, but they do demonstrate the principles by which managers and users of huntable waterbirds can minimise the threats and maximise the opportunities. We have taken a forward-looking perspective with the hope that this will inspire Parties to advance their policies for the sustainable harvest of migratory waterbird populations.

Summary

Background and scope *(Sections 1-3)*

The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) recognises harvesting as a legitimate form of use of migratory waterbirds. The Agreement also requires that any harvesting of waterbirds is sustainable, such that populations are maintained in a 'favourable' conservation status over their entire range.

Due to the cross-border movements of the majority of migratory waterbird populations within the AEWA region, this requires that Parties to AEWA cooperate in order to ensure that their hunting legislation, regulation and practices, both individually and collectively, implement the principle of sustainable use and that any harvest of waterbirds is based on the best available knowledge of their ecology, and an adequate flyway-wide assessment of their conservation status and the socio-economic systems within which they occur.

The protection of huntable waterbirds, which was previously supported by the remoteness of breeding and/or wintering grounds, is now under increasing threat, as are their habitats, due to human development, climate change and other detrimental impacts. It is thus becoming more important than ever to address the long-standing challenge of developing internationally coordinated harvest management.

Advances in knowledge of waterbird populations, modern information and communication technologies and the development of harvest management strategies, such as adaptive management and interlinked social-ecological frameworks, mean that such coordinated management is now more achievable than ever before.

Aim *(Section 4)*

The overall aim of these guidelines is to provide guidance on ways of ensuring and managing sustainable harvests of waterbirds in the AEWA region to the benefit of waterbirds and people, whilst acknowledging the enormous diversity across the region in the modes and motivations in harvest regimes, biological knowledge, institutional frameworks and capacity.

Principles of sustainable harvest management of migratory waterbirds *(Section 5)*

The sustainable management of migratory waterbirds requires the following biological data. Management should be carried out at the individual population (flyway) scale and requires:

- An agreement on population delineations;
- Regular, systematic and timely reporting of population estimates, preferably on an annual basis;
- An estimate of total harvest; and
- Coordinated data on pre-nuptial migration and breeding periods to set appropriate open hunting seasons.

Additional demographic data, including parts surveys of shot birds, can provide an invaluable understanding of population processes and the impacts of harvest. While ongoing research projects and population monitoring systems cater for the population information (although coverage has to be improved, particularly outside Europe), there is no centralised facility to internationally collate harvest information, which currently prevents an assessment of the sustainability of waterbird harvest.

Decision-making and organisational framework for harvest management *(Section 6)*

The move towards accountability and explicitness in natural resource management has led to a need for a more structured approach to decision-making. Gaining knowledge and information is vital throughout a decision-making process, not only biological population or ecological data but also social data, i.e. information about human usage of a resource, user goals, motivations and incentives, and the interactions amongst different user groups and institutional organisations.

Following a structured decision-making process helps frame management decisions and tasks in the broader socio-ecological context, whereby engagement with stakeholders, the formulation of management objectives and options, the sharing of knowledge and information, a greater understanding of uncertainties and acknowledgement of risk can lead to better management decisions and their effective implementation.

An adaptive management approach, allowing for institutional and social learning as well as mechanisms for flexible harvest regimes, should be an integral part of a flyway-based approach to harvest management. It is recommended that a flyway coordination unit is established with the aim to annually:

- Collate integrated information about the status and harvest of waterbird populations;
- Assess the sustainability of harvests; and
- Report to range states and AEWA working groups.

To achieve efficient and cost-effective decision-making and organisation, it might be beneficial to establish an overarching advisory working group under AEWA tasked with providing advice to range states and population-specific management plan working groups, and supporting the development of management strategies.

To facilitate the effective implementation of such a management structure, it would be prudent to work, where possible, with suites of populations sharing similar management issues. Starting with species such as northwest European geese or seaducks, which are relatively rich in data, would provide experience that could be extended to other regions and groups of species in the AEWA region.

Understanding modes and motivations for harvesting *(Section 7)*

Motivations for harvesting vary greatly across the AEWA region and include subsistence, livelihood, commercial, cultural, recreational and management, though these are seldom exclusive. This creates challenges and opportunities for the development and implementation of policies that provide effective regulation of harvests whilst balancing the needs and expectations of stakeholders.

To devise and develop sustainable harvest management strategies for migratory waterbirds, it is essential to understand, respect and incorporate these motivations and modes in order to identify the most appropriate tools, mechanisms and management actions that work with the social, economic and cultural systems of local people.

It is recommended that national and international harvest management systems should take an interlinked socio-ecological approach and build on experiences in participatory approaches, ensuring that the governance structure provides end users with a tangible role to play in the decision-making process. This can be facilitated through the creation of regional, national and local working groups, feeding into the international process, that are composed of decision-making authorities, stakeholders and scientific institutions supplying national population and harvest information.

Code of conduct in harvesting *(Section 8)*

The engagement of hunters in harvest management is essential, but generally requires trust-building and a willingness by stakeholders to work together. This can be achieved by agreement on common objectives for management, an open and transparent decision-making process and respect for diverse viewpoints. Hunters, on the other hand, can facilitate the sustainability and social acceptance of their activities through their code of conduct, contribution to waterbird monitoring, including the reporting of harvest data, habitat conservation activities and sharing of expertise.

Education and training in waterbird harvesting, ranging from mandatory proficiency tests to obtain a hunting license to locally organised training courses, personal transfer of knowledge and establishment of clubs, are key components for ensuring the longer-term sustainability of harvesting.

Specific management issues related to harvest *(Section 9)*

These guidelines also provide advice on limits of taking (*i.e.*. advantages and disadvantages of different methods of harvest regulations), tackling problems posed by look-alike species, phasing out of lead shot, illegal harvest, and restocking for hunting purposes. Restocking is widespread, particularly of Mallard (*Anas platyrhynchos*) in Europe, but is poorly regulated and often carries a multitude of negative ecological and management implications.

For restocking to continue on a sustainable basis that is compatible with sustainable harvest management of wild waterbird populations, it is recommended that any restocking programme should be carefully evaluated and should adopt internationally agreed guiding principles.

Habitat management and mitigation of disturbance effects *(Section 10)*

Waterbirds use networks of sites for breeding, moulting, staging during migration periods, and wintering. Abundances of waterbirds and the timing of annual cycle events are dependent on their life history strategies, abiotic conditions and the carrying capacity of habitats.

Protection, restoration and management of habitats and sites are means of improving the status of populations and thus support the long-term sustainability of harvest. Creation of flyway-wide networks of protected sites designed to meet the annual ecological requirements of hunted waterbird species can mitigate disturbance while ensuring local human use of sites and their resources.

1. Introduction

The African-Eurasian Waterbird Agreement (AEWA) recognises harvesting as a legitimate form of use of migratory waterbirds. The Agreement also requires that any harvesting of waterbirds is sustainable such that populations are maintained in a ‘favourable’ conservation status over their entire range. Due to the cross-border movements of the majority of migratory waterbird populations within the AEWA region, this requires that Parties to AEWA cooperate in order to ensure that their hunting legislation, both individually and collectively, implements the principle of sustainable use and that any harvest of waterbirds is based on a flyway-wide assessment of the best available knowledge of their ecology and conservation status.

To support the development of a framework for sustainable harvest of waterbirds in the AEWA region, the AEWA Conservation Guideline No. 5 *Guidelines on Sustainable Harvest of Migratory Waterbirds* (Beintema *et al*. 2005) were produced. These revised guidelines update Beintema *et al*. (2005) with the latest knowledge on harvest management and, for the first time, include information on all harvest types pertinent to the whole AEWA region.

In its broadest sense, harvesting incorporates a number of means for the taking of wildlife or wildlife products, including several modes of hunting (e.g. falconry, wildfowling, shooting), trapping (both live and dead) and aspects such as egg collecting or the taking of other products (e.g. down feathers). The motivations for harvesting vary greatly across the AEWA region and include subsistence, livelihood, commercial, cultural, recreational and management incentives, though motivations are seldom exclusive.

This creates challenges for the development and implementation of policies that provide effective regulation of harvests whilst balancing the needs and expectations of stakeholders. Notwithstanding the limitations of any broad categorization such as this, these motivations can and should be specifically addressed through appropriate policy instruments. To date, most national policy instruments focus primarily on regulating recreational harvesting and, as a result, are usually inadequate for hunting for market sale and management objectives, whilst being inappropriate at best for subsistence and livelihood hunters.

Furthermore, since the publication of Beintema *et al*. (2005), AEWA has developed a series of initiatives to implement policies and actions relevant to harvesting, such as the AEWA Plan of Action for Africa and the first international species management plans that include adaptive management frameworks. And, the list of member states has increased since the writing of the last guidelines, hence resulting in a broader range of harvest regimes. In addition, AEWA has called for guidance on restocking for hunting, limits of taking and minimum requirements of proficiency tests (AEWA Resolutions 4.3, 5.3, 5.10), which are all issues closely related to sustainable harvest management.

These guidelines thus take into account the need to broaden the scope and update existing guidance. Whilst reading the revised guidelines it should, however, be borne in mind that huge knowledge gaps exist in the understanding of both motivations for harvesting as well as the ecology of huntable species, particularly in the most distant breeding and wintering grounds. Until these gaps have been filled, the basis for very precise policy guidance will not exist. Nevertheless, these guidelines attempt to take a forward-looking perspective aiming to inspire Parties to advance their policies for the sustainable harvest of migratory waterbird populations. The approach is based on the IUCN and Convention of Biological Diversity (CBD) guiding principles for sustainable use of biological resources (see Section

2.2) and a general principle that sustainability needs to be achieved through cooperation between stakeholders and countries, dialogue and respect, data sharing and mutual learning.

It is suggested that users of these guidelines should also consult the AEWA Guidelines on National Legislation for the Protection of Species of Migratory Waterbirds and their Habitats[1], which provide more detail on how to use national laws to implement AEWA's provisions on, inter alia, taking, disturbance and habitat protection, these all being issues that are also addressed in the present Guidelines.

[1]http://www.unep-aewa.org/manage/en/publication/aewa-conservation-guidelines-no-15-guidelines-national-legislation-protection-species

2. Definition of Terms

2.1 Harvest

We define harvest as the targeted removal of wild animals or their products, such as eggs, feathers or down, from their natural environment. Harvesting includes a range of modes, including shooting and trapping. We also note that harvesting has a range of motives including personal, social, economic and cultural motives. It does not include poaching or incidental mortality such as bycatch (nevertheless, the Guidelines also deal with how to eliminate illegal killing).

2.2 Sustainable utilisation and wise use

According to the European Charter on Hunting and Biodiversity, sustainable harvesting is defined as the legal use of wild game species and their habitats in a way and at a rate that does not lead to the long-term decline of these species, general biodiversity or hinder their restoration. Such use maintains the potential of biodiversity to meet the needs and aspirations of present and future generations, as well as maintaining harvesting itself as an accepted social, economic and cultural activity. When harvesting is conducted in such a sustainable manner, it can positively contribute to the conservation of wild populations and their habitats and also benefit society (Brainerd 2007). In the EU Guide to sustainable hunting under the Birds Directive (European Commission 2008), it is argued that sustainable use corresponds to 'wise use' of resources. Accordingly, 'Hunting, which represents a consumptive use of wildlife, therefore must be seen in the broader context of sustainable use of resources. The concept of wise use, does not necessarily need to be limited to consumptive use. It must recognise that other nature lovers, birdwatchers, scientists and society as a whole also have a legitimate right to enjoy or explore wildlife, as long as they exercise this right responsibly'.

In line with these definitions, the IUCN's Policy Statement on Sustainable Use of Wild Living Resources[2] gives the following guiding principles: 1) use of wild living resources, if sustainable, is an important conservation tool because the social and economic benefits derived from such use provide incentives for people to conserve them, 2) when using wild living resources, people should seek to minimize losses of biological diversity, 3) enhancing the sustainability of uses of wild living resources involves an ongoing process of improved management of those resources and 4) such management should be adaptive, incorporating monitoring and the ability to modify management to take account of risk and uncertainty.

Similarly, the Addis Ababa Principles and Guidelines for the Sustainable use of Biodiversity of the Convention of Biological Diversity list 14 interdependent practical principles to enhance the sustainable use of biological resources, ranging from international and national legislative matters over adaptive management to education and awareness raising[3]. In support of these, the AEWA (see AEWA Resolution 3.19) has invited its Parties to make full use of the Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity as the relevant framework for the sustainable use of biodiversity[4].

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[2] https://www.iucn.org/about/union/commissions/ceesp_ssc_sustainable_use_and_livelihoods_specialist_group/resources/sustainable_use_policy_statement/
[3] https://www.cbd.int/sustainable/addis.shtml
[4] http://www.unep-aewa.org/sites/default/files/document/res3_19_addis_ababa_0.pdf

2.3 Flyways

Boere & Stroud (2006) defined flyways as: *"the entire range of a migratory bird species (or groups of related species or distinct populations of a single species) through which it moves on an annual basis from the breeding grounds to non-breeding areas, including intermediate resting and feeding places as well as the area within which the birds migrate"*. This definition encompasses flyway or biogeographic 'populations' of a single species, multi-species flyways (which is a grouping of populations with broadly similar patterns of movement (e.g. East Atlantic Flyway, Black-Sea Mediterranean Flyway, West Asian-East African Flyway), and global regions of waterbird management (such as the African-Eurasian Waterbird Agreement area). It also emphasises that a flyway represents the entire ecological system that is necessary to enable a migratory population to survive and complete its annual cycle. Bird movements link sites into a unit which has implications both for habitat and harvest management. Flyway or biogeographic 'populations' thus represent useful management units and more details on their delineation is given in the next section.

2.4 Populations

Scott & Rose (1996) recognised several types of flyway or biogeographic 'populations' and this definition is also accepted by AEWA (see document AEWA/MOP3.12 and AEWA Resolution 3.2):

1. The entire population of a monotypic species.
2. The entire population of a recognised subspecies.
3. A discrete migratory population of a species or subspecies, i.e. a population which rarely if ever mixes with other populations of the same species or subspecies.
4. That 'population' of northern hemisphere birds which spends the non-breeding season in a relatively discrete geographic region. In many cases, these 'populations' may mix extensively with other populations on the breeding grounds, or may mix with sedentary populations of the same species during the migration seasons and/or on the non-breeding grounds.
5. A regional group of sedentary, nomadic or dispersive birds with an apparently rather continuous distribution and no major gaps between breeding units sufficient to prohibit interchange of individuals during their normal nomadic wanderings and/or post-breeding dispersal.

However, it is clear and well recognised (Scott & Rose 1996) that in most species of Anatidae that have been subject to detailed migration studies there is no clear-cut relationship between the various breeding and wintering grounds. Flocks wintering in any given area are likely to contain individuals from several of the main breeding grounds and birds from the same breeding areas may often occur in a number of widely separated non-breeding quarters.

3. Context and Scope of these Guidelines

Harvesting, if sustainable, is recognised as a legitimate use of waterbirds and it provides significant social, cultural, economic and environmental benefits to societies throughout the AEWA region, today as well as historically (Green & Elmberg 2014). In its broadest sense and across the AEWA range, harvesting incorporates a number of means for the taking of wildlife or wildlife products, including several modes of hunting (e.g. falconry, wildfowling, shooting), trapping (both live and dead) and aspects such as egg collecting or taking of other products (e.g. down feathers, guano production).

The term harvesting is, however, most commonly associated with hunting; a term which today is used in a way that encompasses a wide range of harvest modes, strategies and motivations, mostly applied to the European context, but not representative for the full spectrum of harvesting. This creates challenges for the development and implementation of policies that provide effective regulation of harvests whilst balancing the needs and expectations of stakeholders in order to retain potential conservation values and benefits to communities through the sustainable use of wild species. In order to sustainably manage waterbird populations, a better understanding of the various types and motivations for harvesting is therefore a prerequisite.

These guidelines build on the original version of the AEWA Guidelines on Sustainable Harvest of Migratory Waterbirds (AEWA Conservation Guidelines No. 5; Beintema *et al*. 2005). The geographic scope has been much extended to encompass the whole AEWA region and thus relates to the implementation of the AEWA Strategic Plan 2009-2017[5] in the African region and the AEWA Plan of Action for Africa 2012-2017[6,7]. The scope of these revised guidelines has also been extended in light of the recent implementation of the first AEWA international species management plans that use an adaptive management approach.

This approach is useful throughout the AEWA region, including Africa, where the lack of data on harvest modes and levels currently prevents any basic harvest management at an international scale, a gap the AEWA Plan of Action for Africa ultimately aims to fill. Furthermore, these guidelines aim to provide a better understanding of the importance of migratory birds as a natural resource at a flyway scale and provide guidance on how to ensure such use is sustainable for the species as well as for the ecological systems that support them.

[5] http://www.unep-aewa.org/en/documents/strategic-plan
[6] http://www.unep-aewa.org/en/node/1984
[7] The time span of the AEWA Plan of Action for Africa and the AEWA Strategic Plan was extended until 2018. by MOP6 through Resolution 6.14 and applies for the period 2012-2018 and 2009-2018, respectively.

4. Aim and Objectives of these Guidelines

The overall aim of these guidelines is to provide guidance on ways of ensuring and managing sustainable harvests of waterbirds in the AEWA region to the benefit of waterbirds and people, whilst acknowledging the enormous diversity across the region in modes and motivations in harvest regimes, biological knowledge, and institutional frameworks and capacity. The guidelines have to bridge situations where knowledge of the status of huntable waterbird populations and their utilization is almost non-existent to those where it is possible to implement advanced adaptive management frameworks that include the refinement of management actions to optimise harvest based on modelling and monitoring.

The gap between these situations is realistic to bridge within the foreseeable future, so we have taken a forward-looking approach to promote an internationally coordinated management system based on common objectives, dialogue and mutual respect among stakeholders with different interests.

The objectives of the guidelines are to:

◊ Promote flyway-scale harvest management of migratory waterbird populations, including the use of adaptive harvest management frameworks, and describe the information and organisational structures needed;

◊ Highlight the necessity for timely flyway-scale estimates of population size and harvest to enable the assessment of harvest sustainability;

◊ Recognise and incorporate the regional diversity in socio-economic circumstances and cultural values of waterbird harvest in harvest management frameworks;

◊ Promote codes of conduct for waterbird harvest, and through education and training, to achieve ecological, social and ethical sustainability; and

◊ Provide specific guidance on restocking, limits of taking, use of lead shot, look-alike species problems, and handling illegal harvesting, as well as habitat management in relation to harvest management.

5. Principles of Sustainable Harvest Management of Migratory Waterbirds

5.1 Why a flyway approach to waterbird harvest management?

The AEWA Agreement Text states '*that any taking of migratory waterbirds must be conducted on a sustainable basis, taking into account the conservation status of the species concerned over their entire range as well as their biological characteristics*'.

The vast majority of waterbirds in the AEWA region are seasonal migrants (or nomadic) and cross several national borders in the course of their annual cycle. The timing of breeding, moulting, migration and wintering is intimately linked to the availability of resources and habitats along the flyways, but the resources critical for the survival and reproduction of the populations may vary in time and space. The flocking behaviour of many waterbird species and the clumped distribution of their resources and habitats mean that waterbirds often concentrate in large numbers at particular sites for feeding and resting outside the breeding season.

Such sites may be linked, not only nationally but also internationally, and they are often used in a sequence (see the Critical Site Network Tool for waterbirds; http://www.wingsoverwetlands.org/). Waterbirds depend on such critical wetlands for foraging in order to fuel body stores during migration, either prior to breeding or wintering, and as they seek shelter from predation, human disturbance and adverse weather conditions (droughts, storms, high tides, frozen conditions).

Management (or a lack of appropriate management) in one part of the flyway, be it harvest or site management related, may have consequences for the status of a population throughout its range. To ensure the long-term viability of populations, and to maintain harvest opportunities, it is logical and of paramount importance that the management of waterbird populations and their sites should take a flyway-wide perspective. Further, besides harvest, the pressures on waterbird populations are generally increasing, which makes it even more important to strengthen the coordinated management of waterbirds, adapting to changing environmental and socioeconomic conditions. It thus follows that it is also important to take an integrated approach to the management of waterbirds, and not look at harvest management in isolation from other factors affecting waterbird populations and their habitats.

Often, current scientific knowledge does not provide for a precise quantitative assessment of the role of harvest in the population dynamics of waterbird populations. Nevertheless, harvest is often seen as a variable which is easy to adjust and regulate compared to other complex environmental drivers of change, such as climate change effects or land use change.

In the case of populations of conservation concern, the restriction of harvest is often used as the prudent and easiest conservation action to stem a population decline. This has led to criticism and frustration by hunters who sometimes feel victims of decisions they see as not justified by quantitative scientific information. To improve the credibility of management decisions, it should be in the interest of all stakeholder groups to strengthen the knowledge base on which decisions are made and share information. This requires that decision-makers, stakeholder groups (including hunters) and scientists work together nationally and internationally at the scale of flyways, and that they agree to a joint reporting and assessment system as well as a mechanism for political-administrative decision-making.

Proposals for such a management system are provided in Section 6.2. The incentives for different groups of stakeholders to participate is that, rather than the status quo, a common system is more likely to ensure the long-term sustainability of populations and their use, and participants will gain insights and have a voice in the decision-making process.

5.2 Biological information needs

The sustainable management of a population requires some basic biological data that can be compared to the total harvest. As far as possible, management should be carried out at the population (flyway) scale; hence, a basic requirement is to agree on population (flyway) delineations including migratory pathways (see Section 5.2.2). However, an informed approach to setting allowable harvests does not require detailed demographic information which currently is not available for the majority of waterbird populations in the AEWA region. Essential to the process, however, are estimates of either the observed growth rate from a monitoring program or the growth rate expected under ideal conditions. The latter can in turn be based on empirical data or on allometric models.

In addition, periodic estimates of population size are needed, as well as either empirical information or reasonable assumptions about population processes, i.e. about the form of density dependence. It should be stressed that whatever the source of information, managers should strive to account for uncertainty in demographic parameters, as well as for the decision-makers' objectives and attitude toward risk. For technical details on minimum information requirements and simple estimation of allowable levels of harvest, see Madsen *et al.* (2015) and references therein.

5.2.1 Flyway definitions

At a broad flyway scale, encompassing multiple species flyways, it would be inefficient to establish separate management structures for each 'population'. Multi-species flyways (i.e., the Pacific, Central, Mississippi and Atlantic flyways in North America) can conceal considerable between-species differences, but provide a useful framework within which to coordinate the management of waterbird 'populations' with broadly similar distributions, such as the Flyway Councils in North America. Thus, they can be considered as administrative groupings for waterbird management within which discussions on harvest management can take place with the opportunity to consult other flyway councils on specific populations that also relate to other flyway councils. In the AEWA region, no similar management structures have yet been identified although truly sustainable management of waterbird populations would not be possible without establishing some structures where range states could discuss and agree on harvest quota (Madsen *et al*. 2015) (see also Section 6.2).

From a harvest management point of view, it is important to recognise that waterbird populations are often defined based on where they winter. This is a practical approach to accurately estimate population size based on winter counts. However, to set up structures for coordinated harvest management, it is equally important to also include areas where harvest may take place during the autumn migration and, in some countries, spring migration.

In the AEWA Agreement Area most huntable waterbird species are wildfowl or waders. Based on Isakov (1967) and the International Wader Study Group the following multi-species flyways can be defined and used as overall management units:

1. **East Atlantic flyway** (including Palearctic wildfowl usually restricted to the Baltic and North Atlantic, and the majority of Palearctic waders wintering along the western seaboard of Africa).

2. **Black Sea - Mediterranean flyway** including the Sahel, it includes Palearctic waterbirds mainly from Central Europe to West Asia but there are also some intra-African migrants restricted to the Sahel only.

3. **West Asian - East African flyway**: with some populations restricted only to Southwest Asia, some waterfowl reaching also East Africa, while Palearctic waders tend to reach also Central and Southern Africa and there are many semi-migratory populations in Eastern and Southern Africa.

Within this delineation, Russia is the source of flyways for most huntable Palearctic species in all three flyways; Germany, France and Central European countries host waterfowl populations that belong to either the East Atlantic or the Black Sea - Mediterranean flyways.

5.2.2 Population delineation

The flyway definition given in Section 2.3 follows the accepted approach used by Waterbird Population Estimates (Wetlands International 2015), which underpin the identification of important sites (e.g. by the Ramsar Convention) and other conservation mechanisms. Further, the flyway atlases for Anatidae (Scott & Rose 1996) and waders (Delany *et al*. 2009) also take this approach. However, there is increasing evidence that there could be substantial overlap between parts of flyways currently treated as discrete populations (e.g. for dabbling ducks see Guillemain *et al*. 2005, for Greater White-fronted Goose (*Anser a. albifrons*) see Mooij *et al*. 1999, Kruckenberg 2007). With the advancement of marking and tracking methods that provide greater insights into the migratory behaviour of waterbird populations, it is likely that our understanding of the suitability the current delineations of individual waterbird 'populations' will be refined and management structures and goals will thus need to adapt. That end will be advanced by integrated analysis of both census counts and movements of marked birds (as stressed by document AEWA/MOP 3.12). The Waterbird Population Estimates (Wetlands International 2015) and its updates should be used as the source of such information.

5.2.3 Population estimates

Without an accurate estimate of population size, it is not possible to determine the sustainability of current harvest levels as these two aspects are interdependent.

Population estimates are usually based on surveys undertaken during the non-breeding season, or more rarely during the breeding season and only occasionally during the migration period. It is important that the season when a population estimation will be undertaken is agreed and an adequate sampling regime is implemented in all countries that encompass the seasonal range.

One of the key factors in determining when surveys for a population estimation shall take place is the period when the population is distinct from other populations (i.e. populations that are delineated based on distinct breeding ranges are best monitored at the breeding grounds and populations delineated based on wintering ranges are best monitored at the wintering grounds). In some cases, counts during migration (at very restricted stop-over sites) might be more practical than surveys on either the breeding or the wintering grounds. Figure 1 provides an overview of the main methods that can be used for waterbird monitoring.

For non-breeding birds, the *International Waterbird Census (IWC)* is used to estimate the population sizes of most waterbirds through the collation of data from national waterbird monitoring schemes. The extent to which the IWC can currently be used to estimate population sizes depends on the coverage of wetlands by the observer network, and its utility is different for different populations. Certain waterbird species whose populations are defined based on winter distribution cannot be well monitored during the general IWC counts because they use wetlands only for roosting (e.g. geese and swans) and spend most of the day on agricultural areas. These species can be either counted when flying in to or out from the roost by experienced observers positioned in a way so that most birds can be counted. Alternatively, special counting areas can be used for monitoring on feeding grounds.

Land-based monitoring of seaducks also usually underestimates their numbers and special aerial or ship-based surveys based on sound sampling design are needed (Komdeur *et al.* 1992). Aerial surveys are also the most reliable method to monitor waterbirds on large floodplains and semi-arid regions with ephemeral waterbodies in Africa where waterbird distribution is highly dependent on the extent of floods and local rainfall patterns.

Usually, there are not enough observers to cover all wetlands in a country and sampling design needs special considerations, because many waterbird species are concentrated at some traditional sites. It is important that the national IWC scheme tries to cover a standard selection of sites, not only including important sites but also wetlands outside of these key sites representing a wide range of habitats. These additional sites are necessary because the internationally and nationally important sites should be the subject of special conservation measures as required by AEWA, but for some more dispersed species those areas outside key sites may, however, contain most of the available habitat. In some cases, additional periodic surveys (e.g. Non-Estuarine Coastal Waterbird Survey; Burton *et al.* 2008) and sampling can help estimating the total wintering population size in the form of multiplier factors to account for birds on minor, uncounted wetlands (see e.g. Musgrove *et al.* 2011). Estimating the total national population is especially important because the distribution of wintering waterbirds fluctuates according to winter conditions and it is necessary to account for the different intensity of monitoring in different countries along the flyway.

Breeding counts represent a major source of population estimates for waterfowl and waders in North America, but they are less feasible in Eurasia primarily for logistic reasons. The Pan-European Common Bird Monitoring Scheme (www.ebcc.info/pecbm.html) is the only generic international breeding bird monitoring scheme in Europe. However, it is more suitable to monitor population trends in the most common waterbird species breeding in the European Union, where a large number of volunteers contribute to the scheme, than to estimate population size.

Colonial breeding bird counts represent the most suitable monitoring method to estimate the population size of seabirds, gulls, terns, pelicans, cormorants and herons (including many species that can be legally harvested in certain countries). Estimating the size of breeding populations of most Anatidae, waders, loons and grebes require special schemes designed according to the particular biology of the species (see e.g. Gilbert *et al.* 2011) and the same would also be true in Africa.

To ensure sustainable harvest, population estimates should ideally be provided each year, which will enable decision-makers to adjust harvest regulations according to the status of populations as well as react to sudden unforeseen changes in population sizes. However, for many populations, this is currently not realistic; it is more realistic to provide estimates at intervals of three years. Under this scenario, however, it is important to have an annual sample to allow for detection of trends.

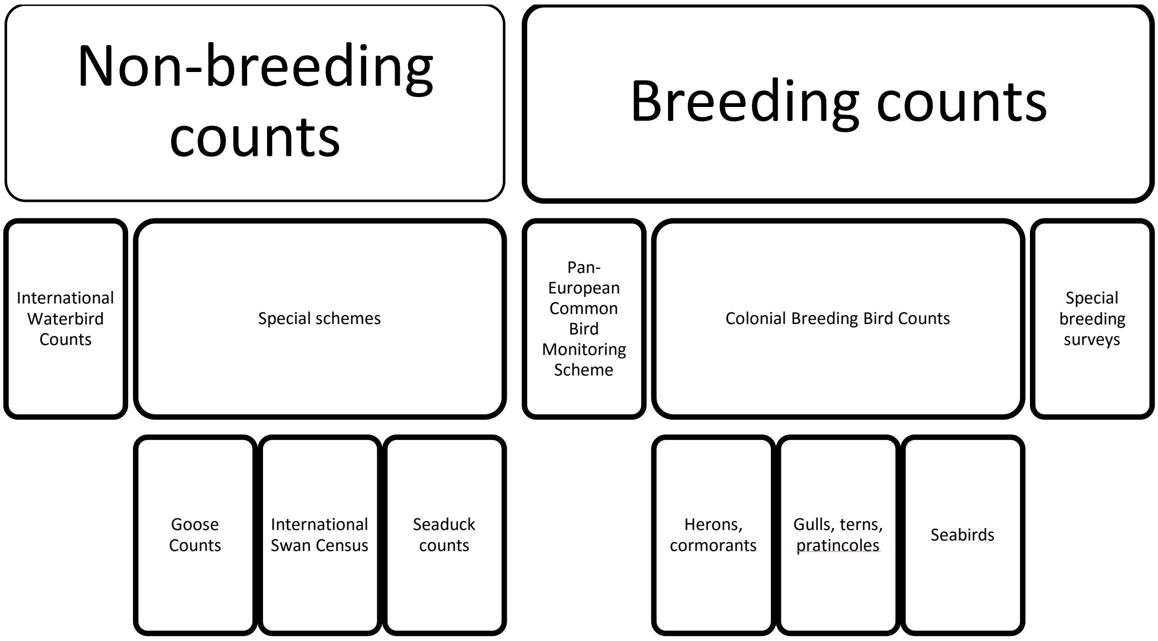

Figure 1. Overview of main monitoring schemes in the AEWA Agreement Area.

5.2.4 Population growth rates and demographic rates

Estimates of population growth rates can be derived from repeated surveys that estimate population sizes, but they can be also be derived from less intensive but still representative monitoring.

Data on demographic rates (i.e. reproductive rates and survival) can help to diagnose the demographic processes and related environmental factors that drive population change. Climate change-related range shifts can also introduce uncertainties in relation to population trend estimates, considering a population trend in the context of known demographic rates can help to assess the reliability of observed trends.

In many waterbird species the age of the individuals can be determined either in the field or from wing samples (Christensen & Fox 2014). The proportion of first-year individuals provides a relative index of breeding success during the previous season. However, it is not only influenced by breeding success but also by any mortality of juveniles, which may take place and can be very high during the first migration episode to wintering areas where age assessments are made (e.g. Guillemain *et al.* 2010). When using wing samples from hunted birds, it should be borne in mind that there may be an age bias arising from first-winter birds being more susceptible to harvest (geese: Madsen 2010; dabbling ducks: Fox *et al*. 2015). Therefore, wing surveys can primarily be used to analyse inter-annual trends in the productivity of a given population or to examine geographical or temporal patterns of age composition of harvest (see also Section 5.4.3), rather than an absolute estimate of annual breeding success.

Apart from a few waterbird species that pass through several plumage stages before obtaining adult plumage, estimating survival rates usually require individual marking and recapture or re-sighting of individuals and thus require systematic marking campaigns at strategically selected locations.

5.3 Knowledge of critical life cycle phases

According to Paragraph 2.1.2 of the AEWA Action Plan, Parties shall regulate any taking of birds and eggs of all huntable populations (listed under Column B) and such legal measures shall in particular prohibit the taking of birds belonging to the populations concerned during their various stages of reproduction and during their return to their breeding grounds if the taking has an unfavourable impact on the conservation status of the population concerned. Hence, defining pre-nuptial migration and breeding seasons for populations is a key requirement for setting open hunting seasons. AEWA has produced an Information document for migratory African-Eurasian waterbirds which is attached as Appendix 1.

5.3.1 Reproduction period

Cramp & Simmons (1977) defined the breeding season as "*the period during which a species lays and incubates its eggs and rears its young to the flying stage*". However, the reproduction period not only covers the breeding season but also includes the occupation of breeding areas as well as the period of young birds' dependence after leaving the nest. Dependence of young birds ends when the loss of parental care does not significantly lower survival prospects of young. The European Commission with the Member States have developed guidance on defining periods of breeding and pre-nuptial migration, initially for the EU15 and more recently for all 28 Member States (European Commission 2009) (see Appendix 1).

5.3.2 Pre-nuptial migration

The EU (European Commission 2008, 2009) defines the wintering period of Palearctic migrants as that which ends, and thus the pre-nuptial migration starts, with the departure from the wintering areas towards the breeding grounds. In the case of Palearctic migrants wintering in sub-Saharan Africa, this means that pre-nuptial migration starts when they begin their return migration towards the Palearctic. For example, Garganey (*Anas querquedula*) winters almost exclusively in sub-Saharan Africa. The first records of this species in Europe are usually in the second half of February, thus indicating that the pre-nuptial migration period has started (and even earlier from Africa). Compared to the case of the Garganey, which is relatively simple, the onset of spring migration cannot generally be assessed from bird counts. Rather, flights (and their direction) should be recorded or, even better, information from marked or tagged birds should be used, as these methods inform about the movements of individuals between separate areas.

In the case of intra-African migrants, the timing of the reproductive period is usually driven more by stochastic environmental factors than seasonality. However, as with Palearctic migrants, they also have non-breeding quarters from where they return to their breeding grounds and this return migration can be considered to be the start of the breeding season. There might be significant differences in the onset of the breeding season of the same species across its range, e.g. the breeding season of the White-backed Duck (*Thalassornis leuconotus*) generally coincides with the period of higher and more stable water levels: within the range of its Eastern and Southern African populations these are September in Ethiopia, April in Uganda, April-August in Malawi, mainly April-June in Zambia. Outside of the breeding season the species congregates on more permanent wetlands from where it disperses to take advantage of ephemeral wetlands. The start of the pre-nuptial migration can thus be considered when birds start their dispersive movements to the breeding grounds. There is general information on periods of reproduction and migration for African-Eurasian waterbirds in Appendix 1.

5.3.3 'if the taking has an unfavourable impact…'

Paragraph 2.1.2(a) of the AEWA Action Plan acknowledges that waterbird populations are close to their minimum population size during spring and that the sustainability of the harvest relies on good reproduction. Even a small harvest during this period might have a disproportionate effect on a breeding population, particularly if sexes follow different migration routes or they pass through stop-over areas at different times, since this could result in a disproportionate take of one sex. Or, in species where pairs are already formed, killing of one of the mates will reduce the chance of the widowed individual to find a new partner and breed.

In the context of AEWA's overall objectives and fundamental principles (including the precautionary principle, which Article II.2 says Parties should take into account when implementing the Action Plan) this provision should be interpreted as follows:

- ◊ If it is known that taking will have an unfavourable impact on conservation status, taking must be prohibited (unless a para 2.1.3 exemption is applicable);
- ◊ If there is not sufficient data to determine whether taking will have an unfavourable impact, taking should be prohibited in accordance with the precautionary principle since it cannot be shown that any take will be sustainable;
- ◊ If it is known that there will not be an unfavourable impact, Parties are not required to prohibit taking (although they may of course choose to do so, per Article XI.2).

5.3.4 Moulting

The moult is another highly sensitive period for waterbirds, especially for wildfowl as they undergo a simultaneous moult of all their flight feathers rendering them flightless for around 3-4 weeks. Often, substantial proportions of populations may aggregate at special moult sites that provide adequate food and protection from predation. Maintaining undisturbed conditions is thus a key part of the management of such sites. Although the large concentration of flightless birds may provide a highly effective harvesting opportunity this should be avoided as it is likely to have a large negative impact on the population. In some cases, the traditional harvesting of moulting birds may be important for indigenous people, and in such cases may continue if strictly regulated in accordance with the principles of sustainable harvest management. In addition, moult concentrations are also sensitive to pollution and should be protected by reducing human activity.

5.3.5 Extreme environmental conditions

Extreme weather events, such as prolonged cold spells with ice and snow that cover wetlands, or of drought, fires or heatwaves in more arid regions, can have significant impacts on food availability for waterbirds and their physiology, causing them to migrate and possibly undergo periods of severe stress (Ridgill & Fox 1990; Zwarts *et al*. 2008). As recognised in Criterion 4 for the identification of Wetlands of International Significance under the Ramsar Convention, it is important to identify and protect refuge areas that may host important waterbird concentrations during such severe weather conditions.

As food availability is more limited during such periods, greater regulation of hunting and other forms of disturbance should be implemented to reflect the increased vulnerability of waterbirds at this time. Temporary hunting moratoriums are recommended to deal with such emergency situations. Since most waterbirds are swift in moving on in response to extreme conditions, harvest limitations may not only be applied to the affected regions themselves, but also those where the birds seek refuge. As delays in decision-making might cause additional waterbird mortality at such times, it is important to define the conditions that should trigger rapid adoption and roll out of such temporary hunting bans in advance, as well as define the stakeholders to be involved in the process. National hunting legislation should contain provisions that allow for such measures to be introduced swiftly when necessary (e.g. Stroud *et al.* 2006). AEWA Conservation Guideline No. 2[8] gives guidance on responses to such emergency situations.

[8] http://www.unep-aewa.org/sites/default/files/publication/cg_2new_0.pdf

5.4 Harvest data on flyway scale

In order to underpin sustainable waterbird harvest management, including an adaptive approach, various data pertaining to the harvest are needed. Much of such data are provided by hunters and allow managers to understand the nature of the harvest and, in conjunction with biological data, make an assessment of its sustainability. When used within an adaptive management framework, these data also facilitate the setting of season lengths and bag limits that are appropriate for the current size of waterbird populations, and thus sustainably manage them.

Current national schemes for the collection of harvest data are extremely variable, from annual mandatory online species-specific reporting schemes organised by the national authorities responsible for wildlife management, to voluntary schemes at local/regional level organised by national hunters' organisations, to a complete lack of data collection. Relatively few range states collect statistics of the types described below that are adequate for an adaptive harvest management approach. These national schemes also vary according to the types of harvesting being carried out; these influence the types of data that can be collected and the manner in which this is carried out.

In Europe, national schemes exist in the majority of countries, and metadata from each are available via the online database ARTEMIS, hosted by FACE (http://www.artemis-face.eu). However, currently there is no centralised flyway-wide data collation and interpretation, apart from a small number of specific exceptions, e.g. Svalbard population of the Pink-footed Goose (*Anser brachyrhynchus*) (Madsen *et al.* 2015). Elsewhere in the AEWA region, national schemes are few in number.

Thus, currently, the basis for flyway-wide management of most huntable waterbirds does not exist due to the lack of coordinated harvest data, although as we have set out elsewhere (Section 6.2), given adequate resourcing this is readily achievable and doing so at a flyway scale would provide significant cost efficiencies and other benefits for those individual countries cooperating in flyway-wide management schemes for the collection of harvest data.

5.4.1 Types of harvest data

The types of harvest data needed for adaptive harvest management are as follows:

<u>Total bag size</u>

An estimate of total bag size at flyway/biogeographical population is needed so the scale of the harvest can be assessed against estimates of population size, provided that these estimates are based on sound sampling design integrating uncertainty. It can best be directly measured on a species-specific basis. It is important to estimate bag size for all types of harvesting (i.e. the total take from the population), including illegal harvest; this can be done using a system such as the one in Iceland where national legislation prevents data from bag returns being linked with permit renewal applications.

<u>Hunter effort</u>

If undertaking a sampling procedure to estimate total bag size, an understanding of hunter effort is crucial for scaling the harvest data in order to assess harvest per unit effort. Simple data like total number of outings including unsuccessful ones should be easily included in harvest surveys.

<u>Age and sex composition</u>

These data provide an important understanding of the composition of the bag that is needed for accurate population modelling and assessment of sustainability. These do not necessary have to be determined by the hunters themselves, but parts survey or collection of hunting bag photographs can be sent to a central place where these are later analysed.

Crippling rates
The number of birds injured through shooting and that subsequently die as a result but which are not retrieved (and therefore not recorded in bag estimates) is an important component of the harvest that needs to be incorporated into population models.

In some cases, harvest trend data have been used to assess sustainability (e.g. Aebischer & Harradine 2007; Bregnballe et al. 2006) but are generally inadequate because they do not reveal underlying causal relationships, hence cannot assess the possible impact of harvest. However, comparing population trends against harvest bag estimates can represent a first realistic step, although with the reservation that such comparison needs to be at a scale encompassing the population distribution.

These data also provide useful information for management purposes on the spatial and temporal distribution of the harvest. With all these data types it is important to evaluate the biases involved by comparing results with estimates from independent sources, such as mark-recapture data (Padding & Royle 2012).

5.4.2 International collation

The assessment of sustainability of harvest as well as adaptive harvest management systems require harvest (and other relevant) data collection schemes to be coordinated at a flyway scale. These harvest data also need to be collated and evaluated promptly and to an agreed timeline (before the subsequent harvesting period), in order to provide a basis for adaptive decision-making regarding the harvest in the forthcoming harvesting period. In many cases, e.g. some livelihood-based harvests, this may not be possible, in which case robust estimates of harvest data (that can be used for a period of time) should be made regularly. These may include methods that incorporate socio-ecological and/or economic surveys.

Within the AEWA region, systems to coordinate flyway-wide harvest management need to be developed in line with the objective of para 4.1.3 of AEWA's Action Plan. It is important to do this efficiently, and this could be achieved through the development of a single data management body responsible for collating all waterbird hunting information from national scheme operators. National scheme metadata (e.g. methodology, geographical coverage, species coverage) should also be collated centrally. Such international coordination is expected to be even more complex and resource demanding, at least to begin with, than the IWC coordination because of all the facilitation, negotiation and data-formatting work that will be necessary.

It is thus likely that international collation and coordination of harvest data will be feasible only if a specifically funded framework is set up for this aim. One option for funding this process is a licensing system for those wishing to hunt waterbirds that generates the necessary income for sustainable harvest management activities (see proposal for such a governance structure in Section 6.2). This would also have the advantage of immediately allowing the quantification of the number of participants in waterbird harvest, which is completely unknown so far.

5.4.3 Input from national schemes

There are a number of methods and means of data collection available to those operating national harvest monitoring schemes. These schemes can be mandatory or voluntary, but whichever is selected it is important that robust harvest data are generated. It is most important, though not essential, that the registration of hunters is mandatory, in order to minimise sample bias being introduced into the subsequent data collection process. Alternatively, the total number of hunters can be estimated by sampling.

An essential prerequisite for any effective harvest monitoring scheme is knowledge of who are hunters, as well as trends within a hunter population. The most effective way of assessing this is through a hunter licensing/registration system that collects basic information about the location of the hunter, the type of quarry they target, and their level of activity. This information provides the basis for subsequent sampling of hunters to collect data on bag size and composition, and other statistics. Various methods exist for sampling from the hunter list (e.g. Raftovich *et al*. 2014). In some countries, only partial non-random knowledge of the hunter community exists, e.g. the members of hunting organisations. However, this can still be used as a basis for a harvest monitoring scheme if the biases and representativeness of the organisations' membership are understood.

Questionnaire surveys are used in some countries to estimate total bag size. This can be measured directly by contact with all registered hunters who are obliged to complete an end of season return, or it can be estimated using a sample of hunters who are selected based on knowledge of their location and activities. A sampling approach requires contact with the hunter before the start of the hunting season so that they know they have been selected to take part, upon which they are usually asked to complete a daily hunting diary; this reduces memory and prestige bias, both of which result in overestimation of harvest (Atwood 1956). Increasingly, these surveys can be conducted using online platforms, although in some cases other methods may be required in order to achieve a sufficient and representative sample of hunters.

In remote areas, typically where most harvesting is carried out for livelihood (either direct consumption or for selling at market), direct surveys of hunters may not be feasible. In such cases it may be possible to monitor harvest by sampling markets where hunted birds are sold. Total harvest may not be possible to estimate using this method, but trends in numbers and species composition of the harvest (provided that there is not a bias towards species of greater value being sold at the market) should be.

Parts surveys, carried out in conjunction with a sample questionnaire survey that provides an estimate of total bag size, are the most common method for estimating species-specific bag size. Parts surveys can also provide an estimate of the age and sex composition of the bag (depending on the species concerned). A clear advantage of a parts survey is that it does not rely on hunters being able to accurately identify the species, age and sex of their quarry. Typically, parts are sent by hunters to a coordinating body, after which they are collated and examined to determine the species, age and sex of each bird. The Danish wing surveys constitute an example of a long-term operating system where hunters voluntarily send in wings from shot waterbirds to a central laboratory with expertise in species identification, sexing and aging[9].

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[9] http://bios.au.dk/videnudveksling/til-jagt-og-vildtinteresserede/vinger

Traditionally, these surveys have been conducted by post, but online surveys now open the possibility of conducting more extensive surveys. The use of digital images may offer an alternative means if images can be accurately captured that allow the determination of species, age and sex (e.g. see Finnish Wildlife Agency “My Hunt” system; https://oma.riista.fi/). Parts surveys can also be useful to verify the accuracy of questionnaire/diary based surveys (e.g. Alhainen *et al*. 2010).

Parts surveys can also provide cost-effective support for wider demographic monitoring for conservation and management purposes (e.g. Christensen & Fox 2014, Guillemain *et al*. 2010, 2013, Péron *et al*. 2012), although it is important to understand the biases involved in collecting data this way (Fox *et al*. 2015).

Crippling can be estimated using x-rays of live captured birds, usually captured as part of long-term marking programmes. This is thus typically conducted by research groups rather than hunters. It does not need to be conducted annually; e.g. the AEWA Svalbard Pink-footed Goose International Working Group conducts such assessments every 2-4 years (Madsen & Williams 2012).

6. Decision-making and Organisational Framework for Harvest Management

6.1 Decision-making framework

In North America, waterbird harvest management has been coordinated within a structured and flyway-based framework for the last two decades (e.g. Nichols *et al.* 2015). This has not been the case in the AEWA region. The text in this section draws on the North American experience, and portions of the text have been excerpted with permission from Williams *et al.* (2007).

The move towards accountability and explicitness in natural resource management has led to a need for a more structured approach to decision-making. Improved clarity about key elements in a decision-making process can help decision-makers focus attention on what, why, and how actions will be taken, as well as their likely impacts. Furthermore, consideration must be given to stakeholders involved in the decision-making or the implementation of policy: who has the authority, responsibility and resources to implement actions. It is important to acknowledge distinctions between those designated as decision-makers and other stakeholders who may implement actions or be affected by them, as well as their respective roles and influence in the decision-making process.

Gaining knowledge and information is vital throughout the decision-making process, not only biological population or ecological data but also social data, i.e. information about human usage of a resource, user goals, motivations and incentives, and the interactions amongst different user groups and institutional organisations. Following a structured decision-making process helps frame management decisions and tasks in the broader socio-ecological context, whereby engagement with stakeholders, the formulation of management objectives and options, the sharing of knowledge and information, a greater understanding of uncertainties and acknowledgement of risk can lead to better management decisions and their effective implementation.

6.1.1 Activities in structured decision-making processes

Activities in a structured approach to decision-making include the following:

- ◊ Developing a shared understanding of the problem in a socio-ecological context;
- ◊ Setting up an appropriate organisational structure for the planning process;
- ◊ Engaging the relevant stakeholders in the decision-making process;
- ◊ Specifying objectives and trade-offs that capture the values of different stakeholders;
- ◊ Setting targets linked to key issues that reflect desired management objectives and outcomes;
- ◊ Identifying the range of decision alternatives from which actions are to be selected;
- ◊ Specifying assumptions about resource structures and functions;
- ◊ Projecting the consequences of alternative actions;
- ◊ Identifying key uncertainties;
- ◊ Measuring risk tolerance for potential consequences of decisions;
- ◊ Accounting for future impacts of present decisions;
- ◊ Accounting for legal requirements and constraints.

Once a good understanding of the social-ecological context is developed, the remaining activities need not be carried out sequentially, as long as they are carried out as part of an iterative and learning process. It is this iterative process, whereby decision-makers actively engage, act and learn with stakeholders that can lead to the institutional changes required for ensuring the sustainable management and harvesting of waterbird populations.

Scientists assist the process by providing predictive models to better understand the biological system and predict outcomes of management actions, as well as by providing guidance on the design of monitoring protocols needed to assess the effects of alternative management actions. Scientists can also facilitate the iterative learning process as 'honest brokers' to ensure that the scientific models and evidence are correctly interpreted, and then incorporated into decision-making processes according to the overall objectives.

6.1.2 Sustainable management and harvesting of waterbird populations as part of a socio-ecological system

Management of migratory waterbirds is largely about managing human organisations and it requires coordination between countries and people who often have different socio-economic, political and cultural settings and values. Therefore, assessing and taking into account how human interests relate to the status and ecology of the target species is an important prerequisite if international management plans are to be effective.

A good understanding of the socio-ecological system is therefore the first step in the process. This requires assessment of:

◊ The biological/ecological system;

◊ The spatial and temporal scales at which management is to be applied;

◊ The socio-economic-political systems in the geographic range of the target species:
  - Regulatory governance frameworks (international directives, treaties, conventions, national legislation that pursue biodiversity protection and sustainable use); and
  - Regulatory regimes (which may encompass a range of cultural aspects: customs, norms, as well as economic market forces that can influence the outcomes of a governance system);

◊ Stakeholders: who are they? What are their expectations? And what influence do they have on the system and the target species?

Successful development and implementation of a management plan requires understanding the linkages between governance levels (from international to local, and between stakeholder groups) and feedbacks among different elements of the socio-ecological system, from international to local levels. This facilitates dialogue, learning and decision-making amongst institutions and groups, as well as helping connect both top-down (e.g. regulatory instruments) and bottom-up (e.g. co-management of waterbird habitats and the organisation of hunting via local voluntary agreements between stakeholder groups) initiatives. It is also important to recognise the boundaries of the management plan, i.e. what is realistically within and beyond the scope and influence of the plan in question. For example, a management plan is unlikely to change an international directive or convention, but can influence national/regional regulations or policies.

6.1.3 Organisational structure

It is important to build sufficient institutional capacity and networks that can facilitate decision-making processes and ensure the transfer of knowledge at multiple levels. Building trust between stakeholders is key to success and this is best achieved by:

- ◊ An open and transparent process;
- ◊ Communication across all governance levels;
- ◊ Respect for various viewpoints and trade-offs (such as scientific and local knowledge); and
- ◊ Understanding of the participants' roles in the process.

Developing and implementing a management plan requires leadership and long-term commitment by institutions and by people who are able to bridge the viewpoints of various stakeholders and have the capacity to keep the process going, including securing the funding for its operation.

An organisational structure should reflect the relevant scale, levels and types of governance and stakeholder interests (see Section 6.2). Organisations that can play an intermediary function between different levels and scales, known as boundary or bridging organisations, can enable the co-production of knowledge and facilitate stakeholder participation with decision-making processes (Cash *et al*. 2006). Some AEWA International Species Working Groups are an example of such bridging organisations.

A management plan will most often provide a set of alternatives of future scenarios, as well as advice and guidance, as part of the decision-making process. The responsibility for making the ultimate decision will lie with the national regulatory agencies or governments. Thus, the mandate of the management plan IWG and the role of individual participants should be clearly defined from the outset to reflect its scope and manage expectations.

6.1.4 Information management

One of the critical aspects of a structured decision-making process is the utilization and application of information (information management). This is particularly the case in relation to the explicit recognition and handling of uncertainties that are inherent within complex socio-ecological systems (Rauschmayer *et al*. 2009, Berghöfer *et al*. 2008). Not only are there biological uncertainties but also uncertainties about human aspects of the socio-ecological system, e.g. behavioural responses to and economic consequences of management actions.

A first step is to recognise and clarify potential sources of information, not only scientific but also local experience-based knowledge and expertise (Berghöfer *et al*. 2008). Hunters can be a good source of information for scientists, providing insights about the local dynamics of waterbird populations, their behaviour and resource use. In addition, understanding the goals, motivations and behaviours of hunters can help gauge the likely impact of management actions and ultimately their effectiveness.

In order to gain a fuller understanding of the socio-ecological system, collaboration is required between ecological and social scientists. Information requirements will also depend upon, and should be aligned with, the likely management strategies to be employed. The challenge then is to integrate and transform these different knowledge types into formats that are accessible and usable for those involved in the decision-making process. Locally derived experience-based knowledge is often generated over shorter time spans than scientific knowledge. This has additional implications for integrating both knowledge types into an iterative decision-making process where knowledge availability and its timing may not coincide with key decision points. The synthesis of information and knowledge is likely to require new formats, mechanisms and a willingness to share it, not only between scientists, managers and lay stakeholders but also between scientific disciplines, e.g. the biological and social sciences (Berghöfer *et al*. 2008).

The use of information within adaptive management, as part of an iterative decision-making process, can help tackle issues related to uncertainty. The inclusion of stakeholders as part of this process, combining scientific and localized knowledge, can help develop solutions that are tailored to a specific context and ensure effective implementation of management actions by involving relevant actors. To enable this deliberative and discursive process will require new organisational (institutional) structures and arrangements to engender and sustain collaborations for the adaptive co-management of waterbird populations. These organisational structures will, in turn, need to be able to adapt as the context of the biological and socio-economic systems changes.

6.1.5 Adaptive management

Adaptive management is itself a structured approach to decision-making, in that it includes the key elements described above. The distinguishing features of adaptive management are its emphasis on sequential decision-making in the face of uncertainty and the opportunity for improved management as learning about system processes accumulates over time. Adaptive management can be described in terms of a set-up or planning phase during which some essential elements are put in place, and an iterative phase in which the elements are linked together in a sequential decision-making process (Figure 2). The iterative phase uses the elements of the set-up phase in an on-going cycle of learning about system structure and function, and managing based on what is learned.

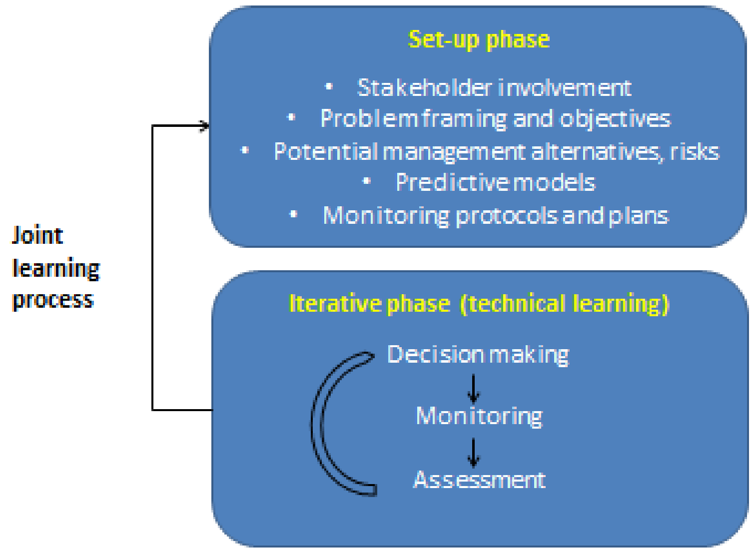


Figure 2. Process of adaptive management (from Williams et al. 2007).

The elements in the set-up phase of adaptive management include:

- ◊ Stakeholder involvement;
- ◊ Objectives;
- ◊ Management alternatives;
- ◊ Predictive models; and
- ◊ Monitoring protocols.

Stakeholder involvement

Stakeholders bring different perspectives, preferences, and values to decision-making. It is important to have at least some stakeholder engagement in all the set-up elements of a project, and to continue that engagement throughout the project. A key challenge is to find common ground that will promote decision-making despite the potential for disagreements among stakeholders about what actions to take and why. Failure to engage important stakeholders, and disagreement about how to frame a resource problem and identify its objectives and management alternatives, are common stumbling blocks.

A crucial step to ensure effective stakeholder participation is the systematic identification of relevant decision-makers (with the authority or mandate for making decisions), actors (with responsibility for management actions), and other stakeholders (with an interest in the situation but not necessarily carrying authority or responsibility) for consideration within the decision-making process. Stakeholder analysis (*sensu* Conroy and Peterson 2013) can be used to identify and assess the importance of different people, groups or organisations in terms of:

- ◊ The ability of the decision to affect the stakeholder;
- ◊ The stakeholder's ability to affect the decision by asking a series of questions:
  - Who is potentially affected by the decisions made?
  - Who is usually involved in similar decisions and (just as importantly) who is normally excluded and why? Should they be included now?
  - Who can provide knowledge of how the system works, e.g. biologists, ecologists, and social scientists?
  - Who has the legal authority and is able (i.e. has the resources) to implement management actions?

Distinguishing between decision-makers, actors and other stakeholders can help clarify the role of these different stakeholder types in the process and their potential influence on outcomes. Once initial stakeholders have been identified it must be borne in mind that these stakeholders can (are likely to) change over time or as new situations arise. A flexible approach for stakeholder participation is likely to be needed, using a variety of participatory methods, to encourage different stakeholder groups to learn from each other over time.

Objectives

Successful implementation of adaptive management depends on a clear statement of plan objectives. Objectives represent benchmarks against which to compare the potential effects of different management actions, and serve as measures to evaluate the effectiveness of management strategies. Objectives can often be represented by measurable targets, but these must be explicitly linked to the issues under consideration and desired management outcomes. Targets, such as those for populations and habitats, should be informed by scientific assessments but must also be agreed upon as part of the collaborative decision-making process, as they are socially constructed measures.

Management Alternatives

Adaptive decision-making requires the clear identification of a set of potential alternatives and scenarios from which to select an action at each decision point. Some actions might affect the resource directly; others might have indirect effects. Learning and decision-making both depend on our ability to recognise differences in the consequences of different actions, which in turn offers the possibility of comparing and contrasting them in order to choose the best action.

Predictive models

Models play a critical role in adaptive management, as expressions of our understanding of the resource, as engines of ecological inference, and as indicators of the benefits, costs, and consequences of alternative management strategies. Importantly, they can represent uncertainty (or disagreement) about the resource system. Models are used to characterize resource changes over time, as the resource responds to fluctuating environmental conditions and management actions. Where data allow, predictive models may be complex, but in situations where data are more fragmentary models may simply be conceptual and reflecting of professional judgment.

Monitoring Protocols

Monitoring provides the information needed for both learning and evaluation of management effectiveness. The value of monitoring in adaptive management is inherited from its contribution to decision-making. To make monitoring useful, choices of what ecological and socio-economic attributes to monitor and how to monitor them (frequency, extent, intensity, etc.), must be linked closely to the management situation, objectives and targets that motivate the monitoring in the first place, as well as practical limits on staff and funding. While monitoring the ecological sustainability has been an integral part of the development of the adaptive management approach, monitoring the effect of decision-making on social and economic sustainability is also an important part of the process to ensure that decisions can be successfully implemented.

In the iterative phase of adaptive management, the elements in the set-up phase are folded into a recursive process of:

- ◊ Decision-making;
- ◊ Follow-up monitoring;
- ◊ Assessment;
- ◊ Learning and feedback; and
- ◊ Institutional learning.

Decision-making

The actual process of adaptive decision-making entails decisions at recurring points in time that reflect the current level of understanding and take into account future scenarios and consequences of decisions. Decision-making at each decision point considers management objectives, resource status, and knowledge about consequences of potential actions. Decisions are then implemented by means of management actions on the ground.

Follow-up monitoring

Monitoring provides information to estimate resource status, underpin decision-making, and facilitate evaluation and learning after decisions are made. Monitoring is an on-going activity, conducted according to the protocols developed in the set-up phase.

Assessment

The data produced by monitoring are used, along with other information, to evaluate management effectiveness, understand resource status, and reduce uncertainty about management effects. Learning is promoted by comparing predictions generated by the models with data-based estimates of actual responses. Monitoring data can also be compared with targets representing desired outcomes, in order to evaluate the effectiveness of management and measure its success in attaining management objectives.

Learning and feedback

The understanding gained from monitoring and assessment helps in selecting future management actions. The iterative cycle of decision-making, monitoring, and assessment, repeated over the course of a project, leads gradually to a better understanding of resource dynamics and an adjusted and improved management strategy based on what is learned.

Institutional learning

Periodically it is useful to interrupt the technical cycle of decision-making, monitoring, assessment, and feedback in order to reconsider project objectives, targets, management alternatives, trade-offs, cost-benefits of the plan process and other elements of the set-up phase. This may be necessary because the socio-ecological system changes in a direction that was not originally foreseen and it may require a change in the stakeholders involved in the process. This reconsideration constitutes an institutional learning cycle that complements, but differs from, the cycle of technical learning. In combination, the two cycles are referred to as “double-loop” learning.

6.2 Governance structure needed to manage harvest at flyway level

6.2.1 Regulatory instruments available (AEWA, EU Birds Directive)

AEWA and the EU Birds Directive provide a legal framework for sustainable management of migratory waterbird populations. The main shortcoming of both instruments is that it leaves harvest decisions of a shared resource to individual Member States and Contracting Parties without providing a shared information base and mechanism to assess the impact of harvest and coordinate actions in relation to mutually agreed objectives. With regard to migratory waterbirds, a shortcoming of the EU Birds Directive is that it does not encompass entire flyways where these extend beyond the EU.

AEWA Parties are under a broad obligation to ensure that any use of migratory waterbirds is sustainable (Article III.2 (b)). To ensure the conservation and sustainable harvest of waterbirds in the AEWA region, different management regimes are set out in the AEWA Action Plan for waterbird populations according to their conservation status. In general, Parties shall prohibit the taking of birds and eggs from the populations that are listed in Column A of Table 1. However, for a small number of these, hunting may continue on a sustainable basis if undertaken within the framework of an international species action plan that implements the principles of adaptive harvest management (Paragraph 2.1.1).

In the case of populations listed in Column B of Table 1, Parties shall regulate the taking of birds and eggs with the objective of restoring or maintaining these populations at a favourable conservation status

(Paragraph 2.12). Although Parties are permitted to grant certain types of exemptions to the taking-related prohibitions required by AEWA, these must not operate to the detriment of Table 1 populations (Paragraph 2.1.3). The AEWA Action Plan also recognises that certain populations may cause significant damage, in particular to crops and to fisheries, and requires Parties to collaborate in developing species management plans (Paragraph 4.3.4).

Within the European Union, the Birds Directive constitutes a legally binding framework applicable to all Member States. Article 2 of the Directive requires Member States to maintain the populations of European bird species at a level that corresponds to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt a population to that level. Such requirements include hunting as one of the legitimate uses of waterbirds and also recognise the positive effects hunting can have on waterbird populations through habitat maintenance and predator control. In principle, only the species listed on Annex II of the Directive can be hunted across the EU or in certain Member States, and in all cases, Member States shall ensure that the hunting of these species does not jeopardise conservation efforts in their distribution area (range) as required by Article 7.

Although Parties to AEWA and EU Member States are individually responsible for complying with the requirements of the Agreement and the Directive, it is also important to realise that, for migratory species, individual countries cannot take rational harvest management decisions in isolation. It is essential that such decisions are taken in collaboration with other range states and with a full understanding of the status of the 'population' (i.e. its total population size, its growth rate) and the total harvest of the population. Indeed, Paragraph 4.1.1 of the AEWA Action Plan requires Parties to 'cooperate to ensure that their hunting legislation implements the principle of sustainable use … taking into account the full geographic range of the waterbird populations concerned and their life history characteristics'; while paragraph 4.1.3 requires cooperation 'with a view to developing a reliable and harmonized system for the collection of harvest data in order to assess the annual harvest of populations listed in Table 1'.Without explicit agreement between the range states on the distribution of harvest, there is a high risk of over-harvesting.

In North America, coordinated adaptive harvest management is well-established and the principles developed there underpinned the first species management plan developed in the AEWA region, for the Svalbard population of the Pink-footed Goose, which was adopted by MOP5 in 2012. This management plan has tested the mechanisms that could be further expanded in order to implement adaptive harvest management for other hunted populations in the AEWA region (see http://pinkfootedgoose.aewa.info/). The key structures for adaptive harvest management in the AEWA context are derived from the experience with single species action plans and should comprise:

◊ An International Working Group (IWG);
◊ A Flyway Coordination Unit; and
◊ National Working Groups (NWG).

6.2.2 International Working Group

As a minimum, adaptive harvest management at a flyway scale requires policy-level agreement amongst relevant range states concerning the management objectives and related actions, including allocations of allowable harvest. Without such agreements, it is not possible to plan for coordinated efforts for recovery or regulating numbers and it is possible that conservation efforts elsewhere will be jeopardised. An International Working Group should thus include both policy and technical experts representing their Range State. Besides decision-making and coordination amongst the range states, an International

Working Group would also be responsible for involving other relevant stakeholders to provide input and agree upon objectives and actions.

6.2.3 Flyway Coordination Unit

A Flyway Coordination Unit should be responsible for technical support of the International Working Group through the collection and synthesis of monitoring and harvest data. As such, it can act as an honest broker by analysing the consequences of management actions, communicating assessments to the relevant International Working Group, facilitating the exchange of information and knowledge, as well as maintaining records of the management process to ensure transparency (see Madsen & Williams 2012).

6.2.4 National Working Groups

Ideally, decision-making at a flyway scale is not a top-down process. Lasting agreements require input from the bottom-up to find solutions to management challenges and to distribute ownership of the process for effective implementation. National Working Groups would thus:

- ◊ Provide fora to determine the mandate/position of the national representatives in the IWG and, after an agreement is reached;
- ◊ Provide fora to develop and implement actions towards achieving the agreed objectives; and
- ◊ Ensure communication of agreements at the international level to relevant national decision-making bodies and other stakeholders.

Consequently, National Working Groups should ensure that the relevant authorities (i.e. the ones responsible for wildlife management, nature conservation, wetland management, etc.), key user groups and other stakeholders are involved in its work and thus indirectly the IWG. The NWGs should include the national technical institutions responsible for monitoring of population status and harvest.

6.2.5 Short-term and longer-term goals

So far, the above structure has only been tested for a single population (Svalbard population of the Pink-footed Goose). In order to avoid the inevitable duplication that multiple single population processes would provide, and to better coordinate and develop efficient and cost effective strategies in a common approach to international management, it is proposed to develop IWGs for groups of populations that would benefit from common, or very similar, management protocols and actions.

Such groups of populations are likely to include geese in northwest Europe and European seaducks. Such multispecies management plans would require a Flyway Coordination Unit collating and assessing timely population-specific monitoring data, as well as species- specific data on harvest from all range states involved. An International Working Group would act as a governing body and will provide guidance on population specific actions, based on a set of overall objectives and principles.

In the longer term and based on the first experiences with multispecies management, the processes could perhaps be further streamlined to cover entire flyways (e.g. East Atlantic flyway), including the central European flyway and central Asian flyway, and subsequently cover intra-African flyways. In these latter regions, more case studies are first needed in order to better understand the harvest systems, both at biological and socio-ecological levels, before embarking upon the development of a more sophisticated approach.

A first step could be to focus on tourism hunting, as this form of hunting is generally organised and controlled by AEWA Parties in Africa (Sissler 2000). However, the two already better known cases of subsistence/commercial hunting (Lake Chilwa in Malawi and the Inner Niger Delta in Mali) could serve as pilot studies for the development of multispecies adaptive management in Africa.

6.2.6 What additional resources are needed for an international management structure?

International management of shared wildlife resources will require sharing financial resources, e.g. in the form of national contributions to run a Flyway Coordination Unit on a permanent basis (Section 6.2.3), including a facility to collate harvest data on an international basis, and for attending meetings of an International Working Group (Section 6.2.2). For those countries which do not have an appropriate harvest monitoring system at present, its development and cost of maintenance need to be funded.

7. Understanding Modes and Motivations for Harvesting

7.1 Why the need to know motivations?

To achieve, develop and devise sustainable harvest management, regulatory authorities need to understand their constituency. Specifically, this includes understanding the motivations, modes and objectives to decide on the appropriate tools, mechanisms and management actions to ensure sustainable harvest. Otherwise, non-compliance, no (or little) cooperation and illegal behaviour occur and hamper the successful implementation of management decisions.

There are multiple motivations, objectives and modes for harvest throughout waterbird flyways. Modes are sometimes basic (stick), sometimes creative (ashes spread on ground), and sometimes non-specific (hooks and nets). Motivations may include livelihood support, nature experience, maintenance of personal identity, subsistence, recreation, social networks, tradition, culture and beliefs, commercial, trophy hunting (not common in relation to harvesting of waterbirds), trade and hunting for nature stewardship.

Personal identity, social networks, tradition, recreation, culture and beliefs are all part of a non-commercial activity that increases the wellbeing of the people involved rather than an economic profit. Modes might include harvesting in groups such as in clubs or with friends, in a community, or as individuals, and can be carried out as trapping, shooting, archery, with dogs or birds of prey (i.e. falconry), or the collecting of eggs, down and feathers. Some techniques, such as poisoning, nets and hooks, are listed in Paragraph 2.1.2 (b) of the AEWA Action Plan, requiring Parties to prohibit their use unless an exemption permitted by the Agreement applies.

While hunting in Europe is mostly for reasons other than livelihoods, in Africa it is often practiced for livelihoods. Paragraph 2.1.2 (b) also permits Parties to grant exemptions to accommodate harvest for livelihood purposes, where practiced sustainably. For instance, in the Arctic, where subsistence harvest in some areas is directly linked to food security issues, Arctic people are in many cases exempted from national harvest regulations. As long as they do not result in unsustainable use, such exemptions are permissible under AEWA. The arising challenge of sustainability needs to be tackled and it is of utmost importance to better investigate harvest levels and modes to be able to develop management plans that incorporate and reflect livelihoods of local people. Knowledge gaps remain significant in many regions of Africa, the Middle East, central Asia and the Arctic, but also in Europe.

Understanding hunting motivations, objectives and modes allows the development of tools and control mechanisms to adapt harvesting by accounting for, or changing, hunter behaviour. Examples of targeted management actions include top-down mechanisms such as day, season and hunter limits, fees and closure of specific areas, as well as bottom-up mechanisms such as shared management of a resource or an area. Bottom-up mechanisms support self-organisation of hunters and representation at higher governance levels, which is the case in the AEWA International Species Management Plan for the Pink-footed Goose where local hunting representatives participate in the negotiations about appropriate measures to regulate the harvest by the International Working Group[10].

It is recommended that decisions on harvest regulations take into account local modes and motivations for harvesting using social science and participatory approaches; this knowledge allows the development

[10] http://pinkfootedgoose.aewa.info/

of management actions that are able to change behaviour within the range of local modes and motivations and thus foster collaboration, buy-in and support from local people. This can be facilitated through the creation of national and local working groups, feeding into the international process, and composed of decision-making authorities, stakeholders and scientific institutions supplying national population and harvest information (see also Section 7).

7.2 Motivations

Here we provide a list of motivations for and objectives of legal harvest. For the purpose of these guidelines we use the following definitions;

Subsistence relates to basic provisioning, usually in a climate of uncertainty or extreme remoteness, in this case waterbirds for food or barter for other basic necessities.

Livelihood: For an explanation of livelihoods we use the definition of Chambers and Conway (1991): "*A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term*".

Commercial motivations involve the monetary trade of waterbirds for profit to support an existence above a livelihood threshold, which will vary from country to country.

Trade: In the context of waterbirds trade involves the transfer of the ownership of waterbirds or waterbird products in exchange for other goods or services or for money. Trade can be linked to subsistence, livelihood, commercial and other motivations (e.g. incidental selling of waterbirds by recreational hunters).
With this, subsistence, livelihood and commercial trade will all have different motivations and at different levels, which for the purpose of management will demand different interventions.

Livelihood & subsistence
Subsistence and livelihood hunting is recorded in at least nine African countries and in numerous areas of the Arctic. Two of the best documented cases of livelihood waterbird harvest in Africa are in the Inner Niger Delta in Mali and at Lake Chilwa in Malawi. In both cases, commercial hunting and hunting for conflict resolution with rice cultivation are also common practices. At Lake Chilwa, possibly more than one million waterbirds (mainly Anatidae and Rallidae) are shot or trapped in gill nets, collars, hoop nets or birdlimes by over 400 farmers and fishermen for their own consumption and for trade to augment farming or fishing income (Van Zegeren & Wilson 1999, Bhima 2006).

This trade is estimated to generate over 200,000 USD on an annual basis. In the Inner Niger Delta Bozo fishermen traditionally trap tens of thousands of waterbirds, mostly ducks and waders, for their own meat consumption as well as for additional income through market trade (Tréca 1985, 1989, Traoré 1996, Kone *et al*. 1999, 2000, 2002). They use guns, nets, traps and snares. The overall socio-economic value of this waterbird harvest activity remains relatively unknown although some preliminary approaches have been developed on a sample of villages (Kone *et al*. 2002). In both the Malawi and Mali cases, subsistence hunting is so successful that significant commercial hunting activity has developed in parallel. Livelihood hunting is probably widespread in Africa, although possibly under-recorded in many countries (e.g. storks are hunted in many northern African countries).

In the Arctic, motivations for hunting are often highly mixed. The meat not only represents the traditional diet and a vital source of nourishment, but may also be an integral part of the emotional, spiritual, and cultural well-being of indigenous Arctic people. With respect to provisioning, hunting in the Arctic is very often part of a mixed household economy, which blends formal and informal economic activity. The formal economy provides the cash needed to purchase e.g. snowmobiles, dinghies, rifles and other tools needed for hunting, while the meat and products from hunting make up the informal contribution to the economy through barter and savings associated with being partially self-sufficient (Ross & Usher 1986, Huntington 2013).

In Greenland, commercial hunters are allowed to sell the meat or other animal products, and hunting thus becomes part of the formal economy. In some Arctic communities, hunting (combined with other natural food sources, e.g. fish and berries) is more tightly linked to food security as the formal economy is insufficient to secure such needs (see definition in FAO 1996). A perhaps extreme example is the Nunavut region in northern Canada, where an Inuit Health Survey (2007-2008) reported that nearly 70% of households of indigenous people were food insecure (Rosol *et al*. 2011).

<u>Commercial hunting / trade of killed waterbirds</u>

Besides Lake Chilwa and the Inner Niger Delta, the Nile Delta (in Egypt) provides another example of long-lasting commercial hunting (well described by Mullié & Meininger 1983, Goodman *et al*. 1989) in an important north African wetland complex. It was estimated that, on average, half a million waterbirds of over 60 species were sold annually in markets of the largest cities of the Nile Delta during the 1980s. They were shot or trapped using ancient traditional nets or traps, e.g. clap-nets or hexagonal nets (Heneim 2001).

Commercial hunting is prohibited in most Arctic countries, with the exception of Greenland (see above) where the harvest is sold at local markets in the larger cities and constitutes a long-lasting tradition (Merkel & Barry 2008). However, the number of active commercial hunters has decreased considerably over the past 20-30 years, as has the length of the open season and the daily quota (Huntington 2013).

Within the European Union, the Birds Directive prohibits trade of wild birds, although according to Article 6, it may be permitted, for species listed in Annex III part A (throughout the whole territory) and III part B (within the territory of member states making provision for certain restrictions), provided that the birds have been legally killed or captured or otherwise legally acquired, and after consultation with the European Commission. The AEWA Review on Hunting and Trade legislation found only slight discrepancies between the Birds Directive's Annexes II and III and the AEWA Action Plan and its Table 1. However, EU Member States may also choose to introduce stricter measures than those provided for under the Birds Directive.

Quantitative data on the scale of trade in waterbirds in the EU is not readily available, but it appears that trade in waterbirds is not a primary motivation for harvest. This mainly takes place for species which are shot in larger numbers, as in the case of the Mallard (*Anas platyrhynchos*); in some countries, hunters also sell shot geese to game meat product dealers, but few are able to make a living from it.

<u>Culture and beliefs</u>

Black Crowned Crane (*Balearica pavonina*) is captured and kept alive for household domestication in Mali at least for its cultural, aesthetic and medicinal values (Kone *et al*. 2007). This species is traditionally believed to bring good luck, protect from spirits and intruders, and eat bugs. They are generally not consumed but parts of their body are used to improve or regain health, social status, cure diseases and protect against evil spirits. For these reasons, this species is thus largely captured for sale and traded in Mali and beyond. Another example of hunting for traditional belief by Ndebele people in Zimbabwe is the persecution of plovers (probably from the genus *Vanellus* or *Charadrius*) because of their association with witches (Msimanga 2000).

Nature experience, recreation, trophy hunting

Waterbird hunting in developed countries is mostly motivated by nature experience and recreation, and less so for trophies. For example, Vaske *et al*. (1986) found that high satisfaction among waterfowl hunters in the USA was achieved through a combination of interactions with wildlife other than the target species, with the target species and with other participants, as well as through the sport/challenge aspect. Satisfaction did not increase with bag size (Vaske *et al*. 1986) which is in line with other waterfowl studies from the USA (e.g. Schroeder *et al*. 2006) indicating that satisfaction is primarily driven by overall experience rather than hunting success.

Hunting ecotourism for waterbirds is widespread in Europe and Africa. Generally, little documentation of its biological and socio-economic effects exists. In Africa, where this economic activity remains poorly studied (but see Sissler 2000), there are at least 10 countries where waterbird hunting can be practiced through specialised ecotourism agencies. Almost all these agencies operate waterbird hunting from North Africa, the Sahel region or, mainly, in southern Africa, but there is almost no information available on their harvest practices, bag size, and other data.

Conflict resolution through waterbird hunting

This is a major issue in Europe and Africa. In Africa, conflicts are mostly recorded in relation to ducks, geese and waders in Sahelian ricefields, where they are consequently shot and netted (Tréca 1989), and with Egyptian Goose (*Alopochen aegyptiacus*) in South Africa, where the largest flocks in agricultural fields are recommended to be shot (Mangnall & Crowe 2002); further conflicts with this species possibly occur in the region of Lake Nasser where it can be legally hunted.

Northwest European goose numbers have doubled or tripled over the last few decades. Countries affected by rising goose numbers include the United Kingdom, Belgium, The Netherlands, Germany, Denmark, Sweden, Norway and Estonia. Tombre *et al*. (2013) outlined the use of hunting as part of an adaptive management process to manage goose populations in Norway. This involved three main groups of stakeholders with opposing objectives that resulted in conflict: environmentalists (BirdLife Norway), stakeholders with agricultural interests (Farmer’s Union) and hunters (Norwegian Association of Hunters and Anglers). Hunting quotas can play an important part in resolving the conflict (economically and socially) in combination with other actions, such as subsidies, compensation and scaring schemes (Bunnefeld *et al*. 2015).

7.3 Conflicts and synergies

Conflicts arise when parties have opposing views on the motivations, objectives and modes of hunting. Modes of hunting of one party can impact and limit the activities and the choice of hunting modes of another party. This often leads to unsustainable use, loss of socio-economic benefits and ultimately loss of biodiversity. Understanding the motivations, modes and objectives of a particular constituency can help to understand and mitigate competing or conflicting activities and the impact of these activities on the natural system and the people involved. Conservation conflicts are defined as ‘situations that occur when two or more parties with strongly held opinions clash over conservation objectives and when one party is perceived to assert its interests at the expense of another’ (Redpath *et al*. 2013).

Conflicts can be considered as decision-making problems with multiple parties seeking different outcomes (Colyvan *et al*. 2011). The idea of conflict resolution is to bring those parties together to find a shared solution to the problem that all parties can accept. In many cases, a clear consensus may not be possible because of three main constraints (Redpath *et al*. 2013):

- ◊ A stakeholder can only win or lose and any compromise is seen as a loss, e.g. during conflicts over protected or rare bird species conservation, parties with conservation interests may not be prepared to compromise on their objectives (e.g. strictly no hunting), such that there is no genuine search for shared solutions;
- ◊ One party does not depend on the resource for their livelihood (e.g. conservation organisations), whereas the other party does (e.g. farmers), making the pay-offs between parties unequal, e.g. situations in which one party may aim for total protection of a species, even if the species (e.g. geese) can have economic consequences for other stakeholders (e.g. farmers); and
- ◊ Excessive uncertainties, including environmental stochasticity, about system functioning and responses to management actions, prevent engagement.

Conflict resolution projects therefore need to understand both (a) the conditions under which negotiated solutions are likely to be possible, and (b) what outcomes are likely for different ecosystems and their characteristics when solutions are negotiated vs. when stakeholders act solely according to their own interests.

A range of conservation conflicts can occur over increasing waterbird populations between different groups of stakeholders. Mapping the type and people/organisations involved in these conflicts is crucial for making successful mitigation decisions. For example, conflicts all over Europe arise between those focused on the conservation of waterbirds (i.e. conservation NGOs), those focused on the production of food (i.e. farmers) and those focused on the use of waterbirds (i.e. hunters), since many waterbird populations (e.g. geese, swans, and cranes) have increased greatly in many areas.

However, it would be too simplistic to view this as a conflict between farmers, environmentalists and hunters, because governments may play an important role in the conflict, for example by implementing local and national regulations in relation to EU obligations for the conservation of waterbirds (EU Habitats and Birds Directives). Equally, conflicts can arise between different groups of hunters along the flyway over the (sustainable) use of the same waterbird population. People sharing an interest in hunting and birdwatching can actually contribute to a better understanding of viewpoints and have been shown to have a broader conservation interest (Cooper *et al.* 2015).

A range of approaches exist for conflict management and should be employed to allow parties to develop synergies. Approaches and tools for conflict management include:

- ◊ Game theory, which allows participants to understand the strategic interactions between two or more parties;
- ◊ Multi criteria decision analysis to map and rank non-economic objectives; and
- ◊ Socio-ecological modelling to predict the effects of management actions on conflict mitigation and future sustainable harvesting (Bunnefeld *et al*. 2011).

Innovative collaborative approaches to flyway-scale harvest management could potentially include payments for maintaining suitable habitats and payments for sharing harvests (Kark *et al*. 2015).

7.4 Need for information

To evaluate the objectives and motivations of harvesting it is important to estimate the number of engaged in harvesting as well as collecting data about their motives, activities, practices, the off-take, and the contribution of harvesting to their wellbeing/livelihood. The value of sampling and appropriate analysis at the appropriate scale might be more efficient than a total account. There are various scientific approaches and methods to gather information about the constituency which include scientific methods for the analysis of samples of the constituency to make inferences about hunters, including:

- ◊ Hunter and harvest registration (demographics);
- ◊ Questionnaire surveys (e.g. typology of hunters, experience seeker vs bag hunter);
- ◊ Participatory appraisal (e.g. stakeholders to share knowledge);
- ◊ Economic accounting and valuation of harvest activities (e.g. willingness to pay); and
- ◊ Market surveys and household consumption surveys.

To be able to move towards sustainable management, information about the users should be collected, collated and provided. A range of tools and methods are available to facilitate the collection of information about users (Milner-Gulland & Rowcliffe 2007). In many countries, hunters, along with their harvest, are registered. Such information can include demographic information which provides valuable understanding of effort, in turn allowing trend estimates based on catch per unit effort in relation to who hunts. This information can be used to develop a typology of users (e.g. experience seeker vs bag hunter) that will allow for more nuanced management actions targeting specific groups. The methods most often used include questionnaire surveys or interviews with individuals and groups.

For example, in the Camargue, southern France, private and public hunting estates cohabit. Hunting managers from almost 50% of the Camargue private estates have voluntarily sent the estates' bag statistics to ONCFS since 1999 (Mondain-Monval *et al*. 2009) following a series of meeting interviews. For the public estates, a simple questionnaire form has been given to 2,000 hunters on communal and company shooting estates since 2004. The voluntary return of these forms to ONCFS is still rather low with *c*. 5% returned. These harvest statistics often include long-term time-series of species-specific bag data and also a measure of the hunting effort involved so that it can be scaled by hunting day, by hunter and even by hectare of hunting estate. Trends in the bag records are compared with the trends in wintering numbers for the corresponding species in the West Mediterranean region, and estate specific results are provided to managers as a tool to help with sustainable management.

More indirect methods include household consumption surveys and market surveys. The value of a natural good/product can be estimated using various economic valuation methods such as ones that provide a measure of willingness to pay for said good/product (e.g. meat, opportunity for harvest, etc.). An overview of tools and approaches is provided by Milner-Gulland & Rowcliffe (2007).

7.5 Tools to control harvesting by accounting for and changing user behaviour

There is a range of traditional control mechanisms to limit harvesting in relation to user behaviour, of which the more classical ones are temporal (i.e. to limit the time, number of days, the length of the season, daily bag limits) demographic (the number or age of hunters) and spatial (area). These measures tend to be accompanied by punitive measures to ensure adherence.

Other tools also exist where incentives are given to enhance control and/or change behaviour. For example where management can support self-organisation and devolution of rights to resource users, this can lead to sustainable community-based resource management. Another tool that has potential is payment for ecosystem services (PES), to cover the costs of restoration, conservation and management of multiple and potentially competing ecosystem services (Bullock *et al*. 2011). An example of PES has been developed since 2002 in the Inner Niger Delta aiming at reducing waterbird hunting (van Eijk & Kumar 2009). This 'bio-rights' mechanism could financially support alternative activity through bank microcredit provided that those being granted the credit agree to stop harvesting waterbirds.

8. Code of Conduct in Harvesting

Box 1. Examples of Code of Conducts in harvesting

Wildfowlers code
(UK – Solway Estuary wildfowling poster, BASC (then WAGBI) circa 1970)**:**

- Know your quarry
- Cut long range shooting
- Wildfowling will be judged by your behaviour

The ten commandments of the wildfowler:
(France; translated from Cheyron. 1995)

1 Acquire a perfect knowledge of birds in conditions of optimal visibility;

2 Learn their natural behaviour;

3 Carefully choose your optics and look after them;

4 Gain knowledge of your wetland and the birds present;

5 Use visual reference points and note placements of decoys;

6 Memorise the shape and size of decoys;

7 Take time to let your eyes adjust to low light conditions;

8 Look, listen, compare, and have confidence in those with more experience;

9 Remain humble and continue to gain or renew experience;

10 All birds which cannot be identified should be considered as protected;

Final word; never forget that the selectivity of hunting is the result of both knowledge and the ethics of the hunter.

8.1 Which requirements do hunters need to have to hunt in a sustainable way?

Quality of hunting is only ever as good as the hunter's personal attitude towards their way of hunting. Knowledge and learning also strongly influence the way of harvesting. Thus, hunters should have:

<u>The willingness to hunt in a sustainable way</u>
As defined in Section 3, a fundamental aspect of harvesting wild resources is to ensure that its use does not compromise the future use of the resource. When hunting more sedentary game birds this concept becomes very clear; if too many are hunted or the habitat is mismanaged one year, the following year's harvest will be poor. This provides a strong motivation for sustainable hunting.

For migratory waterbirds the situation differs in that the individual hunter can feel less empowered and perhaps less responsible for the conservation of the resource because the effects of overexploitation or poor habitat management may not be apparent, or may be considered the result of the actions of others. Existing ethics, codes of conduct and regulation help to reduce the risk of overexploitation (Box 1).

Regardless of the impact of hunting, it should be the aspiration of all hunters to do so sustainably and with due attention to the fact they are a shared resource throughout the flyway. In the words of the Ramsar Convention (1971) and repeated in the Edinburgh Declaration (2004): "*Waterbirds, in their seasonal migrations may transcend frontiers and so should be regarded as an international resource*".

The long-standing challenge of developing international coordination of harvest is becoming more important than ever. Protection that was previously afforded by the remoteness of breeding and wintering grounds is now under threat, as are the habitats themselves. On a more positive side, advances in our knowledge of waterbird populations, new technological means of communication and the development of harvest management strategies mean that such coordination is now more achievable than ever before.

To conclude it is not only necessary to have the will to hunt in a sustainable way, but also the will to engage in an international process for the conservation of migratory waterbirds.

<u>Species knowledge</u>
The examples of earlier codes of conduct for wildfowlers in Box 1 show the importance given to this aspect. The message is clear: To acquire good species recognition skills under hunting conditions and not to shoot if there is any uncertainty.

The most effective means to learn such skills is to accompany experienced hunters, and take time to learn which species are present in the hunting area. Identification guides, including those specifically for hunters, are invaluable, as identification in low light - when hunting often takes place - is more challenging than during the day. These guides can also provide lists of huntable and non-huntable/protected species. Having such guides in national/regional languages is also important and these should be provided in conjunction with practical training on species knowledge and best practice for efficient and sustainable hunting.

<u>A general understanding of the sustainability concept</u>

From a biological point of view:
Harvest should be biologically sustainable (see definition in Section 2.2). In this context it should be ensured that hunters are informed about conservation measures that can be taken to improve

reproductive success and reduce mortality, and the role they can play in their implementation. This will of course vary depending on geographic location. It is also a benefit that greater knowledge of the biology and behaviour of species will enhance the experience of hunting.

From a socio-economic point of view:
It is an advantage for hunters to ensure that their practices are also socially sustainable, but this will depend on the political and cultural context in a given country. Other than the requirement that hunting should be biologically sustainable, the aspect of 'usefulness' is important as it plays a role in the wider social acceptance of hunting. The opinion of hunting may be greater where it has a wildlife management role, such as reducing damage to agriculture or by providing meat. Access to hunting should also be equitable, involving local communities.

From an ethical point of view:
Linked to the above issue on public opinion is the need to ensure a high standard of welfare for harvested waterbirds, and that the harvest is properly used.

'The sportsman's aim is to achieve the instantaneous kill of each bird or animal that he or she shoots at, and then its speedy retrieval so that it is put to good use and not wasted. Every bird and animal (including so-called 'pest' species) is a sentient creature and should not suffer unnecessarily as a result of our sporting shooting or pest control activities.' (BASC 2010).

Hunters must be:

- ◊ Aware of hunting regulations and comply with them;
- ◊ Aware of the possibilities and limitations of hunting methods used;
- ◊ Able to use the hunting methods in an adequate / proper way, to avoid:
  - Crippling;
  - Loss of dead birds; and
  - Disturbance.
- ◊ Able to identify short term major problems for the species, such as periods of prolonged cold weather, drought or food shortages, and be willing to adapt their hunting intensity to this situation;
- ◊ Hunters must see themselves as proud and responsible stewards of a natural resource;
- ◊ Respectful of other users of nature.

Example:
The reduction of crippling of wildlife arising from shotgun shooting is an important issue in Danish wildlife management, and a national plan to reduce crippling has been in place since 1997. The focus is on ensuring hunters adhere to a short shooting range for their quarry (e.g. recommended maximum range is 25m for geese, 35m for duck), and use the right ammunition and shotgun for the given purpose. Avoidance of crippling has been built into national proficiency tests and awareness campaigns, including practical training, and has been implemented by the authorities and the Danish Hunters' Association. Overall, this has led to a decrease in crippling rates, e.g. for geese (Noer *et al*. 2007). To avoid the loss of dead or severely crippled birds, it is mandatory to have a retrieving dog in the hunting team.

8.2 How can hunters contribute personally towards a sustainable hunting regime?

Creating personal interest in natural resources, e.g. a sense of ownership, is seen as a useful component of nature conservation (Sterner & Coria 2011). Involving hunters as stakeholders in any kind of processes can foster feelings of ownership among them and thus support sustainable management approaches. This includes:

Reporting harvest

As highlighted above, harvest statistics (including hunting bags) are important to allow the assessment of harvest levels and their sustainability, and to set regulations accordingly. They are also important for the accountability of hunting activities and ensuring the continued inclusion of hunting within the domain of sustainable use of natural resources. However, it should be highlighted that a prerequisite for hunters to report their harvest statistics is the existence of a suitable, adequately resourced and functioning national reporting scheme.

Contribution to waterbird monitoring

This remains an aspect which would benefit from greater collaboration between hunters and organisations involved in monitoring waterbird populations. Besides population counts, there is also an opportunity for hunters to collect biological samples, e.g. wings, that provide demographic data (age and sex ratios) which can help our understanding of the drivers of population change (Christensen & Fox 2014) and samples to test for avian influenza viruses and other diseases. Furthermore, in cases where accurate direct counts are missing, the reporting of harvest statistics may also be used as a population monitoring tool (Grauer *et al*. 2015), in particular of cryptic and/or widely dispersed species, which are difficult to monitor, e.g., Common Snipe (*Gallinago gallinago*) and Jack Snipe (*Lymnocryptes minimus*) (Olivier 2007, Coreau *et al.* 2014).

The contribution by hunters to monitoring of the populations can also create local ownership and incentives to protect the resource. For example, in West Greenland, where spring hunting of Common Eider (*Somateria mollissima*) has been banned to improve the conservation status of the population, local hunters in the breeding area carry out the breeding population monitoring following the guidelines provided by the biologist from the Greenland Institute of Natural Resources. The community-based monitoring has improved the trust between biologists and users who see an incentive to protect the Eiders as a meat and down resource (Merkel 2010).

Contribution to waterbird habitat conservation

The opportunity to hunt waterbirds provides a strong incentive to conserve the wetlands and other habitats upon which they are dependent. Hunters are also well placed to conduct habitat conservation activities as they are organised in a structure, allowing the pooling of resources, and have direct links with land use and site managers / owners (see case studies Section 10.2). Ducks Unlimited[11] in North America provides a much valuable example on what voluntary involvement of hunters can produce in terms of wetland habitat management and conservation (Batt 2012). Further, the long-lasting Federal Duck Stamp Program, based on annual mandatory payments by American waterfowl hunters and voluntary payments by conservationists in general, provides large-scale funding for wildlife habitat conservation and management[12].

In some wetland complexes (e.g. Senegal Delta, Senegal/Mauritania; Venice Lagoon, Italy; Rhone Delta, France), vast areas of natural wetland habitat are maintained, as incomes from hunting are, for the time being, still more profitable than those from agriculture. Providing that hunting is practiced on a sustainable basis and in natural habitats, resources generated by hunting, often in association with fishing (e.g. leases, game meat, fish), can be economically sustainable and can compete with some other

[11] http://www.ducks.org/
[12] http://www.fws.gov/birds/get-involved/duck-stamp.php

forms of land use that are more detrimental to biodiversity (Mathevet & Mesléard 2002). As hunting generally targets only a few typically widespread species within their natural habitats it is often beneficial to a wide array of other, often rare and protected, species that use the same habitats. In this context, the contribution of the private hunting sector is of significant conservation benefit (Otero *et al*. 2003). Additionally, the established Community Based Natural Resource Management Policy in Namibia which devolves rights to communities over the management and use of wildlife has contributed to the protection of some key wetland habitats.

<u>Sharing expertise</u>
Hunters contribute to biodiversity conservation in a wide variety of ways. In an increasingly urbanised world they retain a link to nature regardless of where they live. Hunters carry with them traditional knowledge and practices that are still relevant today in the conservation of nature[13]. They often share their experience to the public (e.g. FNC 2009). Considering the huge challenges facing biodiversity, more effort is needed to share the expertise of the stakeholders in waterbird harvesting to advance towards common goals.

8.3 What can hunters expect from others to support their sustainable actions?

<u>Communication to raise awareness of the value of hunting and sustainable practices amongst hunters and non-hunters</u>
The Agreement sees sustainable harvesting as an appropriate way of using a natural resource. Hunters will almost certainly more readily support activities to sustain waterbirds, if other local stakeholders also show their commitment to this AEWA principle. Communication is required to place hunting in perspective and explain its various forms, including the environmental and societal benefits. In the future, a particular challenge will be to secure the involvement of subsistence and livelihood hunters into the broader harvest management framework. Not only will this allow improved decision-making, but it will also ensure a local commitment to waterbird conservation and that all-important sense of ownership of the shared resource (Beintema *et al*. 2005).

Experience shows that the commitment towards participating in activities supporting waterbird conservation and management can be enhanced by the provision of pertinent information, in particular when hunters provide data there must be adequate feedback on the results. Thus, it is important to provide information about the following, where available:

- ◊ Waterbird population status (short / mid / long term) and drivers of observed trends;
- ◊ Basic population dynamics;
- ◊ How to participate in monitoring efforts;
- ◊ Annual conditions on the flyway (e.g. winter conditions);
- ◊ Hunting methods (new ones, possibilities and limitations);
- ◊ Techniques to improve or restore habitats.

<u>Hunters can expect that recovered species can be hunted again</u>
A general criticism of hunting regulations, by hunters, is that they tend to move towards stricter protection, and once a species has been removed from the list of huntable species it remains so indefinitely. This may result in the loss of interest in the species, including for monitoring and

[13] FACE Biodiversity Manifesto (http://www.face.eu/sites/default/files/documents/english/bdm_en-_final.pdf).

indefinitely. This may result in the loss of interest in the species, including for monitoring and conservation measures. Furthermore, this may cause reluctance to protect new species as some become a cause for conservation concern. By essence, adaptive harvest management should facilitate a process of return of a species to a quarry list following recovery, thus creating an incentive for action and better acceptance for future removals from the quarry list.

8.4 Education and training of people engaged in harvesting

The processes of and needs for education and training relating to the harvesting of migratory waterbirds varies significantly across the flyways depending on the social context and the modes of harvest taking place. The experience of individuals is also highly variable, from rural people born into families where harvesting of wild resources is commonplace, to someone living in a city taking up the activity in middle age. Assumptions should never be made about an individuals' level of knowledge.

The objective of education and training is to create competence and responsibility among those harvesting migratory waterbirds, and a culture within which a lack of this is deemed unacceptable. The means of achieving this should be adapted to national and regional conditions. '*For practices to be ecologically and socially sustainable, those using wild resources are advised to be responsible and proficient regarding methods, equipment and species they utilise'* (Brainerd 2007).

8.4.1 General requirements

To hunt in a sustainable way, hunters need to have the knowledge described in Section 9.1 - code of conduct in harvesting.

To ensure that hunters do have this knowledge:

- ◊ Already established systems could be applied more widely (licencing/exams, with adequate prior training);
- ◊ The transfer of local knowledge could be promoted by:
  - – Establishing local hunting associations and clubs that can disseminate new knowledge;
  - – Using traditional ways of passing experience for example apprenticeship or other forms of mentoring.

The creation of hunting associations and local clubs are useful means to coordinate activities, share knowledge, educate, raise awareness, gain political influence and increase engagement in general. The topics that should be covered in education and training for sustainable harvesting include:

- ◊ Biological issues, e.g. species identification, concept of flyway conservation, critical life stages, habitat conservation, wildlife disease;
- ◊ Legal, e.g. national / regional regulations, especially lists of huntable species, trade restrictions;
- ◊ Hunting methods, e.g. shooting (firearms safety, shooting skills, types of ammunition, judging distance), capture (avoiding non-target species, ensuring high standard of welfare of captured birds);
- ◊ The use of harvested game and how to avoid wastage.

Proficiency tests covering the above aspects are a useful means of achieving a high and standardised level of knowledge among hunters, but may not be applicable in all countries. Traditional ways of educating are also recognised as a valuable tool but it needs to be ensured that basic knowledge

addressed in the code of conduct is being shared. In order to achieve this, training by local organisations is probably the most efficient way of reaching a high standard of knowledge.
To promote sustainable harvesting in countries where proficiency tests are not appropriate, traditional authorities may act as supervising bodies. These traditional authorities therefore need to be aware of the concepts of sustainability and flyway conservation.

To promote commitment towards proficient hunting, hunters should be encouraged to contribute towards the establishment and implementation of a sustainable hunting regime at an international level.

9. Specific Management Issues Related to Harvest

9.1 Limits of taking

In this Section methods of harvest regulation at national and regional/local levels throughout the flyway are listed. The reason for limiting any particular harvest is to avoid overexploitation of the resource. More precise objectives and a greater buffer against potential overharvest are required for species undergoing significant population decline, especially in situations where there is incomplete information on population parameters and/or levels of harvest.

There are various means for limiting harvest which may be used in combination, including:

- ◊ Restrictions on who can harvest and by which method;
- ◊ Which species can be harvested and in what quantity; and
- ◊ Where and when they can be harvested.

In terms of regulation, harvest limits can be statutory or voluntary. It is preferable to have a statutory basis, but this can be reinforced by voluntary measures which are more flexible, less administratively burdensome, and obviously are often associated with greater endorsement by local hunters. Table 1 provides a summary of these means and the advantages and disadvantages of each. All of these examples constitute ways of implementing para. 2.1.2 (c) of the AEWA Action Plan.

Fox & Madsen (1997) summarise guidance on the optimal establishment of refuge areas derived from extensive experimental evidence (see also Section 10.3.2).

Table 1. Advantages and disadvantages of different methods of harvest regulations.

Type of limit	Options	Advantages	Disadvantages
Spatial	Various types of protected area (AEWA Action Plan para. 3.1.1) of differing scales and levels of protection from hunting – from small game refuges to large protected areas. Intermittent access may also be possible – see temporal below.	- Simple approach which can be useful in the absence of more detailed regulations (e.g. licensing, species lists, seasons); - Useful where an open access system is in place (outside protected areas); - Useful for particularly important or sensitive sites; - A well-planned network of refuges can provide win-win benefits for waterbirds and harvesting through 'spill-over' effects on populations outside refuge areas.	- Can create unfair restrictions on those involved in harvesting if other activities are permitted without restriction; - Limits potential benefits of presence of those authorised to harvest (e.g. surveillance, management measures).
Temporal	Open/closed seasons (AEWA Action Plan paras 2.1.2.(a)), diurnally, inter-season closed periods, limited days per week or per season. Harvesting clutches of eggs only at the start of the nesting season to allow adequate time for re-laying of second clutches.	- Avoids harvesting at sensitive times of the year (e.g. stages of reproduction, migration to breeding grounds); - Depending on timing, closed seasons can be very effective in reducing harvest (e.g. periods of peak migration to wintering grounds); - Restriction to morning and evening flights limits disturbance; - Restriction on which days harvesting is permitted, can facilitate enforcement measures, as well as co-habitation with other activities.	For many recreational hunters, the opportunity to hunt is as important, or more important, than achieving a harvest. In some cases, temporal restrictions may not necessarily reduce total harvest, but can create unintended disadvantages for hunters.
Species	See AEWA Action Plan paras 2.1.1 & 2.1.2.	Important for protection of species/populations in unfavourable conservation status, such as those in Column A, category 1 and categories 2, 3 not marked by asterisk.	Requires international coordination in case of cross-border migratory waterbirds.

Type of limit	Options	Advantages	Disadvantages
Cohort/Sex	Sex/age selection (e.g. males only). Protection measures for different populations.	Permitting selectivity within a species, through regulation or voluntary agreement, may provide an alternative to banning harvest of the whole species.	- Not always feasible to set-up (sometimes impossible) depending on species (dimorphic species) and/or hunting methods.
Personal (who can harvest)	Licence systems for persons allowed to harvest Permit systems for species to harvest. Local organisation of hunting (AEWA Action Plan para. 4.1.7)	- Provides basis for controls, education if exam/test involved, generates revenue to cover administrative costs and potentially conservation measures; - Local organisation/clubs help coordinate harvest and self-governance via peer pressure.	- Requires governmental resources for administration and enforcement, but once running can be financed via licence/permit fees; - Will not be perceived as fair
Quantity	Bag limits, daily and seasonal basis Quota on regional or national level. Partial take of clutches of eggs	- Annual quotas can be a component of an Adaptive Harvest Management Plan With daily bag limits as one means to regulate harvest in order to reach quota; - Harvest can be distributed among licence/permit holders; - It is a good practice in voluntary codes of conduct to moderate harvest	- Can be administratively burdensome; - Bag limits may not be effective in limiting overall harvest unless very restrictive; - May encourage hunters to regard bag limits as a target to be reached, when they would otherwise shoot less.
Methods	See AEWA Action Plan para. 2.1.2(b) "*prohibit the use of all means capable of causing mass destruction, as well as local disappearance of, or serious disturbance to, populations of a species, including…*"	Important to ensure that harvest is both sustainable, selective and socially accepted.	Note: Some prohibited methods can be used sustainably, as acknowledged in paragraph 2.1.2.b to accommodate for livelihood purposes, as long as this is sustainable.
Emergency moratoriums	Statutory or voluntary protection in cases of extreme events (AEWA article III.2(f) & Action Plan para. 2.3), *e.g.* moratorium during severe weather conditions, such as	Avoids pressure on birds during times when they are susceptible to over-exploitation owing to their concentration in a particular area and/or reducing opportunities to	Requires good communication network to inform those involved in harvesting that conditions are poor in their region as well as elsewhere in the

Type of limit	Options	Advantages	Disadvantages
	drought or prolonged harsh winter conditions.	feed when birds already have poor body condition.	flyway). However, this problem can be reduced through necessary advanced development of contingency plans with stakeholders.

9.2 Use of lead shot

Lead is an extremely toxic substance and has a wide range of adverse physiological effects in animals and humans (EFSA 2010, Franson & Pain 2011). To reduce human exposure to lead, its use in the composition of many common products has been progressively reduced and eradicated by law in housing (paints, plumbing) in many countries. The World Summit on Sustainable Development (2002) specifically stressed the need to work to prevent, in particular, children's exposure to lead.

Game meat containing lead gunshot is a dietary cause of exposure to lead in Europe (Pain *et al*. 2010, Green & Pain 2012) and, although not specifically studied, in Africa. Most lead pellets contained in the cartridges shot by hunters do not reach their target, but fall into wetlands or other shot-over habitats. Cartridges generally contain about 30-35g of lead which equates to hundreds of pellets, depending on pellet size. Lead pellets may accumulate at different rates in the top layer of wetland sediments, depending on the nature of those sediments, vegetation characteristics and other environmental factors (e.g. climatic and hydrological). Where shooting has been intensively practiced for a long time, up to several tens of spent pellets per square metre may be found on the ground (Pain 1991).

Many bird species, like ducks or waders, ingest grit which they retain in their gizzard, a muscular part of their stomach. The grinding action of the grit inside the gizzard crushes and breaks down food items. Unfortunately, birds can mistakenly ingest spent lead pellets as grit or food particles. These pellets are then eroded in the gizzard, and dissolved by stomach acids. High concentrations of resulting toxic lead salts can then accumulate in the tissue of the bird's vital organs, leading either to death or to a range of sub-lethal effects that in turn can enhance mortality from other causes. For example, in Europe, it has been estimated that up to 8.7 % of the total population of different species of waterbird may die each year of lead poisoning (Mateo 2009).

To act against this unnecessary death and poisoning of birds (which leads to a reduction in the total harvestable resource), Paragraph 4.1.4 of the AEWA Action Plan requires Parties to "*endeavour to phase out the use of lead shot for hunting in wetlands as soon as possible in accordance with self-imposed and published timetables*".

Efficient non-toxic shot alternatives now exist at affordable prices and many countries have already prohibited the use of lead shot in wetlands and several more generally. Based on these countries experiences, AEWA produced several guidance documents to inform Parties about this issue and to advise those that have not yet taken any action against lead poisoning of waterbirds on how to do so[14].

[14] AEWA Web links regarding lead poisoning:
http://www.unep-aewa.org/sites/default/files/document/inf2_2special1-engl_0.pdf
http://www.unep-aewa.org/sites/default/files/publication/lead-shot-en_0.pdf

French example: Between 1995 and 2005, a lead shot ban was self-imposed at the Tour du Valat Foundation estate in the Camargue (southern France). The 15 hunters from this estate used steel shot for an 11-year period whilst lead shot was still allowed for shooting in the rest of the country, since the national ban on lead shot in French wetlands was only enforced from 2006 (Mondain-Monval *et al*. 2015). It was calculated that during this 11-year period, ca 500 kg of lead would have been spread over the 403 ha of wetlands in this estate had this self-imposed lead shot ban not been enforced. The analysis of the gizzards of ducks shot by this small group of hunters showed that at the end of this 11-year period, ca. 8 % of the ducks foraging and killed in this estate had ingested steel pellets. This occurrence of steel pellet in the duck gizzards can be attributed to the steel pellets introduced to the environment by the 15 local hunters only, as lead shot was not yet prohibited at this time in France nor in other countries of this region (Black Sea/Mediterranean). Although hunting pressure was moderate on this estate (0.04 hunters/ha), this example illustrates how fast and important the contamination of birds through ingestion of spent pellets may occur, and how quickly the scale of the problem can be reduced by switching to alternative non-toxic ammunition.

Furthermore, several rare and sometimes endangered species of raptors which prey or scavenge on other birds or mammals shot with lead, may in turn be contaminated (Pain & Amiard Triquet 1993, Fisher *et al*. 2006, Mateo 2009, Berny *et al*. 2015). Because problems may also arise for other groups of birds in terrestrial habitats where shooting with lead occurs, and many waterbirds feed in these habitats too (as well as partial restrictions being complex to enforce), the Contracting Parties to CMS adopted Resolution 11.15 on 'Preventing poisoning of migratory birds', the guidelines of which call for a rapid phase out of the use of lead ammunition in all habitats and its replacement with non-toxic alternatives[15].

9.3 Look-alike species problems

Some waterbird species look similar and are therefore difficult to identify in the field. Therefore, hunters and managers must consider this issue in order to avoid the accidental hunting of rare and protected species that resemble game species that can be hunted. To minimise the risk of accidental hunting of protected species, the first step is to enhance the knowledge and skill of hunters so they can correctly identify the species concerned. Such capacity building must be included, where appropriate, in a proficiency test (see Section 10.2; and AEWA Action Plan para. 4.1.8).

An initial list of look-alike species for the western Palearctic has been prepared by the AEWA Technical Committee[16]. It is the responsibility of Parties to use this document to identify the possible risks of misidentification between protected and game species in their country based on this information. It is also their responsibility to ensure hunters are aware of these risks. Furthermore, as the status of waterbird populations change over time and are reassessed at each MOP, Parties should re-evaluate this issue and their national quarry list after each MOP.

A comprehensive assessment of the risk of confusion must not only consider the similarity between different species in terms of their size, shape, plumage, field marks and vocalizations, but also compare the timing of their migration, their distribution at national and local scales, their behaviour, and their habitat use, the likelihood that a certain hunting method is applicable to both species etc. Only such an integrated analysis can enable a proper assessment of the probability that two or more look-alike species will really be encountered by hunters in the field at the same given time and place. For instance, two

[15] http://www.cms.int/sites/default/files/document/Res_11_15_Preventing_Bird_Poisoning_of_Birds_E_0.pdf

[16] http://www.unep-aewa.org/en/document/guidance-dealing-accidental-shooting-look-alike-species-western-palearctic

look-alike species can have different (or not) periods of migration or different (or not) habitat or local distribution when feeding or roosting, and these factors all affect the degree of risk of accidental hunting.

Once risk has been assessed, the scale and extent of preventive measures should take into account the conservation status of the species involved. If the risk of accidental shooting is deemed to be so high that it might potentially hamper conservation efforts of an endangered protected species, and if no satisfactory solution (e.g. in adapting hunting techniques or timing, e.g. shooting before dawn and after dusk when it is difficult to discriminate species) to avoid it can be found, it would be precautionary for hunting managers to prohibit the shooting of both species, at least in those areas and during periods of joint occurrence.

The problem of accidental hunting is typically addressed more specifically in relevant International Single Species Action Plans. Parties should follow the recommendations of those plans regarding this issue. Per Paragraph 2.2.2 of the AEWA Action Plan, Parties are further called upon to consider, when appropriate, 'the problem of accidental killing of birds by hunters as a result of incorrect identification of the species' in the *national* single species action plans required for Column A populations.

Further guidance can be found in the Guidance document on hunting under Council Directive 79/409/EEC on the conservation of wild birds, *The Birds Directive*, pages 30, 31 & 76 (European Commission 2008).

9.4 Restocking for hunting

9.4.1 Current practice

Restocking for hunting[17] involves the release of native captive-reared animals within the range of wild conspecifics to augment harvest opportunities. Within the AEWA region, it is commonplace in Europe, and for waterbirds almost exclusively involves Mallard. Historically, the translocation and release of Greylag Goose (*Anser anser*) in order to increase goose shooting opportunities was also widespread in some countries, but large-scale restocking of Greylag Goose no longer occurs, although smaller releases to improve local hunting opportunities may take place.

In Africa and southwest Asia, the practice is believed to be significantly less common or even entirely absent, though information is lacking from these regions. Within Europe, recent research has significantly increased the general understanding of the issue (e.g. Champagnon 2011, Söderquist 2015), however it remains poorly monitored and the long-term impacts on wild conspecifics are not properly understood. This is in part due to a lack of licensing and regulation in most countries, and in part due to a lack of focus on the issue by hunting stakeholders. A comprehensive review of restocking was undertaken by Champagnon *et al*. (2012a).

Few accurate data exist about the scale of releases, but it is likely that more than three million Mallard are released annually in Europe. In some cases, the number of restocked individuals can be significantly greater than the wild population, e.g. in France *c*. 1,400,000 Mallard are released annually compared to a wintering population of *c*. 270,000 (Söderquist *et al*. 2013), and in the Czech Republic approximately 250,000 Mallard are released annually, exceeding the wild population by 5–10 times (Čížková *et al*. 2012). As restocking effort has increased, the transport of captive-reared birds has likely also increased.

[17] The term restocking is also applied to releases of native animals for other motivations – see Champagnon *et al.* (2012a) for a full review.

Eggs, ducklings and adults have been subject to extensive, and probably increasing, international trade for decades, certainly within the European Union and probably also at an intercontinental scale.

The suitability of stocked birds for release is highly questionable (Čížková *et al*. 2012). In several European countries individuals from non-local populations have been used to establish captive stocks and hence the genetic status of released individuals is usually unclear. Captive-reared individuals may also have decreased genetic diversity compared to wild birds due to genetic drift and inbreeding (e.g. Earnhardt *et al*. 2004, Theodorou & Couvet 2004). Moreover, relaxed selection on traits that affect fitness under natural conditions may also have contributed to a phenotype shift in the captive-reared population (e.g. Bryant & Reed 1999, Lahti *et al*. 2009).

Information on the legal basis to restocking or the legal issues it raises are not readily available for most countries. Often this is because legislation concerns the release of non-native species, but not native species. In Norway, Mallard and Greylag Goose can be released for hunting, according to state regulations from 1999 (themselves based on the Wildlife Act 1981). Czech legislation dealing with the release of animals into nature[18] imposes restrictions on the release of animals that are interspecific hybrids or hybrids with a domestic species, but enforcement in the case of Mallard is problematic as the general requirement of genetic purity of released individuals is not defined. The desirable genetic markers described by Čížková *et al*. (2012) could be used in the future for such evaluation of restocked Mallard.

In France, it is a legal requirement that captive-reared game birds are individually marked before release in order to separate them from wild birds, yet most Mallard are released unringed (Vittecoq *et al*. 2012).

9.4.2 Motivations and methods

The key motivation for restocking of huntable waterbirds is increasing hunting opportunity (hunter satisfaction), which translates into increasing the profitability of the sale of hunting opportunity. In most cases this means birds are released in areas that maximise the probability of them being hunted, but in some older restocking programmes, the goal was to get released birds to join the wild population or establish new ones, hence they were released in non-hunted areas (Wardell & Harrison 1964).

Champagnon *et al*. (2012a) outlined three main types of restocking practices: (i) release of adults after the hunting season to increase the subsequent breeding population, (ii) release of juveniles before the hunting season, to be harvested during the subsequent hunting season, and (iii) release of individuals during the hunting season.

In most countries where restocking takes place, regulations or guidance that define best practice are limited or non-existent. Furthermore, current practices differ considerably from one country to another. In France, Mallards mostly come from a handful of breeding facilities that sell day-old ducklings. Such birds are then hand-reared in aviaries in the region of release, which generally occurs at the age of 6–9 weeks, about two months before the start of the hunting season. In order to keep hand-reared Mallard on the hunting estate, the provision of corn, wheat or rice is common practice. Hand-reared Mallard are thus likely to be highly faithful to the place where they were released, at least until the hunting season commences (Champagnon *et al*. 2009).

[18] Act No. 114/1992 Coll. on Nature and Landscape Protection, Act No. 449/2001 Coll. On Hunting, and the International Agreement on the Conservation of African–Eurasian Migratory Waterbirds.

Swedish game managers have long used Mallard eggs, ducklings, and adults imported from Denmark, which in turn also imports large quantities from abroad, e.g. France (Söderquist *et al*. 2013).

In the Krasnodar and Rostov regions of southern Russia (Azov/Black Sea region) more than 100,000 ducks (thought to be Mallard) have been released annually in recent years by the local hunter associations and these birds are believed to mostly be derived from China where they were harvested as eggs from wild populations (MaMing *et al*. 2012) and transported to Russia for rearing and release; this practice is feasible due to favourable costs of egg harvesting and transport (Melnikova 2013).

9.4.3 Consequences and impacts

A number of detrimental effects from restocking have been recorded on wild recipient conspecific (WRC) populations, and these may also extend to wild donor populations (i.e. wild populations that are harvested to provide stock for release elsewhere). Research demonstrates that restocking may cause a variety of significant disruptions to natural patterns in wild populations. Furthermore, intensive restocking activities may impact wetland ecosystems.

Whilst still significant in many cases, the impacts of releases are reduced due to the lower survival of released individuals which limits the extent of their recruitment into the WRC population. In some cases, there is evidence that most individuals are harvested during the first hunting season, i.e. few survive until the following breeding season. For example, Champagnon *et al*. (2012b) found that only 44% of Mallards released in the Camargue, southern France, survived from release until the start of the hunting season, and that just 11% remained by the onset of the following breeding season.

Nevertheless, whilst survival probabilities are low for individual restocked birds, the large number released means that enough can survive to form a significant proportion of the breeding population. Söderquist *et al*. (2013) found that even a conservative estimate of survival of restocked Mallard meant that such birds formed 1-5% of the national (Swedish) breeding population, though in reality this is a much higher proportion in the geographically limited areas where releases are concentrated. Champagnon *et al*. (2015) found that at the onset of the breeding season a minimum of 34% of the Mallards in Brenne region (central France) have captive origins.

In terms of direct harvest, the effect of restocked individuals on WRC populations appears variable. As restocking is designed to increase hunting opportunity, increased hunting pressure is to be expected and this may result in an increased harvest of wild birds as well as restocked individuals (Bro *et al*. 2006). Though the total harvest is spread among more individuals, over-harvesting of the WRC population is possible or even likely (Sokos *et al*. 2008), yet this is rarely if ever assessed. On the other hand, WRC populations may benefit from the release of captive-reared conspecifics if the latter reduce hunting pressure on the former.

Genetic pollution is an area of particular concern as it may threaten the integrity of WRC populations in a number of ways through introgression with captive-reared birds that, typically, have different genetic and/or geographic origins (Čížková *et al*. 2012). These mainly concern decreased genetic diversity arising from the limited number of individuals typically used for breeding purposes, and the more pronounced effects of genetic drift and inbreeding. The degree to which this introgression threatens wild populations through deleterious effects is less clear, but Čížková *et al*. (2012) concluded that the release of captive-reared individuals does threaten the genetic integrity of the wild population through gene swamping, whereby foreign, unadapted genotypes are introduced into a wild population. Furthermore, natural patterns of genetic variation and adaptation may be disrupted, leading to a reduction of a population's ability to adapt to future environmental change (Lande & Shannon 1996).

The stable environment experienced in captivity, together with inbreeding effects, can result in loss of crucial morphological adaptations. Generally, these changes are not welcome as such captive-reared morphological drift may be maladaptive in the wild environment. Morphological change arisen in captivity may affect wild populations if the traits are heritable and if wild individuals breed with captive-reared ones after release (Tufto 2001). Duck breeders tend to discard the most phenotypically atypical individuals, but subtle morphological differences between wild and domestic populations are sometimes not even visible (e.g. in Mallard; Byers & Cary 1991, Champagnon *et al*. 2010, Söderquist *et al*. 2014). Reduced flying ability is a common phenotypic defect of captive-reared Mallards in the Czech Republic (Hůda; cited in Čížková *et al*. 2012), which reflects the short flight distances inferred from ring recoveries of released Mallards (see below). Furthermore, in other taxa, restocking of game species frequently introduces non-native genes because captive stocks may be a mix of different taxa or strains. This is not currently believed to be an issue for waterbirds, but best practice guidance for restocking needs to highlight this risk.

Migratory behaviour of WRC populations may also be altered through the introduction (and subsequent introgression) of sedentary stock (Champagnon *et al*. 2012a, Söderquist *et al*. 2013). Unnaturally high densities of birds may also cause behavioural changes. Adler (2010) found that the introduction of large numbers of Mallard led to regular forced copulations by groups of males, which may make feeding breaks dangerous (and therefore less frequent) for already exhausted incubating females.

Several factors make captive-reared animals particularly susceptible to infectious diseases, e.g. high population density, naïve immune systems, contaminated food, cross-species contact and stress (Lafferty & Gerber 2002). They therefore potentially have heavy pathogen loads that can be transmitted to wild populations, so-called 'pathogen spillover', when the two come in contact (Power & Mitchell 2004). Release of infected captive animals into the wild can then cause disease outbreaks, premature mortality, and otherwise reduce fitness and reproductive success of the wild population (Hudson *et al*. 1998).

Avian influenza virus (AIV) prevalence in captive-reared Mallard destined for release onto hunting estates in France has been shown to be highly variable but sometimes extremely high, approaching 100% of the tested birds (Vittecoq *et al*. 2012). However, no exchange of AIV between captive-reared birds and the WRC population was found, although it is considered likely. Further, it could not be determined if the captive-reared birds were the source of the virus or were themselves contaminated by surrounding wild conspecifics.

Nevertheless, even if wild birds were the original source, the high susceptibility of captive-reared birds to further infection makes them an important epidemiological reservoir and vector from which infection rates can be amplified and disseminated. Indeed, large numbers of captive-reared Mallard are transported prior to release, e.g. >400,000 Mallards are transported annually as eggs, chicks or adults from one single major poultry farm in France to other countries in Europe and North Africa (Champagnon 2011). Such activities can potentially quickly spread pathogens, such as highly pathogenic AIV, if such a strain were to develop in a breeding farm (Handberg *et al*. 2010).

Duck Viral Enteritis (DVE) has been associated almost exclusively with captive-reared or non-migratory waterfowl in Europe, Asia and North America, and Mallards and Muscovy Ducks

(*Cairina moschata*) are particularly susceptible (Gough 1984, Brand 1988, Brand & Docherty 1988, Gough & Alexander 1990). Sporadic outbreaks in wild waterbirds often follow contact with captive or released birds, but asymptomatic birds can also spread the virus for years through deposition of their faeces (Burgess *et al*. 1979, Burgess & Yuill 1982). Thus, the release of wildfowl for hunting has the potential to promote the incidence of DVE in wild populations with potentially catastrophic effects (Fox 2009).

Restocking may also negatively impact on wetland biodiversity as a result of high stocking densities or unfavourable management practices. Wetlands subject to dense stocking could add significantly to the mobilisation of carbon, nitrogen and phosphorus (Callaghan & Kirby 1996). Studies in Denmark have showed that lakes stocked with captive-reared Mallards had significantly higher phosphorus concentrations in the water than those not subject to stocking, but it was not possible to establish cause and effect, especially because variation among unstocked lakes was so high (Noer *et al*. 2008). These authors highlighted that any effects from Mallard stocking on lake biodiversity was highly dependent on the nutrient status, with acidic, nutrient-poor waterbodies being more sensitive to change in elevations of phosphorus concentrations.

Mallard are usually released at wetlands that are managed specifically for them and not for biodiversity and the overall quality of the habitat. These wetlands are thus managed very artificially, e.g. such wetlands may support high densities of invasive species such as *Ludwigia repens*, and instead of controlling such invasive plants by implementing a dry period, site managers are more likely to use chemicals, such as glyphosate, in order to make the wetland suitable for released birds (Champagnon *et al*. 2013).

9.4.4 Code of best practice

Currently there is limited regulation and adherence to best practice regarding restocking programmes, nor is there adequate ongoing monitoring to provide data that can underpin the development of best practice guidance. Given this, the likely consequences of any restocking programme should be thoroughly evaluated before it is implemented. For restocking to continue on a sustainable basis that is compatible with sustainable harvest management of wild waterbird populations, there are a number of recommendations that should be implemented.

Given these negative impacts and the lack of regulation, restocking should, ideally, be discontinued and efforts instead invested in managing wetlands for wild ducks such that there is no need to further artificially enhance hunting opportunities. However, if restocking continues, the following practices should be implemented in order to meet minimum requirements for the restocking programme to be compatible with the management and conservation goals of AEWA:

1. All countries where restocking schemes are carried out should develop and implement a registration system, such that records are maintained of the activities and practices of each restocking programme, including the provenance of released birds, the number released, and the number subsequently harvested;

2. All released birds should be individually identifiable through the use of metal rings or some other suitable marking method, and this information should be shared with national ringing programme organisers and other stakeholders;

3. Released birds should be the same genotype and phenotype as the local WRC population and not show phenotypic aberrations resulting from domestication / genetic drift, including subtle characteristics such as in bill morphometrics. This may require the development of a well-managed captive-breeding programme. Assessments of the genetic status of WRC populations should be undertaken at suitable intervals;

4. Stock for release should be sustainably sourced (i.e. should not negatively impact any wild population, e.g. through over-harvesting of eggs or birds);

5. To help limit the adverse biological effects of restocking wild populations with captive-origin individuals, those operating restocking schemes should pay attention to the impacts of restocking and cease releasing birds for a period after a few generations;

6. The size of the captive population should be reasonably large and the number of released captive-reared individuals should be kept at a low level;

7. Captive birds should be isolated from wild birds in order to minimise the risk of disease transfer;

8. Captive birds should be subject to regular disease screening and vaccination;

9. Efforts should be made to minimise the number of released birds that survive and enter the wild breeding population, including efforts to harvest as many as possible before the following breeding season, and no efforts be made to improve their intrinsic survival abilities. This may, however, require efforts to minimise dispersal through the provision of food which could indirectly increase survival probability;

These key recommendations and others pertaining to best practice for restocking methods should be set out in a local or national code of practice and implemented in conjunction with stakeholders.

9.5 Illegal harvesting

Illegal harvesting, regrettably, occurs commonly worldwide and threatens biological diversity in many ecosystems; if left unchecked it may impact and limit sustainable use. Reducing and eliminating illegal harvest is important because it both constitutes a conservation risk for species which are deemed not huntable, might reduce legal harvest opportunities and compromise the social acceptability of legal harvest. Illegal harvesting can also affect huntable species if not conducted within hunting restrictions. This adds uncertainty to the scale and impact of harvesting and increases the risk of inappropriate management actions being implemented. Paragraph 4.1.6 of the AEWA Action Plan therefore requires Parties to ‘develop and implement measures to reduce, and, as far as possible, eliminate, illegal taking’.

Monitoring is necessary to be able to detect the changes in non-compliance and illegal behaviour. The true extent of illegal activities is hard to quantify due to the cryptic nature of the behaviour (Gavin *et al*. 2010), but a range of methods have recently been developed to achieve this. These include law-enforcement records, key informants and self-reporting (Gavin *et al*. 2010). Furthermore, a range of indirect questioning methods has been developed to elicit the extent of illegal behaviour and their incentives while protecting peoples’ anonymity (St John *et al*. 2010, St John *et al*. 2012, Cross *et al*. 2013). The idea behind these methods is that people are more likely to give honest answers when their anonymity is protected (Lensvelt-Mulders *et al*. 2005, Nuno *et al*. 2013). Such a system has been introduced in Iceland, where hunters are asked to report not only legal but also illegal/accidental harvest.

In order to assess the extent of illegal harvest and achieve a reduction, managers need to regularly monitor the extent, methods, species targeted and locations of illegal harvest. They need to identify and regularly monitor the motivations and incentives of those involved in illegal harvest, including social, economic and cultural behaviour is socially and/or culturally accepted and how much it contributes to food consumption or cash income for local people. As part of management actions there is a need to provide incentives to reduce and eliminate illegal harvest based on knowledge of social, economic and cultural factors such as investment in developing alternative food, mainly protein, sources based on local preferences, e.g. chicken and fish (Moro *et al.* 2013). Another incentive for local people to stop illegal hunting could be provided through employment for example in national parks as game wardens (Nuno *et al.* 2013, Nuno 2015); in these cases, hunters may play an important role in controlling illegal activities. Further approaches to avoid illegal harvest are through national and international law enforcement and through aligning national and international policies with formal and informal rules and norms, but these top down approaches rarely work without the support from local people.

In some countries, including those in Africa, regulating harvest through legislation might require modernising and improving enforcement mechanisms on the ground (maybe through international policy cooperation) and ensuring the scope of national legislation follows international agreements such as AEWA. In particular, there could be a need to update national harvest regulations every three years following AEWA MOPs, notably because of species status changes in Table 1 of the Agreement.

In many countries, there is no specialised body in charge of the management of hunting. When such a body does exist, it is often inadequately prepared, trained and equipped. The control of big game (mammal) hunting is generally the priority and typically only the conventional police are allowed to fine poachers. Further, knowledge of birds and the regulations relevant to them within the conventional police is generally very low. It is therefore of utmost importance to strengthen the capacity of the relevant bodies to manage waterbird harvest issues and/or devolve rights to local communities particularly in critical areas, allowing them to implement and enforce adequate controls.

Further guidance on the prevention of illegal killing, trapping and trade of birds in general is provided by the EU 'road map'[19], the Tunis Action Plan of the Bern Convention[20], and supported by the CMS Mediterranean Task Force on Illegal Killing of Birds established under Resolution 11.16 on the Prevention of the Illegal Killing, Taking and Trade of Migratory Birds[21].

[19] http://ec.europa.eu/environment/nature/conservation/wildbirds/docs/Roadmap%20illegal%20killing.pdf
[20] https://wcd.coe.int/ViewDoc.jsp?p=&id=2138467&Site=&direct=true
[21] http://www.cms.int/aquatic-warbler/sites/default/files/document/Res_11_16_Illegal_Killing_Migratory_Birds_En_0.pdf

10. Habitat Management and Mitigation of Disturbance Effects

The Agreement Text requires Parties to identify sites and habitats for migratory waterbirds occurring within their territory; encourage the protection, management, rehabilitation and restoration of these sites; and to coordinate their efforts to ensure that a network of suitable habitats is maintained or, where appropriate, re-established throughout the entire range of each migratory waterbird species concerned.

To achieve this, the AEWA Action Plan requires Parties to produce national habitat inventories, identify all sites of international or national importance and to endeavour to establish protected areas to conserve habitats for populations listed on Table 1 in the AEWA Action Plan, especially at sites of international importance. It also has provisions for the conservation of all wetlands and other habitats and for the rehabilitation and restoration of areas which were previously important for birds. Parties are also required to take measures to limit the impact of disturbance where it threatens the conservation status of waterbird populations listed in Table 1.

The AEWA Strategic Plan sets the target (Target 1.2) that "*A comprehensive and coherent flyway network of protected and managed sites and other adequately managed sites, of international and national importance for waterbirds is established and maintained, while taking into account the existing networks and climate change*".

AEWA Conservation Guidelines already exist on:

◊ The preparation of site inventories for migratory waterbirds (No. 3)[22]

◊ The management of key sites for migratory waterbirds (No. 4)[23]

◊ Measures needed to help waterbirds to adapt to climate change (No. 12)[24]

Therefore, the present guidelines focus on those elements of habitat management that are relevant for harvest management. As most huntable waterbird species tend to show markedly different distribution patterns during their breeding and non-breeding periods, appropriate habitat management strategies differ significantly between these two periods.

10.1 Non-breeding season

A large number of huntable waterbird species, particularly ducks, geese and many waders, tend to be congregatory during different stages of the non-breeding season (i.e. moulting, stop-over and wintering). In Africa, the non-breeding season for most waterbirds tends to overlap with the dry season. Thus, the key ecological factor explaining congregatory behaviour is the limited availability of suitable areas where all the requirements of the species (e.g. suitable feeding areas and safe roosting sites, pair formation) can be fulfilled. This limited number of sites and their high concentrations of birds means that flocking birds are highly vulnerable to habitat loss and degradation, pollution and disturbance.

Migratory waterbirds need a network of sites to complete their annual cycle. In the absence of other limiting factors, the population size is determined by the minimum carrying capacity of the breeding, staging and wintering areas. Therefore, the provision and adequate management of habitats across the

[22] http://www.unep-aewa.org/sites/default/files/publication/cg_3new_0.pdf
[23] http://www.unep-aewa.org/sites/default/files/publication/cg_4new_0.pdf
[24] http://www.unep-aewa.org/sites/default/files/publication/cg_12_0.pdf

flyway, and the limitation of other mortality factors, are essential components of sustainable harvest management and increasing sustainable yield, and these also require international coordination.

Recognising the need of adequate management of an international site network for migratory waterbirds, has led to the relevant provisions of the Ramsar Convention on Wetlands (Matthews 1993), the EU Birds Directive and AEWA itself (Boere 2010).

10.1.1 Sites of international importance

Criteria for identifying internationally important sites are based on the conservation status of a species or population, and the proportion of a population or the total number of waterbirds regularly (or periodically) supported by the site. The Critical Site Network Tool[25] developed by the UNEP-GEF funded Wings Over Wetlands: The African-Eurasian Flyway Project provides access to information on a list of sites by species or country that meet at least one of the following two criteria:

1. The site is known or thought to regularly or predictably hold significant numbers of a population of a globally threatened waterbird species;

2. The site is known or thought to regularly or predictably hold >1% of a flyway or other distinct population of a waterbird species.

It is necessary that the Critical Site Network Tool is regularly updated and improved. It is important to note that the criteria for the selection of critical sites focuses on site networks for species rather than multi-species aggregations. Therefore, it does not include a criterion based on the total number of waterbirds present, such as Criterion 5 of the Ramsar Convention, which recognises sites with 20,000 or more waterbirds as internationally important.

A full explanation to the site selection criteria under the Ramsar Convention can be found in the Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance of the Convention on Wetlands[26].

The Important Bird Area (IBA) programme of BirdLife International uses a similar set of criteria[27] but these apply a nested set of global and regional thresholds.

10.1.2 Nationally important sites

A threshold-based approach can also be applied to identify nationally important sites. For example, the United Kingdom applies 1% of the national population as a criterion to identify nationally important Sites of Special Scientific Interest (Drewitt *et al.* 2015). These national 1% thresholds are applicable also for creating comprehensive and coherent reserve networks to serve national conservation objectives. However, such simple approaches may lead to underrepresentation of certain species or populations (Hopkinson *et al*. 2000). Therefore, it is useful to set representation targets and select sites that meet certain criteria related to population size or density, species range, reproductive success, history of occupancy, providing protection to multiple species, naturalness or serving as weather refuges during cold spells or dry periods (e.g. see Drewitt *et al.* 2015). The objectives for the reserve network for waterbirds in Denmark (Madsen *et al*. 1998) also included some functional objectives such as:

[25] http://dev.unep-wcmc.org/csn/default.html#state=home
[26] http://archive.ramsar.org/pdf/cop11/res/cop11-res08-e-anx2.pdf
[27] http://www.birdlife.org/datazone/info/ibacriteria

1. In each of the wintering areas within the country there should be a reserve network that sustains the priority populations; priority populations were defined considering their vulnerability to disturbance that considered proximity to disturbance, spatial distribution, flock size, diet and quarry status;

2. Within Special Protection Areas (relatively large areas classified under the EU Birds Directive), reserves should be established that provide for the needs of waterfowl for both foraging and resting and where recreational objectives are compatible with the principles of sustainable use;

3. The size of reserves and associated zoning should be tailored according to the international importance of the area for waterfowl and should, as a whole, be able to accommodate a certain pre-determined population size for a shorter or longer period under any disturbance situation;

4. Reserves should be designed such that the total numbers, length of stay and diversity of waterfowl are maximised in relation to the habitat's carrying capacity.

From the local hunter's point of view, it is important to recognise that reserves usually enhance hunting opportunities in adjacent areas (Guillemain 2002). Therefore, maintaining some local refuges is important for enhancing local hunting opportunities. Duriez *et al*. (2005) showed that reserves increased the survival rate of wintering Eurasian Woodcock (*Scolopax rusticola)* as they spent more time in reserves in Brittany (France). This means that reserves can contribute to sustaining the long-term viability of a population, although additional direct harvest management measures might also be needed.

10.1.3 Forms of site protection

All sorts of protected sites can be classified according to the IUCN Protected Areas Categories System[28], ranging from strict nature reserves to protected areas with sustainable use of natural resources. Some require statutory conservation under national or international law (e.g. EU Birds Directive, Ramsar Convention, World Heritage Convention), though effective protection could also (or additionally) be provided in the form of community or private reserves. The most suitable form of protection depends on national and local circumstances, including the requirements of national and international law. What is important is that the form of protection should be adequate for the conservation objectives to be met, both for habitats and species. In general, zoning of permissible human activities, including temporal regulations, facilitates multiple use of such reserves and harmonising various interests. The Ramsar Convention's handbook on wetland site management gives considerable guidance on these issues (Ramsar Convention Secretariat 2010).

10.1.4 Limits of site protection

Protected site networks are primarily suited to flocking species and are less effective for dispersed species, e.g. snipes. These require a patchwork of suitable habitat across their range. Although dispersed species are less sensitive to localised threats, they might be sensitive to widespread homogenisation of the landscape if that removes or degrades the habitats upon which they depend. Therefore, habitat conservation measures applicable in the wider countryside are important for such species and are typically delivered through a range of policy mechanisms including agri-environment measures within farming landscapes and/or other incentive mechanisms that influence land use.

[28] http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/

10.2 Breeding season

The majority of harvested waterbird species have a dispersed distribution during the breeding season, but some are colonial breeders. The management strategies applicable in these two groups are very different.

10.2.1 Dispersed breeders

In the case of widespread and dispersed breeding species, the protection of nationally or internationally important sites is not an effective conservation strategy because it would require the protection of vast areas in order to protect an adequate proportion of the population. Focusing efforts on maintaining high quality landscapes is more effective (e.g. prairie potholes in North America and Boreal forest in Fennoscandia), because the reproduction of the population fundamentally depends on the extent and quality of breeding habitat, as well as the level of predation and weather.

Loss or degradation of breeding habitat has led to the decrease of European meadow bird populations, such as Northern Lapwing (*Vanellus vanellus*), Black-tailed Godwit (*Limosa limosa*) and Eurasian Curlew (*Numenius arquata*), to a level that presents a significant limitation to the harvest potential of these species without jeopardizing the effectiveness of conservation efforts elsewhere[29]. It follows that the restoration of formerly lost habitat can support sustainable waterbird harvesting by ensuring good reproduction and potentially providing a harvestable surplus.

Thus, the management of breeding areas for dispersed species requires maintaining, restoring or creating a network of suitable habitat that meets the breeding and feeding requirements of waterbirds and provides safe conditions for them to raise their chicks. Food and habitat requirements of waterbirds vary widely (see species fact sheets on the BirdLife International DataZone[30]; examples of management guides: Ward *et al*. 1995, Dodds 1996, Hawke 1996, Treweek 1997).

A general scheme for planning habitat management includes:

1. Recognising opportunities to protect, enhance or create habitat;
2. Identifying broad management goals;
3. Identifying and consult people and authorities with a stake in the management of the area;
4. Identifying and evaluate the site;
5. Identifying constrains;
6. Evaluating and present choices for:
    a. Modification of current management;
    b. Rehabilitation of degraded habitat;
    c. Creation of habitat;
7. Developing detailed management objectives and implementation plans;
8. Implementing work;

[29] According to Paragraph 2.1.1 of the AEWA Action Plan, parties shall provide protection to populations listed in Column A of Table 1 of the Action Plan. By way of exception, hunting may continue on a sustainable use basis under the framework of an international species action plan that implement the principles of adaptive harvest management for populations listed in Categories 2, 3 and 4 in Column A. Furthermore, Paragraph 2.1.2 requires regulation of taking of populations listed in Column B of Table 1 with the objective of restoring those populations to favourable conservation status. In the EU, Article 7.1 of the Birds Directive requires that hunting of species does not jeopardise conservation efforts in their distribution area.

[30] http://www.birdlife.org/datazone/species

9. Monitoring and evaluating expected benefits and side effects, and
10. Adjusting management objectives.

A successful example from Finland is shown in Box 2. on page 69.

10.2.2 Colonial breeders

Adults, chicks, eggs, down or the guano of some colonial birds are harvested (see Denlinger & Wohl 2001 and Merkel & Barry 2008 for northern seabirds) and in some areas there have been traditional cultural constraints on such harvests (e.g. Nørrevang 1986 for the Faroe Islands).

Suitable locations for colonies are often limited. Many colonial breeding birds require predator free cliffs or islands and sufficient feeding areas in relatively close proximity of the colony. Disturbance, associated with human activities including harvesting, may cause breeding birds to interrupt their incubation or chick brooding, which, in turn, may lead to cooling (in temperate or boreal climate) or overheating (in tropical climate) of the eggs/chicks. This can significantly reduce the overall breeding success of the population and lead to unsustainable exploitation, even if set limits of harvest are respected. Repeated disturbance can lead to the abandonment of the colony.

In many areas, prolonged unsustainable harvest levels have led to the functional extinction of seabirds over extensive areas (e.g. Burnham *et al.* 2014 regarding Greenland).

A special case of commercial harvest is the harvest of down from Common Eider (*Somateria molissima*), which is or has been practiced in most of the Arctic countries. The harvest can be a highly sustainable alternative to hunting and even a powerful management tool if practiced carefully and wisely (Bédard 2008). The commercial aspect is negligible in most countries, except for Iceland, which are responsible for about 70% of the world's eiderdown production, and in 2003 the commercial market value reached USD 2.2 million (Bédard 2008). In Iceland the eiderdown harvest tradition dates back nearly a thousand years and is sometimes referred to as eiderduck farming as the eiders in many cases breed on private land, which some landowners actively seek to improve as suitable eider nesting habitats, e.g. by adding nest shelters or guard against potential predators (Snaebörnsson 2001).

In Iceland, the down is harvested once or twice during the incubation period, but in countries where eiders are less adapted to human presence, it is recommended to harvest only once and as late as possible during incubation (but before hatching) to minimise potential impact of disturbance. If waiting to collect the downs until after the breeding season, disturbance can be avoided all together, but in most cases this will compromise down quality (Bédard 2008).

Guano is a valuable product of some seabird species because of its high phosphate content. For some species, e.g. African Penguin (*Spheniscus demersus*), it provides nesting substrate where they can breed more successfully than on the bare surface of the ground. If the birds breed on guano, its extraction should take place only after breeding has been completed and extraction levels should ensure that future breeding conditions are not jeopardised due to over-extraction.

10.3 Key issues for management

In general, protected areas should provide protection to the entire functional unit required for birds to meet all their daily requirements while they reside in that area (Tamisier 1979; Stroud *et al.* 1990). In the non-breeding season, these primarily include feeding and roosting areas (Fox & Madsen 1997). In predator or disturbance free areas, waterbirds may also roost at the feeding area. If this is not possible, it is important to minimise the distance between the roost and feeding areas as well as to consider secondary, refuge areas for use when main areas used are subject to disturbance (e.g. Tamisier 1979).

10.3.1 Carrying capacity

One key consideration from a management perspective is that sufficient habitat carrying capacity should be available across the flyway in order to sustain a population at the desired level of abundance. Carrying capacity in this context is defined as the maximum number of individuals that can be maintained in an area on a long-term basis (Konar *et al*. 2013). The implication of this is that at a site level, the feeding area should be sufficiently large to sustain the desired number of birds during their stay at the site. This requirement is strictest in the case of long-distance migrants with specialised feeding requirements, e.g. Bewick's Swan (*Cygnus columbianus bewickii*), because of the extended time needed for them to accumulate and maintain the fat reserves required to complete the next stage of their migration and the potential impact on their breeding performance if they fail to do so (carry-over effects). The importance of ensuring that sufficient carrying capacity is available is more critical when the availability of alternative sites is very limited; an extreme example on the dependence of limited habitat (in this case intertidal mudflats) is the Red Knot (*Calidris canutus*) (Piersma 2002).

Maintaining and improving carrying capacity at breeding, staging and wintering areas is a key aspect of flyway-level management of (huntable) waterbirds. In general, the main factor of carrying capacity is food availability and accessibility, but in some cases, e.g. for colonial nesting seabirds and for highly territorial species, availability of breeding sites might also limit population growth.

Examples from North America illustrate that habitat restoration measures can be very effective in increasing huntable surpluses, e.g. the Wetland Conservation (Swampbuster) Provision and the Conservation Reserve Programmes implemented by the US Department of Agriculture in the Prairie Pothole Region. As a result of these programmes, 2 million additional ducks per year were produced in North and South Dakota and northeastern Montana and a large number of small, shallow wetlands that would have been lost to drainage were protected, which, in total, could have led to a 37% loss of wetlands (Reynolds 2007). In Europe, carrying capacity was explicitly considered in designing the reserve network for waterfowl in Denmark (see Madsen *et al*. 1998).

Although the consideration of carrying capacity in sustainable harvest management is important, estimating habitat carrying capacity has a number of theoretical and practical challenges (Williams *et al*. 2014). Differences in dietary requirements and behaviour have important implications for reserve design and the requirements of a species may change during its annual cycle. Generally, the inclusion of feeding areas in a protected area network is more important when the availability of those areas is more restricted than when suitable feeding areas are readily available across the landscape.

Box 2. Case study of habitat restoration from Finland

Finland is one of the key breeding areas for waterbirds in Europe. The country is characterised by a high quantity of lakes, rivers and marsh complexes. Finland has experienced a major loss of wetlands due to drainage for agriculture and forestry. The results of their drainage have provided income for the nation, but there are also costs for nature and people as a result of the degradation of habitat, water quality and flood retention services. In many places, where drainage has not provided the expected results, sites can be restored to compensate for the lost habitats and ecosystem services.

Internationally and nationally important wetlands for breeding and staging waterbirds are protected through conservation programmes. However, during the breeding season huntable waterbirds are dispersed throughout rural areas widely used for agriculture and forestry. The importance of wetlands outside of conservation programmes is significant for the production of a harvestable surplus. Voluntary based restoration, even small sites, creates ownership of wetlands and their breeding waterbirds, supporting sustainable use and the continuation of effective habitat and harvest management at the site, including predator control.

Voluntary habitat management by local hunters' associations and landowners has a long tradition that forms the basis of the LIFE+ Return of Rural Wetlands project, a biodiversity project targeting areas outside of national protection programmes (often private land) and focusing on waterbird habitats and brood production of huntable ducks.

The main objectives are: 1) to inspire people to take care of and restore local wetlands for the benefits they provide to recreational use, such as hunting and birdwatching, water protection and landscape conservation, and 2) to demonstrate a landowner-based framework for cost-effective wildlife habitat restoration working at a local level and utilizing the Finnish tradition for voluntary work. The objectives were achieved through building a network of demonstrative wetland sites with landowners and by active communication, education and awareness raising among stakeholder groups.

The project restored or re-created 48 wetlands with local landowners and hunting associations and provided significant support for the use of other existing funding mechanisms for wetland construction. Several additional sites have been created by people inspired by the project examples, education events, the project website (www.kosteikko.fi) and active media work.

Waterbirds have made excellent use of the sites with high brood production from the first summer. The wetlands have significant local level impacts for breeding waterbirds, with landscape level potential if work is continued over longer time periods. The future of huntable bird populations cannot rely only on protected areas. An active integrated approach in the areas of agriculture and forestry is needed to sustain the vast network of wetland habitats needed for dispersed breeders.

Example of a 1.5 hectare wetland constructed in cooperation with a local landowner within the framework of the Life+ Return of Rural Wetlands project that provides habitat for five species of waterbirds, producing approximately 10 broods annually at a cost of 5,000 Euros. Hunting is the key incentive for local level habitat restoration to provide harvest opportunities through increased brood production and a harvestable surplus.

10.3.2 Disturbance

Disturbance limits the carrying capacity for and the efficient use of an area by waterbirds because it forces them to escape or otherwise modify their behaviour. Human activities other than hunting (e.g. motor boats, windsurfers, kite surfers, swimmers, anglers, photographers, dog walkers) may also cause disturbance to waterbirds (Plateeuw & Henkens 1997). Disturbance can result in one or more of four basic responses:

- ◊ Avoidance;
- ◊ Mortality;
- ◊ Behavioural responses, e.g. flying away; or
- ◊ Physiological responses, e.g. increased stress.

Birds can become habituated to certain disturbance factors under certain conditions, resulting in a lower impact from individual disturbance events.

The AEWA Action Plan contains several provisions in relation to disturbance. According to Paragraph 2.1.1(b), Parties with populations listed in Column A of Table 1 shall prohibit *deliberate* disturbance of those populations in so far as such disturbance would be *significant* for the conservation of the population concerned. According to Paragraph 2.1.2(b), Parties shall regulate the modes of taking of birds and eggs of all populations listed in Column B of Table 1 that can cause *serious disturbance* of the population. Paragraph 4.3.6 requires Parties to take measures to limit the level of threat where human disturbance threatens the conservation status of waterbird populations listed in Table 1.

The relative impact of disturbance can be the most severe for a waterbird population during periods of lowest nutrient reserves and/or increased energy expenditure. These usually overlap with periods of food shortage (either in terms of availability e.g. in relation to wetland availability in arid zones or when resources are already depleted, or accessibility e.g. due to snow/ice cover), after completion of migration flights or at the time of moulting, mating or egg production. Hunting and other activities that cause disturbance may result in local or large-scale redistribution of waterbirds, and if sufficiently severe, the abandonment of the site altogether.

The reduction of hunting and other disturbances ideally should be encompassed in an overall site and site network management strategy. A key method for the reduction of disturbances is to create disturbance-free areas (Fox & Madsen 1997). Such disturbance-free areas should be designated in such a way that they include roosting areas and areas that provide adequate feeding opportunities for the target species and are thus able to support the adequate numbers of the target species for a sufficient period of time. This needs to take into account differences between waterbird species in their habitat use when feeding and roosting, at different times of day/night, as well as during their overall annual cycle. These interspecific differences affect the vulnerability of different species to shooting disturbance.

The ideal disturbance-free refuge encompasses both sufficient safe feeding grounds to support bird numbers within the area and provide occasional support for birds displaced from other areas. When designating refuge areas, the relative merit of protecting feeding areas and roost sites needs to be taken into account. Protecting night roosting sites of geese or day roosting sites of ducks, where they concentrate in large numbers, is relatively more important than protecting feeding areas that might be more widely available.

Fox & Madsen (1997) identified three different elements of a reserve system:

- ◊ *Core refuge*: where all disturbance is excluded. These are areas that are so far from the periphery that they enable the birds to continue their normal activities without being physically displaced;
- ◊ *Buffer zones*: represent areas within the refuge where effects of disturbance still manifest despite the proscription of disturbing activities;
- ◊ *Rest of the reserve*: with controlled levels of disturbance.

Understanding the escape flight distance, its species specific and temporal variation, and site specific factors such as food availability provide the fundamental basis for refuge design. Fox & Madsen (1997) recommended that the diameter of the core refuge and the buffer should be at least three times the escape flight distance in order to provide effective protection from disturbance. On the other hand, once the escape flight distance of the most sensitive species exceeds half the diameter of the refuge area, that species will desert the site.

Large regular units of refuges provide the most effective protection against disturbance because of their relatively high core-to-buffer ratio. The ideal shape of the refuge would be a circle because that would provide the maximum effective core refuge compared to any other shape. In addition, large areas are likely to accommodate the requirements of multiple species. Bregnballe *et al*. (2009) recommended using the escape distance of the largest species to design buffer zones.

The zonation of hunting and other potentially disturbing human activities outside of the disturbance-free zone can be a useful supplementary tool to increase waterbird numbers while maintaining hunting opportunities. Generally, birds are more tolerant to hunting from punts or hides (i.e. from fixed points) than to mobile hunting activities i.e. from (motor) boats or on foot.

The temporal regulation of hunting is generally not an effective way to minimise hunting disturbance. The frequency of disturbance affects the probability that birds return to the site and hence increases the lag in recovery time. Best practice requires longer periods (weeks rather than days) that are free from disturbance, however this depends on the situation, e.g. intervals can be shorter at migration stopover sites where there is a larger turnover of individuals (Jensen 2014). Generally, spatial regulation is more effective than temporal.

Some evidence also indicates that daily hunting periods, e.g., only allowing shooting in the mornings or the evenings, respectively, should be adequate for waterbirds to meet their dietary requirements. However, this is site and species-specific and a general ban on goose shooting after 10 am in Denmark did not result in more staging geese (Madsen 2001).

Other aspects of site management may also be used to reduce disturbance, e.g. vegetation height correlates negatively with escape distance because it can conceal visitors or other movements (Bregnballe *et al*. 2009).

The reduction of disturbance is an essential part of the design of protected area networks, both nationally and internationally. In Denmark, a network of waterbird reserves in wetland Special Protection Areas has been designated to provide a network of protected stepping stones for migratory waterbirds. The development followed a long debate concerning the disturbance effects of recreational activities, especially hunting, on waterbirds in Danish wetlands.

The management actions taken have primarily been spatial and temporal restrictions of hunting and other disturbing human activities in order to reduce the effects of disturbance. The implementation followed an assessment of potential sources of disturbance (Madsen 1998a) followed by a series of field experiments with spatial, diurnal and intermittent restrictions on hunting (Madsen 1998b; Bregnballe *et al*. 2004; Bregnballe & Madsen 2004) as well as an evaluation of the biological needs by waterbirds at site level (Fox & Madsen 1997) and in a flyway context (Madsen *et al*. 1998).

Subsequent monitoring has demonstrated a dramatic increase in autumn-staging waterfowl, particularly dabbling ducks, as a result of the network establishment (Clausen *et al*. 2013). In populations that are limited by food resource availability during winter, the protected area network is likely to have had a positive effect at a population level (Madsen & Fox 1997); however, it remains to be demonstrated in practice as this is scientifically difficult because the impacts of disturbance may first become manifest far away from the place where it happened.

11. References

Adler, M. 2010. Sexual conflict in waterfowl: Why do females resist extrapair copulations? Behavioral Ecology 21: 182–192.

Aebischer, N.J. & Harradine, J. 2007. *Developing a tool for improving bag data of huntable birds and other bird species in the UK.* Report to DEFRA and the Scottish Executive, Wrexham, Game Conservancy Trust, Fordingbridge and British Association for Shooting and Conservation.

Alhainen, M., Väänänen, V.-M., Pöysä, H. & Ermala, A. 2010: Duck hunting bag in Finland – what do wing samples tell us about the species composition and age structure in a bag. Suomen riista 56: 40-47. (In Finnish; Engl. Summary).

BASC 2010. A code of practice: Respect for Quarry. http://basc.org.uk/cop/respect-for-quarry

Batt, B. 2012. *The marsh keepers journey - the story of Ducks Unlimited Canada.* Ducks Unlimited Canada.

Bédard, J., Nadeau, A., Giroux, J.-F. & Savard, J.-P.L. 2008. *Eiderdown: Characteristics and harvesting procedures.* Québec, Société Duvetnor Ltée and Canadian Wildlife Service, Environment Canada, Québec Region: 48 pp.

Beintema, A., Beintema, D., Brenninkmeijer, A., Delany, S. & Kirby, J. 2005. AEWA *Conservation Guidelines No.5. Guidelines on sustainable harvest of migratory waterbirds.* Prepared by Wetlands International. Adopted AEWA MOP 2002, updated 2005.
http://www.unep-aewa.org/sites/default/files/publication/cg_5new_0.pdf

Berghöfer, A., Wittmer, H. & Rauschmayer, F. 2008. Stakeholder participation in ecosystem-basedapproaches to fisheries management: A synthesis from European research projects. Mar. Policy32: 243–253.

Berny, P., Vilagines, L., Cugnasse, J. M., Mastain, O., Chollet, J. Y., Joncour, G., & Razin, M. 2015. VIGILANCE POISON: Illegal poisoning and lead intoxication are the main factors affecting avian scavenger survival in the Pyrenees (France). Ecotoxicology and Environmental Safety 118: 71-82.

Bhima, R. 2006. Subsistence use of waterbirds at lake Chilwa, Malawi. *In* Waterbirds around the world. Boere, G.C., Galbraith C.A., Stroud D.A. (eds.). The Stationery Office, Edinburgh, UK: pp. 255-256.

Boere, G.C. 2010. The History of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds. UNEP/AEWA Secretariat, Bonn, Germany.

Boere, G.C., Galbraith, C.A. & Stroud, D.A. (eds). 2006. *Waterbirds around the world*. The Stationery Office, Edinburgh, UK, UK. 960 pp. http://jncc.defra.gov.uk/worldwaterbirds

Boere, G.C. & Stroud, D.A. 2006. The flyway concept: what it is and what it isn't. *Waterbirds around the world.* Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. pp. 40-47. http://jncc.defra.gov.uk/PDF/pub07_waterbirds_part1_flywayconcept.pdf

Brainerd, S. 2007. *European Charter on Hunting and Biodiversity.* Council of Europe, Bern Convention, Strasbourg (T-PVS(2007)07revE 29 November 2007).

Brand, C.J. 1988. Duck Plague. In: Friend, M. (ed.), *Field Guide to Wildlife Diseases: general field procedures and diseases of migratory birds*: 117–128. US Fish and Wildlife Service Resource Publication No. 167, Washington DC.
http://www.nwhc.usgs.gov/publications/field_manual/field_manual_of_wildlife_diseases.pdf

Brand, C.J. & Docherty, D.E. 1988. Post-epizootic surveys of waterfowl for duck plague (duck viral enteritis). Avian Diseases 32: 117–128.

Bregnballe, T. & Madsen, J. 2004. Tools in waterfowl reserve management: effects of intermittent hunting adjacent to a shooting-free core area. Wildlife Biology 10(4): 261-268.

Bregnballe, T., Madsen, J. & Rasmussen, P. 2004. Effects of temporal and spatial hunting control in waterbird reserves. Biological Conservation 119(1): 93-104.

Bregnballe, T., Noer, H., Christensen, T.K., Clausen, P., Asferg, T., Fox, A.D. & Delany, S. 2006. Sustainable hunting of migratory waterbirds: the Danish approach. *Waterbirds around the world.* Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. pp. 854-860.

Bregnballe, T., Speich, C., Horsten, A., & Fox, A.D. 2009. An experimental study of numerical and behavioural responses of spring staging dabbling ducks to human pedestrian disturbance. Wildfowl Special Issue 2: 131-142.

Bro, E., Mayot, P. & Mettaye, G. 2006. Opérations de repeuplement en perdrix sans arrêt de la chasse : quel impact sur les populations ? Quelques éléments de réflexion sur ce mode de gestion mixte. Faune Sauvage 274: 34-39.

Bryant, E.H. & Reed, D.H. 1999. Fitness decline under relaxed selection in captive populations. Conservation Biology 13: 665-669.

Bullock, J.M., Aronson, J., Newton, A.C., Pywell, R.F. & Rey-Benayas, J.M. 2011. Restoration of ecosystem services and biodiversity: conflicts and opportunities. *Trends in Ecology and Evolution* 26(10): 541-549.

Bunnefeld, N., Hoshino, E. & Milner-Gulland, E.J. 2011. Management strategy evaluation: A powerful tool for conservation? Trends in Ecology & Evolution 26: 441-447.

Bunnefeld, N., Redpath, S. & Irvine, J. 2015. *A review of approaches to adaptive management.* Scottish Natural Heritage Commissioned Report No. 795.
http://www.snh.org.uk/pdfs/publications/commissioned_reports/795.pdf

Burgess, E.C., Ossa, J. & Yuill, T.M. 1979. Duck plague: a carrier state in wildfowl. Avian Diseases 23: 940–949.

Burgess, E.C. & Yuill, T.M. 1982. Super-infection in ducks persistently infected with duck plague virus. Avian Diseases 26: 40–46.

Burnham, W., Burnham, K.K. & Cade, T.J. 2005. Past and present assessment of birdlife in Uummannaq District, West Greenland. Dansk Orn. Foren. Tidsskr. 99: 196–208.

Burton, N.H.K., Rehfisch, M.M., Stroud, D.A. & Spray, C.J. (eds) (2008). The European Non-Estuarine Coastal Waterbird Survey. *International Wader Studie*s 18. International Wader Study Group, Thetford, UK. 108 pp.

Byers, S. & Cary, J. 1991. Discrimination of Mallard strains on the basis of morphology. Journal of Wildlife Management 55: 580–586.

Callaghan, D.A. & Kirby, J.S. 1996. Releases of Anatidae for hunting and the effects on wetland diversity – a review and evaluation. Gibier Faune Sauvage, Game and Wildlife 13: 1049–1068.

Chambers, R. & Conway, G.R. 1991. *Sustainable rural livelihoods: practical concepts for the 21st century.* IDS Discussion Papers 296. Institute of Development Studies. http://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/775/Dp296.pdf?sequence=1

Champagnon, J. 2011. *Consequences of the introduction of individuals within harvested populations: the case of the Mallard* Anas platyrhynchos. PhD thesis, University of Montpellier, France.

Champagnon, J., Guillemain, M., Gauthier-Clerc, M., Lebreton, J.-D., & Elmberg, J. 2009. Consequences of massive bird releases for hunting purposes: Mallard *Anas platyrhynchos* in the Camargue, southern France. Wildfowl Special Issue 2: 192–201.

Champagnon, J., Guillemain, M., Elmberg, J., Folkesson, K., & Gauthier-Clerc, M. 2010. Changes in Mallard *Anas platyrhynchos* bill morphology after thirty years of supplemental stocking. Bird Study 57: 344–351.

Champagnon, J., Elmberg, J., Guillemain, M., Gauthier-Clerc, M. & Lebreton, J.-D. 2012a. Conspecifics can be aliens too: A review of effects of restocking practices in vertebrates. Journal for Nature Conservation 20: 231-241.

Champagnon, J., Guillemain, M., Elmberg, J., Massez, G., Cavallo, F. & Gauthier-Clerc, M. 2012b. Low survival after release into the wild: Assessing "the burden of captivity" on Mallard physiology and behaviour. European Journal of Wildlife Research 58(1): 255-267.

Champagnon, J., Gauthier-Clerc, M., Lebreton, J.-D. Mouronval, J.-B, & Guillemain, M. 2013. Les canards colverts lâchés pour la chasse interagissent-ils avec les populations sauvages ? Faune Sauvage 298: 4–9.

Champagnon, J., Legagneux, P. Souchay, G. Inchausti, P. Bretagnolle, V. Bourguemestre, F., Van Ingen, L. & Guillemain, M. 2015. Robust estimation of survival and contribution of captive-reared individuals to a wild population in a large-scale release programme. Oral presentation, 4th Pan-European Duck Symposium, Hanko, Finland. April 2015.

Čížková, D., Javůrková, V., Champagnon, J. & Kreisinger, J. 2012. Duck's not dead: Does restocking with captive bred individuals affect the genetic integrity of wild mallard (*Anas platyrhynchos*) population? Biological Conservation 152: 231-240.

Cheyron, P.D. 1995. *Reconnaître les oiseaux d'eau la nuit*. Association Picarde des Chasseurs de Gibier d'Eau. Corbie, France. ISBN No. 2-9509490-0-2.

Christensen, T. K. & Fox, A.D. 2014. Changes in age and sex ratios amongst samples of hunter-shot wings from common duck species in Denmark 1982–2010. European Journal of Wildlife Research 60: 303-312.

Clausen, P., Holm, T.E., Laursen, K., Nielsen, R.D., & Christensen, T.K. 2013. *Rastende fugle i det danske reservatnetværk 1994-2010: Del 1: Nationale resultater.* - Videnskabelig rapport fra DCE - Nationalt Center for Miljø og Energi; No. 72. Aarhus Universitet, DCE - Nationalt Center for Miljø og Energi (in Danish).

Colyvan, M., Justus, J. & Regan, H.M. 2011. The conservation game. Biological Conservation 144: 1246-1253.

Conroy, M.J. & Peterson, J.T. 2013. *Decision Making in Natural Resource Management: A Structured, Adaptive Approach*; John Wiley & Sons, Ltd.: West Sussex, UK, 456 pp.

Cooper, C., Larson, L., Dayer, A., Stedman, R. & Decker, D. 2015. Are wildlife recreationists conservationists? Linking hunting, birdwatching, and pro-environmental behavior. Journal of Wildlife Management 79: 446-457.

Coreau, D., Ferrand, Y. & Février, P. 2014. *2013-2014 French Snipe Report*. WI/IUCN-WSSG Newsletter 40: 24-32.

Cramp, S. & Simmons, K.E.L. 1977. *The Birds of the Western Palearctic* Volume I. Oxford University Press, Oxford, New York, 722 p.

Cross, P., St John, F.A.V., Khan, S. & Petroczi, A. 2013. Innovative techniques for estimating illegal activities in a human-wildlife-management conflict. PLoS ONE 8(1), e53681.

Delany, S., Scott, D.A., Dodman, T., & Stroud, D.A. (eds.) (2009). *An atlas of wader populations in Africa and western Eurasia.* Wetlands International, Wageningen, The Netherlands. 524 pp.

Denlinger, L. & Wohl, K. 2001. *Seabird harvest regimes in the circumpolar nations.* Conservation of Arctic Flora and Fauna (CAFF).

Dodds, G.W., Appleby, M.J. & Campbell, L. 1996. *A management guide to birds of upland farmland*. RSPB, Sandy, UK.

Drewitt, A., Whitehead, S. & Cohen, S. 2015. *Guidelines for the Selection of Biological SSSIs. Part 2: Detailed Guidelines for Habitats and Species Groups. Chapter 17 Birds.* JNCC, Peterborough, UK. http://jncc.defra.gov.uk/pdf/SSSI_Chptr17_Birds2015June.pdf

Duriez, O., Eraud, C., Barbraud, C. & Ferrand, Y. 2005. Factors affecting population dynamics of Eurasian woodcocks wintering in France: assessing the efficiency of a hunting-free reserve. Biological Conservation 122: 89-97.

Earnhardt, J., Thompson, S. & Schad, K. 2004. Strategic planning for captive populations: projecting changes in genetic diversity. Animal Conservation 7: 9–16.

EFSA Panel on Contaminants in the Food Chain (CONTAM). 2010. Scientific opinion on lead in food. EFSA Journal 2010 8(4): 1570. doi: 10.2903/j.efsa.2010.1570. Available online:

http://www.efsa.europa.eu/en/efsajournal/doc/1570.pdf

European Commission 2008. Guidance document on hunting under Council Directive 79/409/EEC on the conservation of wild birds "The Birds Directive". http://ec.europa.eu/environment/nature/conservation/wildbirds/hunting/docs/hunting_guide_en.pdf

European Commission 2009. Key Concepts of Article 7(4) of Directive 79/409/EEC. Period of reproduction and prenuptial migration of Annex II bird species in the 27 EU Member States. 476 pp. http://ec.europa.eu/environment/nature/conservation/wildbirds/hunting/key_concepts_en.htm

FAO 1996. The state of food and agriculture 1996. Food and Agriculture Organization of the United Nations, FAO Agriculture series no. 29, http://www.fao.org/docrep/003/w1358e/w1358e00.HTM

Fisher, I.J., Pain, D.J., & Thomas, V.G. 2006. A review of lead poisoning from ammunition sources in terrestrial birds. Biological Conservation 131: 421-432.

FNC 2009. Chasseurs et zones humides : Action ! Vingt-trois actions exemplaires de sauvegarde, de préservation, d'entretien et d'ouverture au public des zones humides menées par les Fédérations de Chasseurs. FNC, Issy-les-Moulineaux, France. 46 pp.

Fox, A.D. 2009. What makes a good alien? Dealing with the problems of non-native wildfowl. British Birds 102: 660-679.

Fox, A.D., Clausen, K.K., Dalby, L., Christensen, T.K. & Sunde, P. 2015. Age-ratio bias among hunter-based surveys of Eurasian Wigeon *Anas penelope* based on wing vs. field samples. Ibis 157: 391–395.

Fox, A.D. & Madsen, J. 1997. Behavioural and distributional effects of hunting disturbance on waterbirds in Europe: implications for refuge design. Journal of Applied Ecology 34: 1-13.

Franson, J.C. & Pain, D.J. 2011. Lead in Birds. In: Beyer, W. N. and Meador, J. P. (eds). Environmental contaminants in biota. Interpreting tissue concentrations. Taylor & Francis, Boca Raton, pp. 563–593.

Gavin, M.C., Solomon, J.N. & Blank, S.G. 2010. Measuring and monitoring illegal use of natural resources. Conservation Biology 24: 89-100.

Gilbert, G., Gibbons, D. W., & Evans, J. 2011. Bird Monitoring Methods: a manual of techniques for key UK species. Pelagic Publishing. 464 pp.

Goodman, S.M., Meininger, P.L., Baha, El Din, S.M., Hobbs, J.J. & Mullie, W.C. 1989. The Birds of Egypt. Oxford University Press, Oxford.

Gough, R.E. 1984. Laboratory confirmed outbreaks of duck viral enteritis (duck plague) in the United Kingdom 1977–1982. Veterinary Record 114: 262–265.

Gough, R.E. & Alexander, D.J. 1990. Duck viral enteritis in Great Britain, 1980 to 1989. Veterinary Record 127: 262–265.

Grauer, A., Koenig, A. & Bunnefeld, N. 2015. Citizen science based monitoring of greylag goose (Anser anser) in Bavaria (Germany): combining count data and bag data to estimate long-term trends between 1988/89 and 2010/11. PlosONE 10(6):e0130159. doi: 10.1371/journal.pone.0130159.

Green, A.J. & Elmberg, J. 2014. Ecosystem services provided by waterbirds. Biological Reviews 89(1): 105–122.

Green, R.E. & Pain, D.J. 2012. Potential health risks to adults and children in the UK from exposure to dietary lead in gamebirds shot with lead ammunition. Food and Chemical Toxicology 50: 4180-4190.

Guillemain, M., Fritz, H. & Duncan, P. 2002. The importance of protected areas as nocturnal feeding grounds for dabbling ducks wintering in western France. Biological Conservation 103(2), 183-198.

Guillemain, M., Bertout, J.M., Christensen, T.K., Pöysä, H., Väänänen, V.M., Triplet, P., Schricke, V. & Fox, A.D. 2010. How many juvenile Teal *Anas crecca* reach the wintering grounds? Flyway-scale survival rate inferred from age-ratio during wing examination. Journal of Ornithology 151: 51-60.

Hawke, C.J. & José, P.V. 1996. Reedbed management for commercial and wildlife interests. Sandy, UK: Royal Society for the Protection of Birds.

Heneim, N. 2001. Du disque de Hemaka au filet hexagonal du lac Manzala. Un exemple de pérennité des techniques de chasse antiques. Bulletin de l'Institut Français d'Archéologie Orientale 101: 237-248.

Hopkinson, P., Travis, J.M., Prendergast, J.R., Evans, J., Gregory, R.D., Telfer, M.G. & Williams, P.H. 2000. A preliminary assessment of the contribution of nature reserves to biodiversity conservation in Great Britain. Animal Conservation 3(4): 311-320.

Hudson, P., Dobson, A. & Newborn, D. 1998. Prevention of population cycles by parasite removal. Science 282: 2256–2258.

Huntington, H.P. 2013. Provisioning and Cultural Services. Pages 593-626 in H. Meltofte (ed.) Arctic Biodiversity Assessment. Status and trends in Arctic biodiversity. Conservation of Arctic Flora and Fauna, Akureyri.

Isakov, Y.A. 1967. MAR Project and conservation of waterfowl breeding in the USSR. In: Salverda, Z. (ed.) Proceedings of the Second European Meeting on Wildfowl Conservation. Noordwijk aan Zee, 9-14 May 1966, Ministry of Cultural Affairs, Recreation and Social Welfare, The Netherlands, pp. 125-138.

Jensen, G.H. 2014. Hunting for the optimal hunt. PhD Thesis, Department of Bioscience, Aarhus University, Denmark.

Kark, S., Tulloch, A., Gordon, A., Mazor, T., Bunnefeld, N. & Levin, N. 2015. Cross-boundary collaboration: key to the conservation puzzle. Current Opinion in Environmental Sustainability 12: 12-24.

Komdeur, J., Bertelsen, J. & Cracknell, G. (Eds.) 1992. Manual for aeroplane and ship surveys of waterfowl and seabirds. IWRB Spec. Publ. 19, Slimbridge, UK, 37 pp.

Konar, M., Todd, M.J., Muneepeerakul, R., Rinaldo, A., & Rodriguez-Iturbe, I. 2013. Hydrology as a driver of biodiversity: Controls on carrying capacity, niche formation, and dispersal. Advances in Water Resources 51: 317-325.

Kone, B., Diallo, M. & Maiga, A.M. 1999. L'exploitation des oiseaux d'eau dans le Delta Intérieur du Niger (Rapport d'étape). Mali-PIN publication 99-03. Wetlands International, Sévaré (Mali)/ Altenburg & Wymenga, Veenwouden, the Netherlands.

Kone, B., Diallo, M. 2000. Exploitation de la faune en général et des oiseaux d'eau dans le Delta Intérieur du Niger en 2000. Rapport d'étape. Mali-PIN publication 00-03. Wetlands International, Sévaré (Mali)/ Altenburg & Wymenga, Veenwouden, the Netherlands.

Kone, B., Diallo, M. & Fofana B. 2007. L'exploitation des oiseaux d'eau. In Wymenga, E.B. Kone, B., Van der Kamp, J. & L. Zwarts (Eds.). Delta Intérieur du Niger. Ecologie et gestion durable des ressources naturelles pp. 201-207. Mali-PIN publication 2002-01. Wetlands International, Sévaré/RIZA, Rijkswaterstaat, Lelystad/Alternburg & Wymenga conseillers écologiques, Veenwouden, the Netherlands.

Kone, B., Fofana, B., Beilfuss, R. & Dodman, T. 2007. The impact of capture, domestication and trade on Black Crowned Cranes in the Inner Niger Delta, Mali. Ostrich 78: 195-203.

Kruckenberg, H. 2007. Zugverhalten markierter Blässgänse *Anser albifrons* in Westeuropa–erste Ergebnisse und Ausblicke auf weitere Untersuchungen. Charadrius 43: 189-195.

Lafferty, K.D. & Gerber, L.R. 2002. Good medicine for conservation biology: the intersection of epidemiology and conservation theory. Conservation Biology 16: 593-604.

Lahti, D., Johnson, N., Ajie, B., Otto, S., Hendry, A., Blumstein, D., Coss, R., Donohue, K. & Foster, S.A. 2009. Relaxed selection in the wild. Trends in Ecology & Evolution 24: 487– 496.

Lande, R. & Shannon, S. 1996. The role of genetic variation in adaptation and population persistence in a changing environment. Evolution 50: 434-437.

Lensvelt-Mulders, G.J.L.M., Hox, J.J., van der Hejden, P.G.M. & Maas, C.J.M. 2005. Meta-analysis of randomized response research. Sociological Methods Research 33: 319-348.

Madsen, J. 2010. Age bias in the bag of pink-footed geese *Anser brachyrhynchus*: influence of flocking behaviour on vulnerability. European Journal of Wildlife Research 56: 577-582.

Madsen, J. 1998a. Experimental refuges for migratory waterfowl in Danish wetlands. I. Baseline assessment of the disturbance effects of recreational activities. Journal of Applied Ecology 35: 386-397.

Madsen, J. 1998b. Experimental refuges for migratory waterfowl in Danish wetlands. II. Tests of hunting disturbance effects. Journal of Applied Ecology 35: 398-417.

Madsen, J., Christensen, T.K., Balsby, T. & Tombre, I. 2015. Could have gone wrong: Effects of abrupt changes in migratory behaviour on harvest in a waterbird population. PLoS ONE 10(8): e0135100. doi: 10.1371/journal.pone.0135100.

Madsen, J., Guillemain, M., Nagy, S., Defos du Rau, P., Mondain-Monval, J-Y., Griffin, C. & Middleton, A. 2015. Towards sustainable management of huntable migratory waterbirds in Europe: A report by the Waterbird Harvest Specialist Group of Wetlands International. Wageningen, The Netherlands: Wetlands International.

Madsen, J. & Williams, J.H. 2012. International Species Management Plan for the Svalbard population of the pink-footed goose *Anser brachyrhynchus*. AEWA Technical Report No. 48. African-Eurasian Waterbird Agreement, Bonn, Germany.
http://pinkfootedgoose.aewa.info/sites/default/files/article_attachments/SPfG%20ISMP_May-2012.pdf

Madsen, J., Pihl, S. & Clausen, P. 1998. Establishing a reserve network for waterfowl in Denmark: a biological evaluation of needs and consequences. Biological Conservation 85: 241-255.

Madsen, J. & Fox, A.D. 1997. The impact of hunting disturbance on waterbird populations - the concept of flyway networks of disturbance-free areas. Gibier Faune Sauvage, Game Wildl. 14: 201-209.

MaMing, R., Zhang, T., Blank, D., Ding, P. & Zhao, X. 2012. Geese and ducks killed by poison and analysis of poaching cases in China. Goose Bulletin (Bulletin of the Goose Specialist Group) 15: 2-11.

Mangnall, M.J. & Crowe, T.M. 2002. Population dynamics and the physical and financial impacts to cereal crops of the Egyptian Goose *Alopochen aegyptiacus* on the Agulhas Plain, Western Cape, South Africa. Agriculture, Ecosystems & Environment 90: 231-246.

Mateo, R. 2009. Lead poisoning in wild birds in Europe and the regulations adopted by different countries. Ingestion of lead from spent ammunition: implications for wildlife and humans, 2009, pp. 71-98. https://www.peregrinefund.org/subsites/conference-lead/PDF/0107%20Mateo.pdf

Mathevet, R., & Mesléard, F. 2002. The origins and functioning of the private wildfowling lease system in a major Mediterranean wetland: the Camargue (Rhone river delta, southern France). Land Use Policy 19: 277-286.

Matthews, G.V.T. 1993. The Ramsar Convention on Wetlands: its history and development. Gland: Ramsar Convention Bureau.
http://www.ramsar.org/sites/default/files/documents/pdf/lib/Matthews-history.pdf

Melnikova, O. 2013. Presentation at the conference 'Biodiversity of the Black Sea Region of Russia'. Kuban Agrarian University (Krasnodar, Russia).

Merkel, F.R. 2010. Evidence of recent population recovery in common eiders breeding in western Greenland. Journal of Wildlife Management 74: 1869-1874.

Merkel, F.R. & Barry, T. 2008. Seabird harvest in the Arctic. Circumpolar Seabird Working Group, Conservation of Arctic Flora and Fauna, Akureyri: 90 pp.

Milner-Gulland, E.J. & Rowcliffe, R.J. 2007. Conservation and sustainable use. A handbook of techniques. Oxford University Press, Oxford.

Mondain-Monval, J.-Y., Olivier, A., & Le Bihan, A. 2009. Recent trends in the number of hunters and the harvest of wildfowl in the Camargue, France: preliminary results. Wildfowl Special Issue 2: 192-201.

Mondain-Monval, J.-Y., Defos du Rau, P., Guillemain, M. & Olivier, A. 2015. Switch to non-toxic shot in the Camargue, France: effect on waterbird contamination and hunter effectiveness. European Journal of Wildlife Research 61: 271-283.

Mooij, J., Farago, S. & Kirby, J.S. 1999. White-fronted Goose Anser albifrons. Pp. 95-12 in: Madsen, J., Cracknell, G. & Fox, A.D. (eds) Goose Populations of the Western Palearctic. A review of status and distribution. Wetlands International Publication No. 48. Wetlands International, Wageningen, The Netherlands. National Environmental Research Institute, Rønde, Denmark. 344 pp.

Moro, M., Fischer, A., Czajkowski, M., Brennan, D., Lowassa, A., Naiman, L.C. & Hanley, N. 2013. An investigation using the choice experiment method into options for reducing illegal bushmeat hunting in western Serengeti. Conservation Letters 6: 37-45.

Msimanga, A. 2000. The role of birds in the culture of the Ndebele people of Zimbabwe. Ostrich 71: 22-24.

Mullié, W.C. & Meininger, P.L. 1983. Waterbird trapping and hunting in Lake Manzala, Egypt, with an outline of its economic significance. Biological Conservation 27: 23-43.

Musgrove, A.J., Austin, G.E., Hearn, R.D., Holt, C.A., Stroud, D.A. & Wotton, S.R. 2011. Overwinter population estimates of British waterbirds. British Birds 104: 364-397.

Nichols, J.D., Johnson, F.A., Williams, B.K. & Boomer, G.S. 2015. On formally integrating science and policy: walking the walk. Journal of Applied Ecology (online first); doi: 10.1111/1365-2664.12406).

Noer, H., Madsen, J. & Hartmann, P. 2007. Reducing wounding of game by shotgun hunting: effects of a Danish action plan on pink-footed geese. Journal of Applied Ecology 44: 653-662.

Noer, H., Søndergaard, M., & Jørgensen,T. B. 2008. Releases of Mallard in Denmark and effects on lake phosphorus levels. Report of the National Environmental Research Institute, Aarhus University. [In Danish]

Nørrevang, A. 1986. Traditions of sea bird fowling in the Faroes: an ecological basis for sustained fowling. Ornis Scandinavica 17: 275-281.

Nuno, A. 2015. Achieving ecological conservation impact is not enough: setting priorities based on multiple criteria. Animal Conservation 18: 16-17.

Nuno, A., Bunnefeld, N., Naiman, L.C. & Milner-Gulland, E.J. 2013 A novel approach to assessing the prevalence and drivers of illegal bushmeat hunting in the Serengeti. Conservation Biology 27: 1355-1365.

Olivier, G.-N. 2007. The Jack Snipe *Lymnocryptes minimus*. OMPO/CICB, Paris, France. 206 p.

Otero Muerza C. & Bailey A.D. 2003. Europe's Natural and Cultural Heritage. The European Estates. Instituto Ibérico para el Medio Ambiente, Friends of the countryside. 701 pp.

Padding, P.I. & Royle, J.A. 2012. Assessment of bias in US waterfowl harvest estimates. Wildlife Research 39: 336-342.

Pain, D.J. 1991. Lead shot densities and settlement rates in Camargue marshes, France. Biological Conservation 57: 273-286.

Pain, D. J., Amiard-Triquet, C., Bavoux, C., Burneleau, G., Eon, L. & Nicolau-Guillaumet, P. 1993. Lead poisoning in wild populations of Marsh Harriers *Circus aeruginosus* in the Camargue and Charente-Maritime, France. Ibis 135: 379-386.

Pain, D.J., Cromie, R.L., Newth, J., Brown, M.J., Crutcher, E., et al. 2010. Potential hazard to human health from exposure to fragments of lead bullets and shot in the tissues of game animals. PLoS ONE 5(4): e10315. doi: 10.1371/journal.pone.0010315.

Péron, G., Nicolai, C.A. & Koons, D.N. 2012. Demographic response to perturbations: the role of compensatory density dependence in a North American duck under variable harvest regulations and changing habitat. Journal of Animal Ecology 80: 960–969.

Piersma, T. 2002. Energetic bottlenecks and other design constraints in avian annual cycles. Integrative and Comparative Biology 42: 51-67.

Platteeuw, M. & Henkens, R.J. 1997. Possible impacts of disturbance to waterbirds: individuals, carrying capacity and populations. Wildfowl 48: 225-236.

Power, A. & Mitchell, C. 2004. Pathogen spillover in disease epidemics. The American Naturalist 164: S79–S89.

Raftovich, R.V., Chandler, S. & Wilkins, K.A. 2014. Migratory bird hunting activity and harvest during the 2012-13 and 2013-14 hunting seasons. U.S. Fish and Wildlife Service, Laurel, Maryland, USA.

Ramsar Convention Secretariat 2010. Managing wetlands: Frameworks for managing Wetlands of International Importance and other wetland sites. Ramsar handbooks for the wise use of wetlands, 4th edition, vol. 18. Ramsar Convention Secretariat, Gland, Switzerland.
http://www.ramsar.org/sites/default/files/documents/pdf/lib/hbk4-18.pdf

Rauschmayer, F., Berghöfer, A., Omann, I. & Zikos, D. 2009. Examining processes or/and outcomes? Evaluation concepts in European governance of natural resources. Environ. Policy Gov. 19:159–173.

Redpath, S.M., Young, J., Evely, A., Adams, W.M., Sutherland, W.J., Whitehouse, A., Amar, A., Lambert, R.A., Linnell, J.D.C., Watt, A. & Gutierrez, R.J. 2013. Understanding and managing conservation conflicts. Trends in Ecology and Evolution 28(2): 100-109.

Reynolds, R.E., Loesch, C.R., Wangler, B. & Shaffer, T.L. 2007. Waterfowl response to the conservation reserve program and swampbuster provision in the prairie pothole region, 1992–2004. Bismarck, ND: US Department of the Interior.

Ridgill, S.C. & Fox, A.D. 1990. Cold Weather Movements of Waterfowl in Western Europe. IWRB Special Publication 13, Slimbridge, UK.

Rosol, R., Huet, C., Wood, M., Lennie, C., Osborne, G. & Egeland, G.M. 2011. Prevalence of affirmative responses to questions of food insecurity: International Polar Year Inuit Health Survey, 2007-2008. International Journal on Circumpolar Health 70(5): 488-497.

Ross, D.P. & Usher, P.J. 1986. From the Roots up: Economic Development as if Community Mattered. Canadian Council on Social Development, Ottawa.

Schroeder, S.A., Fulton, D.C. & Lawrence, J.S. 2006. Managing for preferred hunting experiences: a typology of Minnesota waterfowl hunters. Wildlife Society Bulletin 34(2): 380-387.

Scott, D.A. & Rose, P.M. 1996. Atlas of Anatidae Populations in Africa and Western Eurasia. Wetlands International Publication 41. Wetlands International, Wageningen, The Netherlands.

Sissler, C. 2000. Etude préliminaire des prélèvements effectués sur les oiseaux d'eau (anatidés et limicoles) en Afrique Subsaharienne. Office National de la Chasse et de la Faune Sauvage et Fondation Internationale pour la Sauvegarde de la Faune. 73 pp.

Snaebörnsson, A. 2001. Eiderduck Farming in Iceland. 4th Conference of the Circumpolar Agricultural Association, 27-29 August 2001, Akureyri, Iceland (see the summary available at: http://www.svs.is/caa/CAC%202001).

Sokos, C., Birtsas, P., & Tsachalidis, E. 2008. The aims of galliforms release and choice of techniques. Wildlife Biology 14: 412–422.

Söderquist, P. 2015. Large-Scale Releases of Native Species: the Mallard as a Predictive Model System. Doctoral thesis, Swedish University of Agricultural Sciences, Umeå, Sweden.

Söderquist, P., Gunnarsson, G. & Elmberg, J. 2013. Longevity and migration distance differ between wild and hand-reared mallards Anas platyrhynchos in Northern Europe. European Journal of Wildlife Research 59: 159-166.

Söderquist, P., Norrström, J., Elmberg, J., Guillemain, M. & Gunnarsson, G. 2014. Wild Mallards Have More ''Goose-Like'' Bills Than Their Ancestors: A Case of Anthropogenic Influence? PLoS ONE 9(12): e115143. doi: 10.1371/journal.pone.0115143.

Sterner, T. & Coria, J. 2011. Policy Instruments for Environmental and Natural Resource Management. Johns Hopkins University Press.

St John, F.A.V. 2012. Assessing and sentencing illegal behaviours in conservation. PhD thesis, University of Bangor. http://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.568794

St John, F.A.V., Edwards-Jones, G., Gibbons, J.M. & Jones, J.P.G. 2010. Testing novel methods for assessing rule breaking in conservation. Biological Conservation 143: 1025-1030.

Stroud, D.A., Pienkowski, M.W. & Mudge, G.P. 1990. Protecting internationally important bird sites: a review of the network of EC Special Protection Areas in Great Britain. Nature Conservancy Council, Peterborough. 230 pp.
http://jncc.defra.gov.uk/pdf/Protecting_internationally_important_bird_sites_1990.pdf

Stroud, D.A., Harradine, J., Shedden, C., Hughes, J. Williams, G., Clark, J.A. & Clark, N.A. 2006. Reducing waterbird mortality in severe cold weather: 25 years of statutory shooting suspensions in Britain. Waterbirds around the world. Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. Pp. 784-790.

Tamisier, A. 1979. The functional units of wintering ducks, a spatial integration of their comfort and feeding requirements. Verhandlungen der Ornithologischen Gesellschaft in Bayern 23: 229-238.

Theodorou, K. & Couvet, D. 2004. Introduction of captive breeders to the wild: Harmful or beneficial? Conservation Genetics 5: 1–12.

Tombre, I. M., Eythorsson, E. & Madsen, J. 2013. Stakeholder involvement in adaptive goose management: case studies and experiences from Norway. Ornis Norvegica 36: 17- 24.

Traoré, N. 1996. Gestion et conservation des Anatidae dans le Delta intérieur du Niger au Mali. Gibier Faune Sauvage 13: 1091-1093.

Traoré, N. 1996. Anatidae management and conservation in the Interior Delta of the Niger in Mali. In: Proceedings of the Anatidae 2000 conference, Strasbourg, France, 5-9 December 1994. Birkan M., Van Vessem, Havet P., Madsen, J. Trolliet B. & Moser M. Eds. Gibier Faune Sauvage 13: 1091-1093.

Tréca, B. 1985. Waterfowl catches by fishermen in Mali. Bamako. ORSTOM, 13 pp. http://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_6/b_fdi_45-46/010007919.pdf

Tréca, B. 1985. Les risques de dégâts d'oiseaux sur les rizières sahéliennes. In Le risque en agriculture. Eldin Michel & Milleville Pierre (ed.). Paris: ORSTOM, pp. 167-175 http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers07/27233.pdf

Treweek, J. 1997. The wet grassland guide: Managing floodplain and coastal wet grasslands for wildlife. Royal Society for the Protection of Birds, Sandy, UK.

Tufto, J. 2001. Effects of releasing maladapted individuals: a demographic-evolutionary model. American Naturalist 158: 331-340.

Van Eijk, P. & Kumar, R. 2009. Bio-rights in theory and practice. A financing mechanism for linking poverty alleviation and environmental conservation. Wetlands International, Wageningen, The Netherlands.

Van Zegeren, K. & Wilson, J.G.M. 1999. Bird catching around lake Chilwa, Malawi. Ostrich 70: 246-247.

Vaske, J.J., Fedler, A.J. & Graefe, A.R. 1986. Multiple determinants of satisfaction from a specific waterfowl hunting trip. Leisure Sciences 8 (2):149-166.

Vickery, J.A., Ewing, S.R., Smith, K.W., Pain, D.J., Bairlein, F., Škorpilová, J. & Gregory, R.D. 2014. The decline of Afro-Palaearctic migrants and an assessment of potential causes. Ibis 156: 1–22.

Vittecoq, M., Grandhomme, V., Champagnon, J., Guillemain, M., Crescenzo-Chaigne, B., Renaud, F., Thomas, F., Gauthier-Clerc, M. & van der Werf, S. 2012. High Influenza A virus infection rates in Mallards bred for hunting in the Camargue, South of France. PLoS ONE 7(8): e43974. doi: 10.1371/journal.pone.0043974.

Ward, D., Holmes, N. & José, P. (Eds.) 1995. The new rivers & wildlife handbook. Royal Society for the Protection of Birds, Sandy, UK.

Wardell, J. & Harrison, J. 1964. The use of captive-bred mallard to augment a wild population. Transactions of the VIth Congress of the International Union of Game Biologists, pp. 285-291. The Nature Conservancy, London, Great-Britain.
Wetlands International 2015. Waterbird Population Estimates. Retrieved from wpe.wetlands.org

Williams, B.K., Szaro, R.C. & Shapiro, C.D. 2007. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, D.C.

Williams, C.K., Dugger, B.D., Brasher, M.G., Coluccy, J.M., Cramer, D.M., Eadie, J.M., ... & Webb, E.B. 2014. Estimating habitat carrying capacity for migrating and wintering waterfowl: considerations, pitfalls and improvements. Wildfowl Special Issue 4: 407-435.

World Summit on Sustainable Development 2002. Plan of Implementation of the World Summit on Sustainable Development.
http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf

Zwarts, L., Bijlsma, R. G., van der Kamp, J. & Wymenga, E. 2008. Living on the edge: Birds and wetlands in a changing Sahel. Zeist: KNNV Publishing, 2009.

Appendix 1 - Defining Periods of Breeding and Pre-nuptial Migration for Migratory African-Eurasian Waterbirds[31]

Introduction

Section 2.1.2 of the AEWA Action Plan states:

"*2.1.2 Parties with populations listed in Table 1 shall regulate the taking of birds and eggs of all populations listed in column B of Table 1. The object of such legal measures shall be to maintain or contribute to the restoration of those populations to a favourable conservation status and to ensure, on the basis of the best available knowledge of population dynamics, that any taking or other use is sustainable. Such legal measures, subject to paragraph 2.1.3 below, shall in particular:*

(a) prohibit the taking of birds belonging to the populations concerned during their various stages of reproduction and rearing and during their return to their breeding grounds if the taking has an unfavourable impact on the conservation status of the population concerned; … "

In Resolution 4.3, the Meeting of the Parties requested the Technical Committee, *inter alia*:

5. To review the periods during which huntable bird populations of conservation concern covered by the Agreement return to their breeding grounds and, if needed, to provide further guidance on the implementation of paragraph 2.1.2 (a) AEWA Action Plan.

Previous relevant guidance

Article 7(4) of the EU Directive on the conservation of wild birds contains similar provisions:

4. Member States shall ensure that the practice of hunting, including falconry if practised, as carried on in accordance with the national measures in force, complies with the principles of wise use and ecologically balanced control of the species of birds concerned and that this practice is compatible as regards the population of these species, in particular migratory species, with the measures resulting from Article 2. They shall see in particular that the species to which hunting laws apply are not hunted during the rearing season nor during the various stages of reproduction. In the case of migratory species, they shall see in particular that the species to which hunting regulations apply are not hunted during their period of reproduction or during their return to their rearing grounds. Member States shall send the Commission all relevant information on the practical application of their hunting regulations. [Emphasis added]

The European Commission, with the Member States have developed guidance on defining periods of breeding and pre-nuptial migration, initially for the EU15 and more recently for all 27 Member States (European Commission 2009). That analysis used the following definition:

"Period of reproduction"

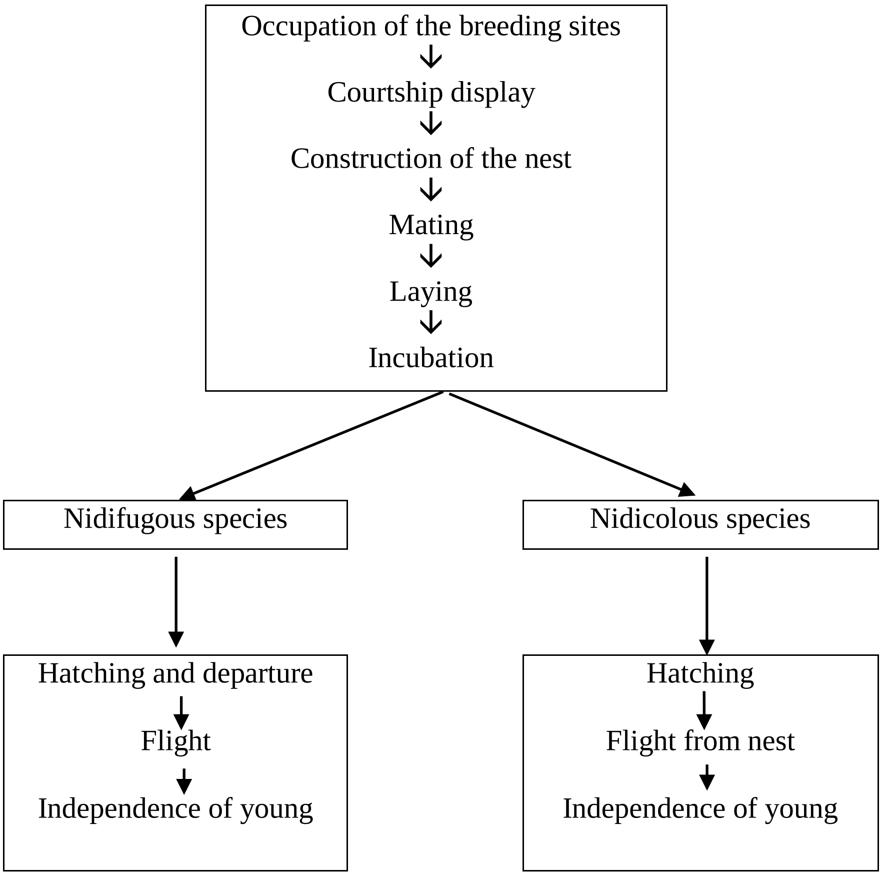
'**Breeding season'**[32] was defined using the definition of Cramp & Simmons (1977): "*the breeding season is the period during which a species lays and incubates its eggs and rears its young to the flying stage.*" However, the '**reproduction period**' not only covers the breeding season but also includes the occupation of the breeding areas as recognised in the 1993 Commission report on the application of the Birds Directive[33]).

[31] Appendix 1 to Resolution 5.10 *Revision and Adoption of Conservation Guidelines*, adopted by MOP5, 14-18 May 2012, La Rochelle, France

[32] This term is considered equal and better English than the term 'rearing season' used in Article 7(4).

[33] COM (93) 572 final. *Second report on the application of Council Directive 79/409/EEC on the conservation of wild birds.* Brussels, 24 November 1993.

"The following scheme, which deals with the different stages of reproduction, was agreed as an appropriate general scheme for the period of reproduction. The sequence and importance of the elements of this general scheme may vary by species according to differences in breeding biology."



"Criteria used to identify the beginning and end of the period of reproduction"

"In general, for migratory species, the stage of reproduction identifying the start of the period of reproduction is the 'occupation of the breeding sites'. However, the occupation of the breeding sites is generally difficult to use where the species is mainly locally resident or where there is a mixing of locally resident and migratory birds. In these cases, the stage identifying the start of the period of reproduction is the 'construction of the nest'. In those situations, where the stage retained is difficult to recognise in the field, a mention is made to the corresponding number of decades counted from the start of egg laying (generally well known for most species).

- "In general, the stage retained to identify the end of the period of reproduction is the 'full flight of young birds', i.e. fledging of all broods including second or third broods for some species (e.g. rails / Rallidae, pigeons / Columbidae, thrushes / Turdidae). Full flight means that young birds are capable of sustained, continuous flight to a similar capacity as adult birds and corresponds to the 'independence of young birds. Nonetheless, for certain species (e.g. crows / *Corvidae*) the full flight occurs before 'independence of young birds'. Young birds are independent when the loss of parental care and/or feeding does not significantly lower survival prospects of young. In those situations, where the 'full flight/independence of young' is difficult to establish in the field, a mention is made to the corresponding number of decades counted from the end of hatching."

Migration

The EU adopted the following guidance with respect to determining the timing of migration (or 'return to the breeding areas'):

> **"Return to the breeding areas"[34]**
>
> "Return to the breeding areas is an annual displacement, in one of more stages, of birds from their wintering areas back to nesting grounds. The wintering period ends with departure from the wintering areas where migrant birds have been more or less stationary since the end of the post-nuptial (autumn) migration. The return to the breeding areas is commonly called 'pre-nuptial migration' or 'spring migration'.
>
> In Europe, return migration movements are mostly directed north, northeast or northwest. This means that migrants from African winter quarters first cross the Mediterranean, then pass through central Europe on their way to their Northern European breeding areas. This migration normally takes several weeks (including breaks at resting places on the way) but individual birds can complete the journey in one or a few days. The start, end and length of the migration season in a particular country are determined by a number of biological, geographical and methodological factors.
>
> Regarding the beginning of the pre-nuptial migration, all individuals of a species within a same region do not end their wintering period at the same time. Not only are there individual differences, but within a single wintering area, birds of different populations having different annual cycles come together. Birds belonging to northern populations, for example, often start their return flight much later than birds breeding more to the south. An extreme case is the so-called 'leapfrog' migration (e.g. in the Redshank): birds breeding in more northern latitudes travel greater distances and move to more southerly wintering areas than those that nest farther south.
>
> The fact that birds leave a wintering area does not necessarily mean that they start their return migration. They can move to other wintering quarters because of changes in the local ecological conditions, exhaustion of food resources, disturbance or changes in climatic conditions. When migratory and sedentary birds of the same species coexist on the same wintering grounds, the situation can be even more complex. Thus, apparent discrepancies may arise among the data for large countries. Major differences between neighbouring regions can reflect ecological differences more than actual differences in migration timing. For example, although the southern parts of Spain (Andalucía) and Italy (Sicilia) are situated on the same latitude (37th) this does not necessarily imply similar arrival dates of migrants because different populations might be involved.
>
> The length of the migration period does not only depend on the north-south extension of the country concerned but also on the availability and the use of resting places. A typical example concerns the Bar-tailed Godwits, which migrate from the African winter quarters to Siberian breeding areas. After a continuous flight from the Banc d'Arguin in Western Africa, they stay several weeks in the Wadden Sea. The migration period length is also determined by the quantity and the geographical range of the birds involved: a small population can pass in a few days while a numerous species with an extensive breeding range can have a prolonged migratory season encompassing several months. Moreover, the migration period can also be extended if a country is passed over by several populations with different time schedules.
>
> Methodological reasons can also account for a short period: the start and end dates of migration are not recorded accurately because it only involves small numbers of birds which are often not

[34] "return to breeding areas" is taken as a synonym of "return to the rearing grounds"

noted if few observations are available (low chance of recording). As said before, availability of data differs very much from species to species (behavioural differences) and from country to country (e.g. numbers of observers).

In general, the beginning of the return migration can only be estimated by comparison of data from many different regions of the European Union, analysis of ring recoveries and consideration of arrival dates in the breeding areas.

Information defining the timing of pre-nuptial migration was based on statistics relating to populations rather than individual birds."

"Presentation of data [on migration and breeding periods]"

"To avoid spurious precision and to allow for normal between-year variation in timing of migration and breeding events, the data presentations summarise the data on reproduction and return migration in 'decades' or ten-day periods (i.e. 1-10, 11-20, 21 up to 31 in each month).

"A number of general principles were adopted in the gathering of data:

- Where there is a range in timing of pre-nuptial migration or breeding (as will occur in most countries of significant size), the data used relate to the earliest periods in each of the Member States concerned. This is generally relating to the southernmost parts or lowest altitudes. Likewise, for the end of the reproduction, the data used refers to the latest dates. This means that regional differences may exist for prenuptial migration and reproduction periods within the territory of one Member State, which may be relevant. …
- Where significant between-year variation occurs on a regular basis, data from the earliest periods have always been taken;
- Where different populations of the same species migrate through a country at different times, information relating to the earliest migrating population has been used. In some cases, where different populations (i.e. different subspecies or different flyways) are clearly distinguishable in the field, their correspondent timings where given.
- Extreme, outlying and erratic data have been excluded due to their unpredictable nature and falling outside normal patterns of variation between and within years."

Beyond Europe

In Africa, the definition of breeding seasons and migration periods become increasingly complex as the reproductive cycles of birds relate to different forms of seasonality and environmental predictability. These issues are explored in detail by Dodman & Diagana (2006) who highlighted that, in Africa, there are a range of definitional and other complexities that make the concept of simple latitudinal migration patterns of northern or temperate Eurasia difficult to apply. Such issues include multiple migratory behavioural types, such as:

- Local movers/short distance migrants;
- Rains migrants/ arid zone migrants;
- Nutrition migrants/post-roost dispersers;
- Post-breeding dispersers;
- Nomads;
- Altitudinal migrants; and

- Environmental response migrants.

Further, Dodman & Diagana (2006) stressed that whilst migration in northern climates is strongly determined by seasonal patterns, in tropical regions there are multiple different triggers for waterbird movements, including:

- Sudden availability of productive wetlands;
- Rising water levels/flooding;
- Falling water levels/edge effects; and
- Lack of rain/increasing aridity.

Dodman & Diagana (2006) further highlighted a range of practical problems in relation to defining intra-African migration:

- Many African flyways are diffuse, and not easy to specify.
- Some sites are only important irregularly, e.g. once every few years, especially temporary wetlands.
- Site networks are not always obvious, and may include large numbers of small wetlands or sites that are not used regularly.
- Several species exploit wetlands at different periods and for different reasons, such that sites cannot be maintained in a constant state; rather it is important to permit natural flooding and other cycles.
- Many waterbirds are nomadic and are not faithful to specific routes or annual seasons.
- It is difficult to monitor intra-African migrants: current procedures under the AfWC focused on coordinated biannual censuses are not effective enough in identifying migratory strategies.
- On a practical level, there are low resources and capacity for conserving intra-African migrants, whilst other issues also influence monitoring, such as inaccessibility and security.

They concluded that "the high diversity of "movement strategies" of African waterbirds and the often limited ability to predict movements render their management and conservation quite difficult. The life cycles and movements of most African waterbirds are not precisely known, and the networks of key sites not well determined."

Recommendations related to section 2 of AEWA's Action Plan

The Technical Committee recommends that for the purposes of the implementation of the obligations of section 2 of the AEWA Action Plan, one of the following options are pursued, as appropriate:

1. The Member States of the European Union should continue to use the definitions (above and Table 1) established previously by European Commission (2009), incorporating any future amendments in these should they be agreed by the EU.

2. Other non-EU European countries, which typically are relatively 'data-rich' with respect to ornithological information, should adopt the EU definitions following review to ensure their applicability in the countries concerned.

3. Non-European countries (Africa, Middle East and western Eurasia) should establish definitions appropriate to the country concerned based on knowledge of species' breeding biology in the appropriate regions. These should be used to determine the timing of the start and end of the breeding period. The following guidance may assist this process:

a. Review published knowledge of individual species breeding biology. Particularly valuable sources of information are given in Table 2.

b. Review any published knowledge, if this exists, of breeding biology in the country concerned.

c. Especially in the absence of published knowledge, consider what is known about the timing of breeding in neighbouring countries, or within the region, bearing in mind their position (north or south) of the country concerned and the implication that may have with respect to climatic/seasonal timing.

General recommendations related to intra-African migrants

As noted previously, intra-African migrants provide a range of problems related to the implementation of section 2 (and other parts) of AEWA's Action Plan. The Technical Committee highlights the recommendations previously made by Dodman & Diagana (2006). These remain highly relevant to advancing conservation of such species:"

1. "Improve knowledge of the status of African waterbirds and their migratory patterns through:
   - Applied research of weather patterns, site conditions and waterbird seasonality;
   - Extending the African Waterbird Census (AfWC) to other seasons and other areas;
   - Use/analysis of existing AfWC and other data to identify site linkages and migratory patterns;
   - Increased adoption of satellite telemetry;
   - Initial conservation focus on a series of "high profile species";
   - Monitoring, research and conservation of threatened species;
   - Development of AFRING (African bird ringing scheme).
2. Identify key sites and site networks for intra-African migrants, especially threatened species.
3. Develop Species Action Plans for African waterbirds.
4. Promote increased focus on intra-African migrants in the implementation of the AEWA.
5. Adopt a precautionary principle; it is often necessary to implement conservation action before knowing the full picture.
6. Enhance awareness of African waterbirds, especially their values and ecological roles.
7. Highlight the plight and lack of knowledge of threatened African waterbirds.
8. Mobilize resources for conservation and monitoring of intra-African migrants, especially through development and subsequent implementation of a Conservation Strategy for African Waterbirds."

References

Bauer, K.M. & Glutz von Blotzheim, U.N. 1963. *Handbuch der Vogel Miteleuropas*. Volume 2. Frankfurt am Main.

Brown, L.H., Urban, E.K. & Newman, K. (eds.) 1982. The Birds of Africa. Volume I. Academic Press, London. 521 pp.

Cramp, S. ed. 1985. Handbook of the Birds of Europe, the Middle East and North Africa: the Birds of the Western Palearctic, Volume 4. Oxford, Oxford University Press. 960 pp.

Cramp, S. & Simmons, K.E.L. (eds). 1977. Birds of the Western Palearctic, Volume 1. Oxford, Oxford University Press. 722 pp.

Cramp, S. & Simmons, K.E.L. eds. 1980. Handbook of the Birds of Europe, the Middle East and North Africa: the Birds of the Western Palearctic, Volume 2. Oxford, Oxford University Press. 695 pp.

Cramp, S. & Simmons, K.E.L. eds. 1983. Handbook of the Birds of Europe, the Middle East and North Africa: the Birds of the Western Palearctic, Volume 3. Oxford, Oxford University Press. 913 pp.

Delany, S., Scott, D.A., Dodman, T. & Stroud, D.A. (eds.) 2009. An atlas of wader populations in Africa and western Eurasia. Wetlands International, Wageningen, The Netherlands. 524 pp.

del Hoyo, J., Elliott, A. & Sargatel, J. (eds.) 1992. Handbook of the Birds of the World. Vol. 1. Hoatzin to Auks. Lynx Edicions, Barcelona. 626 pp.

del Hoyo, J., Elliott, A. & Sargatel, J. (eds.) 1996. Handbook of the Birds of the World. Vol. 3. Ostrich to Ducks. Lynx Edicions, Barcelona. 821 pp.

Dodman, T. & Diagana, C.H. 2006. Conservation dilemmas for intra-African migratory waterbirds. Pp. 218-223. In: Waterbirds around the world. Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. At: http://www.jncc.gov.uk/PDF/pub07_waterbirds_part3.4.1.pdf

European Commission 2009. Key Concepts of Article 7(4) of Directive 79/409/EEC. Period of reproduction and prenuptial migration of Annex II bird species in the 27 EU Member States. 476 pp. At: http://ec.europa.eu/environment/nature/conservation/wildbirds/hunting/key_concepts_en.htm

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (eds) 2005. Roberts – Birds of Southern Africa. VIIth edition. Cape Town. At: http://www.robertsonline.co.za/portal.asp

Kear, J. (ed.) 2005. Ducks, geese and swans. Bird Families of the World XVI. Two vols. Oxford University Press.

Kushlan, J.A. & Hancock, J.A. 2005. The Herons. Bird Families of the World XVII. Oxford University Press. 433 pp.

Scott, D.A. & Rose, D.A. 1996. Atlas of Anatidae populations in Africa and western Eurasia. Wetlands International Publication No. 41. Wageningen, The Netherlands.

Taylor, B. 1998. Rails. A Guide to the Rails, Crakes, Gallinules and Coots of the World. Christopher Helm/A & C Black.

Urban, E.K., Fry, C.H. & Keith, S. (eds.) 1986. The Birds of Africa. Volume II. Academic Press, London. 552 pp.

Viljoen, P.J. 2005. AGRED's Gamebirds of South Africa: Field Identification and Management. AGRED.

Table 1. Definitions for the start end of breeding periods as defined by the EU (European Commission 2009). Only species listed by AEWA are listed here.

Species	Start of breeding period	End of breeding period
ANATIDAE		
Cygnus olor	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Anser fabalis	• occupation of the breeding sites	full flight of young birds
Anser anser	• occupation of the breeding sites	full flight of young birds
Anas penelope	• occupation of the breeding sites	full flight of young birds
Anas strepera	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Anas crecca	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Anas platyrhynchos	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Anas acuta	• occupation of the breeding sites	full flight of young birds
Anas querquedula	• occupation of the breeding sites	full flight of young birds
Anas clypeata	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Netta rufina	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Aythya ferina	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Aythya fuligula	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Aythya marila	• occupation of the breeding sites	full flight of young birds

Species	**Start of breeding period**	**End of breeding period**
Somateria mollissima	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Clangula hyemalis	• occupation of the breeding sites	full flight of young birds
Melanitta nigra	• occupation of the breeding sites	full flight of young birds
Melanitta fusca	• occupation of the breeding sites	full flight of young birds
Bucephala clangula	• occupation of the breeding sites	full flight of young birds
Mergus serrator	• occupation of the breeding sites	full flight of young birds
Mergus merganser	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
RALLIDAE		
Rallus aquaticus	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds (3 decades[35] after hatching)
Gallinula chloropus	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds (5 decades after hatching)
Fulica atra	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds (6 decades after hatching)
HAEMATOPODIDAE		
Haematopus ostralegus	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
CHARADRIIDAE		
Pluvialis apricaria	• occupation of the breeding sites	full flight of young birds
Vanellus vanellus	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
SCOLOPACIDAE		
Philomachus pugnax	• occupation of the breeding sites	full flight of young birds

[35] i.e. periods of ten days.

Species	Start of breeding period	End of breeding period
Lymnocryptes minimus	• occupation of the breeding sites	full flight of young birds (c. 4 decades after hatching)
Gallinago gallinago	• occupation of the breeding sites with courtship display • construction of the nest in all other cases	full flight of young birds (c. 4 decades after hatching)
Scolopax rusticola	• occupation of the breeding sites (roding)	full flight of young birds (c. 4 decades after hatching)
Limosa limosa	• occupation of the breeding sites	full flight of young birds
Limosa lapponica	• occupation of the breeding sites	full flight of young birds
Numenius phaeopus	• occupation of the breeding sites	full flight of young birds
Numenius arquata	• occupation of the breeding sites	full flight of young birds
Tringa erythropus	• occupation of the breeding sites	full flight of young birds
Tringa totanus	• occupation of the breeding sites where it is mainly migratory • construction of the nest in all other cases	full flight of young birds
Tringa nebularia	• occupation of the breeding sites	full flight of young birds
LARIDAE		
Larus ridibundus	• courtship display at breeding sites (2 decades before egg laying)	full flight of young birds
Larus canus	• courtship display at breeding sites (2 decades before egg laying)	full flight of young birds
Larus fuscus	• courtship display at breeding sites (3 decades before egg laying)	full flight of young birds
Larus argentatus	• courtship display at breeding sites (3 decades before egg laying)	full flight of young birds
Larus cachinnans	• courtship display at breeding sites (3 decades before egg laying)	full flight of young birds
Larus marinus	• courtship display at breeding sites (3 decades before egg laying)	full flight of young birds

Table 2. Valuable sources of information useful to determining the start and end of breeding seasons, and the timing of migration, of African and Eurasian waterbirds.

Waterbird family	**Information on breeding seasons**	**Information on migration periods**
Sphenisciformes *Spheniscidae* Penguins	Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)	Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)
Gaviiformes *Gaviidae* Divers	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)
Podicipediformes *Podicipedidae* Grebes	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)
Pelacaniformes *Phaethontidae* Tropicbirds *Pelecanidae* Pelicans *Sulidae* Gannets and bobbies *Phalacrocoracidae* Cormorants *Fregatidae* Frigatebirds	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)
Ciconiiformes *Ardeidae* Herons and Egrets *Ciconiidae* Storks *Balaenicipitidae* Shoebill *Threskiornithidae* Ibises	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992); Kushlan & Hancock (2005)	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992); Kushlan & Hancock (2005)
Phoenicopteriformes *Phoenicopteridae* Flamingos	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)	Western Palearctic: Cramp & Simons (1977) Africa: Brown *et al.* (1982); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1992)
Anseriformes *Anatidae* Ducks, geese and swans	Western Palearctic: Cramp & Simons (1977)	Western Palearctic: Cramp & Simons (1977)

Waterbird family	Information on breeding seasons	Information on migration periods
	Africa: Brown *et al.* (1982); Hockey *et al.* (2005); Viljoen (2005) All regions: Bauer & Glutz von Blotzheim (1963); del Hoyo *et al.* (1992); Scott & Rose (1996); Kear (2005)	Africa: Brown *et al.* (1982) Hockey *et al.* (2005); Viljoen (2005) All regions: del Hoyo *et al.* (1992); Scott & Rose (1996); Kear (2005)
Gruiformes *Gruidae* Cranes *Rallidae* Rails, flufftails, crakes, gallinules, moorhens and coots	Western Palearctic: Cramp & Simons (1980) Africa: Urban *et al.* (1986); Hockey *et al.* (2005)); Viljoen (2005) All regions: del Hoyo *et al.* (1996) Rallidae: Taylor (1998)	Western Palearctic: Cramp & Simons (1980) Africa: Urban *et al.* (1986); Hockey *et al.* (2005)); Viljoen (2005) All regions: del Hoyo *et al.* (1996) Rallidae: Taylor (1998)
Charadriiformes *Dromadidae* Crab Plover *Haematopodidae* Oystercatchers *Recurvirostridae* Stilts and avocets *Burhinidae* Thick-knees *Glareolidae* Practincoles *Charadriidae* Plovers *Scolopacidae* Snipes, curlews and sandpipers *Stercorariidae* Skuas *Laridae* Gulls *Sternidae* Terns *Rynchopidae* Skimmers *Alcidae* Auks	Western Palearctic: Cramp & Simmons (1983); Cramp (1985) Africa: Urban *et al.* (1986); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1996)	Western Palearctic: Cramp & Simmons (1983); Cramp (1985) Africa: Urban *et al.* (1986); Hockey *et al.* (2005) All regions: del Hoyo *et al.* (1996) All regions for waders: Delany *et al.* (2009)

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