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Ideas for integrated flamingo conservation: One Plan Approaches, ecology, and management

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Abstract

Effective conservation action relies on partnership and collaboration among interested, involved, and committed stakeholders to successfully implement the objectives of such conservation planning. The IUCN Conservation Planning Specialist Group's "One Plan Approach" is an integrated strategy to species-specific conservation aims and objectives, which incorporates all populations of a species wherever they occur in the world (e.g. wild, semi-wild, captive, managed, free-living). The One Plan Approach removes any boundaries between in situ and ex situ animals, enabling a sliding scale of conservation efforts to be implemented where they are most needed. Plans for a One Plan Approach to flamingo conservation have been suggested and discussed at international symposia as a way of promoting the conservation needs of individual flamingo species, and of the taxonomic group overall. This article expands on how a flamingo themed One Plan Approach could work and provides details on how ex situ populations could be of use to conservation action for wild flamingos, and what wild flamingos could do for flamingos housed under human care. Ideas to promote the conservation needs of flamingos and their habitats are provided, as well as examples of how zoos could build engagement opportunities into the exhibit of their birds to explains the threats that flamingos face and why they warrant conservation action. Ultimately, a One Plan Approach could be built into the regional collection plans that zoos follow as a way of increasing the value of ex situ flamingos and their relevance to wild conservation initiatives.

Resumen

La acción de conservación eficaz se basa en la asociación y la colaboración entre las partes interesadas, involucradas y comprometidas para implementar con éxito los objetivos de los planes de conservación. El "Enfoque de Un Plan" del Grupo de Especialistas en Planificación para la Conservación de la UICN es una estrategia integrada para las metas y los objetivos de conservación de especies específicas, que incorpora todas las poblaciones de una especie en el mundo (por ejemplo, silvestres, semi-silvestres, en cautiverio, manejadas, de vida libre). El Enfoque de Un Plan elimina cualquier límite entre los animales in situ y ex situ, lo que permite implementar una escala móvil de esfuerzos de conservación donde más se necesitan. Se han sugerido y discutido planes para un Enfoque de Un Plan para la conservación de flamencos en simposios internacionales como una forma de promover las necesidades de conservación de especies individuales de flamencos y del grupo taxonómico en general. Este artículo amplía cómo podría funcionar un Enfoque de Un Plan con el tema de los flamencos y proporciona detalles sobre cómo las poblaciones ex situ podrían ser útiles para las acciones de conservación de los flamencos silvestres, y cómo pueden contribuir flamencos silvestres a los flamencos en cautiverio. Se proporcionan ideas para promover las necesidades de conservación de los flamencos y sus hábitats, así como ejemplos de cómo los zoológicos podrían crear oportunidades de participación en la exhibición de sus aves para explicar las amenazas que enfrentan los flamencos y se justifican acciones de conservación. En última instancia, se podría incorporar un Enfoque de Un Plan en los planes regionales de colecciones que siguen los

zoológicos como una forma de aumentar el valor de los flamencos ex situ y su relevancia para las iniciativas de conservación de la naturaleza.

Résumé

Une action de conservation efficace repose sur le partenariat et la collaboration entre les parties prenantes intéressées, impliquées et engagées pour mettre en œuvre avec succès les objectifs d'une telle planification de la conservation. L'« Approche Plan unique » du Groupe des spécialistes de la planification de la conservation de l'UICN est une stratégie intégrée pour des buts et objectifs de conservation spécifiques aux espèces, qui intègre toutes les populations d'une espèce où qu'elles soient présentes dans le monde (par exemple, sauvage, semi-sauvage, captive, gérée, libre -vie). L'approche Plan unique supprime toutes les frontières entre les animaux in situ et ex situ, permettant la mise en œuvre d'efforts de conservation adaptés et calibrés proportionnellement aux nécessités les plus urgentes. Des plans pour une approche unique de la conservation des flamants ont été suggérés et discutés lors de précédents colloques internationaux comme moyen de promotion des besoins de conservation des flamants et du groupe taxonomique dans son ensemble. Cet article explique comment une approche Plan unique sur le thème des flamants pourrait fonctionner et fournit des détails sur la façon dont les populations ex situ pourraient être utiles aux actions de conservation des flamants sauvages, et ce que les flamants sauvages pourraient faire pour les flamants hébergés par nos soins. Des idées pour promouvoir les besoins de conservation des flamants et de leurs habitats sont présentées, ainsi que des exemples de la façon dont les établissements zoologiques pourraient intégrer des opportunités d'engagement dans l'exposition de leurs oiseaux pour expliquer les menaces auxquelles les flamants sont confrontés et pourquoi ils méritent une action de conservation. En fin de compte, une approche Plan unique pourrait être intégrée aux plans de collecte régionaux que les établissements zoologiques suivent afin d'augmenter la valeur des flamants ex situ et leur pertinence pour les initiatives de conservation dans la nature.

Introduction

Flamingos are ubiquitous in zoological collections worldwide, with a total population in Zoological Information Management System (ZIMS) zoos of around 22,370 birds (ZIMS, 2021). Similarly, information from the IUCN (International Union for the Conservation of Nature) Red List suggests a total global population across all six flamingo species of approximately 4.7 million birds (IUCN, 2021). In spite of these large population numbers, flamingos are of conservation concern and three of the six species have projected declining population trends (BirdLife International, 2016, 2018, 2020). Numbers of some flamingo species are increasing in captivity, for example rising populations of greater *(Phoenicopterus roseus)*, Caribbean *(P. ruber)* and Chilean *(P. chilensis)*- see captive population statistics in Flamingo 2020 (Rose, 2020) compared to those published in this edition, Flamingo 2021- and this provides support for *ex situ* conservation efforts. Research outputs on ex situ flamingo populations have also grown in the period from 2009 to 2018 (Rose et al., 2019) showing that zoo-housed flamingos are useful to pure and applied scientific research questions, helping to answer questions relating to conservation needs and actions.

The skills and knowledge of flamingo keepers and flamingo population managers is also helpful to *in situ* conservation efforts, as information on flamingo populations under human care can be translated into field-based conservation action planning (Rose, 2021). Likewise, the expertise of field ecologists and ornithologists studying wild populations of flamingos is essential to the development and evolution of husbandry and management strategies for flamingos in zoological establishments (Mooney, 2021). Even those

more specialised and/or unfamiliar-in-the-zoo species such as the lesser *(Phoeniconaias minor)*, Andean *(Phoenicoparrus andinus)* and puna *(P. jamesi)* flamingos, conservation actions (such as education or advocacy) can incorporate these flamingos too. This two way flow (and usage) of information from the zoo to the wild and vice versa is the bedrock of the IUCN Conservation Planning Specialist Group (CPSG) One Plan Approach to conservation (Byers et al., 2013). As stated by the CPSG, *"The One Plan approach to species conservation is the development of management strategies and conservation actions by all responsible parties for all populations of a species, whether inside or outside their natural range"* (Conservation Planning Specialist Group, 2021). As such, this article evaluates the feasibility of a One Plan Approach for the flamingos (collectively) and suggests ways that wild birds can add conservation value to zoo birds, as well as how zoo birds can be important to those individuals out in the wild.

A One Plan Approach for flamingos?

In 2014, a meeting of flamingo experts who work with both wild and captive birds was held in San Diego, USA as the third International Flamingo Symposium (WWT Flamingo Diary, 2014). One of the themes discussed at this meeting was a One Plan Approach to flamingo conservation (specifically focussing on the lesser flamingo). The wealth of knowledge in the community of flamingo experts, evidenced by the membership of the IUCN Flamingo Specialist Group, suggests that a One Plan Approach for specific flamingo species could bring big gains to conservation efforts and engagement with conservation needs. A particularly strong area to build on under the One Plan umbrella would be linking flamingos housed under human care with those out in the wild (and the needs of these birds and their habitats).

Flamingos housed under human care are excellent resources to use for effective support of the key aims of the modern zoo-conservation, education, engagement and research (Rose, 2018). The large population of captive flamingos means they are frequently seen in animal collections and therefore accessible to many people visiting such institutions. This combined with their popularity with the public (Carr, 2016) appeal in marketing, advertising and on accessible engagement platforms, e.g. social media sites (Irvine & Arluke, 2017; Kight, 2015) means that flamingos can capture an audience's attention and tell conservation-themed stories in an interesting and engaging manner. Linking together captive populations with the management and conservation needs of wild flamingos can provide added value to those individuals with human care, even if the flamingo species housed by the zoo is different to those species of conservation concern out in the wild.

Integrated One Plan conservation approaches build relationships between all stakeholders invested in the management of species or taxonomic groups. Such an approach and can provide ex situ facilities with useful information on how to support wild populations, how to raise awareness and be meaningful in educational messaging and in decisions made around species collection planning and how to ensure population sustainability (Traylor-Holzer et al., 2019). Using the One Plan Approach within regional collection planning can inform decisions about which species to house and why, enabling resources that are important to the maintenance of sustainable populations with actual conservation potential to be used more effectively. Traylor-Holzer et al. (2019) provide clear examples of how collection planning and One Plan Approaches can be used concurrently to support the role the zoo-housed animals as insurance populations, as educational tools or as subjects of conservation-focussed research.

For example, zoo managers and curators can understand how flamingos may respond to the presence of visitors by digesting

information from the literature on the responses of free-living birds to human proximity. Study of wild flamingos suggests that free-living flamingos will display no alarm response to the presence of humans, if there at least a 50m distance between people and birds (Khaleghizadeh, 2010). When human visitors actively disturb the habitats of wild flamingos, there are negative consequences on the birds and this can be problematic for conservation efforts (Baldassarre & Arengo, 2000; Beauchamp & McNeil, 2003; Ugarte-Núñez & Mosaurieta-Echegaray, 2000; Yosef, 1997, 2000), Figure 1. Reviewing such information in conjunction with that collected from zoo birds provides a complete picture of what flamingos need and how to best provide their care. For example Rose et al. (2021) documented that visitor presence and sound, and the prevailing weather conditions, influence where zoo-housed flamingos are likely to be in their enclosure. The wild evidence presented here helps explain how to better manage ex situ populations by reducing any impacts of human presence on the flamingos (e.g. by providing refuge areas or spaces within a flamingo enclosure at least 50m away from all visitor areas so that birds can have a choice to retreat and feel comfortable). Likewise, ex situ flamingos can be used to measure long term influences on behaviour, welfare and reproductive output from human presence and these data be fed into management of wild flocks. Ensuring that reserves or wetland areas created for wild flamingos to breed in are free of pressures or adverse impacts that have been documented in the ex-situ birds will provide a direct conservation link between zoo flamingos and free-living birds.

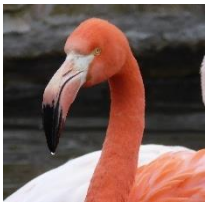
Figure 1: Caribbean flamingos deliberately disturbed by boats containing tourists to get a photographic spectacle negatively affects the birds' behaviour and may cause them to move out of a potentially viable habitat. Explanation of the behaviour of flamingos and their relationship with humans can be conducted with birds under human care (e.g. those in zoological collections) to raise awareness of such practices and hopefully reduce their occurrence if more people are educated about such negative impacts. Photo credit: A. Rae / Wikimedia Commons.

Whilst greater, Caribbean and Chilean flamingos are the most likely to be observed in zoological collections, and greater, Caribbean and lesser flamingos may be easier to observe out in the wild by birdwatchers or ecotourists, this does not detract from the value of all flamingo species to the creation of a One Plan Approach and to the usefulness of such an approach to flamingo conservation action (Figure 2). These more common-to-the-zoo or easily accessible species can be the ambassadors for the conservation needs of all flamingo species and Table 1 expands on the ways in which the more familiar species can promote flamingo conservation needs collectively as well as for the less familiar

species more specifically. Identification of the roles that non-threatened taxa, which are housed in zoological collections, can play towards conservation action for similar but threatened species provides valuable support for living collections (Kerr, 2021), further enhancing an integrated population management approach.

Figure 2: Greater, Caribbean and Chilean flamingos (left to right, top row) are more common in ex situ populations and can tell the stories of the lesser, Andean and puna flamingos (left to right, bottom row) that may be less familiar due to a lesser presence in zoological collection. Greater and Caribbean flamingos are doing well in the wild and their presence in ex situ facilities can tell the conservation story and need for conservation action for the other four, near threatened/ threatened species.

Table 1: How the species of flamingo commonly seen in ex situ populations can be used to support conservation efforts for less commonly seen species or those with a specific conservation need.

Common zoo species	**Support for other flamingo species**
Greater flamingo 	Sympatric with lesser flamingo → greater flamingos in the zoo can educate about the fragility of East African soda lakes and the unique environment of the Rift Valley ecosystem. Close relative of the Chilean → greater flamingos can explain the adaptations of flamingos to specific wetland habitats and how these are easily threatened by human activities (e.g. loss of suitable habitat due to industrial activities and human intrusion in the case of the Chilean flamingo). Coping with human presence → Greater flamingos can cope with some degree of human influence over their habitats (e.g. utilising salt extraction lagoons in urbanised areas). This story is similar to the urban lesser flamingos in India, feeding in mudflats exposed to sewage outlets, but different to the South American flamingos that can be disturbed by industrial action around their wetland homes. Zoo-housed greater flamingos can be used to explain why each flamingo species may cope differently with human proximity and what can be done about this.
Caribbean flamingo 	One of four flamingos found in the Americas → Caribbean flamingos can be hitched to engagement opportunities linked to where flamingos live and why different species have specific habitat requirements. Relationships with humans → Popular due to its very bright plumage, captive Caribbean flamingo populations can be used to explain why ecotourism needs to be regulated (to reduce disturbance) and why sustainable captive flocks ensure birds are not taken out of the wild for public display. Close relative of the greater and Chilean flamingo → Caribbean flamingos can explain the relatedness between species and why specific differences in flamingo behaviour, form and function occur (e.g. paler colours in the greater flamingo and high altitude living in the Chilean flamingo).
Chilean flamingo 	Specialised species in South America → Chilean flamingos are near threatened and have a declining population trend. Their conservation need can be explained alongside that of the Andean and puna flamingos that share the Chilean flamingo's habitats and are under similar pressures. Sympatric with Andean and puna flamingos → Chilean flamingos are a more generalised species regarding foraging niche and this story can be told with images, diagrams and illustrations of the behaviour and anatomy of the Andean and puna flamingos (with their specialised foraging strategies) and therefore why three species can live in the same wetlands. Monitoring and evaluation → Chilean flamingos can move across long distances between feeding and breeding grounds. Explanation of their group courtship display and how this regulates breeding attempts can also include information on the movements and habitat needs of Andean and puna flamingos, and why, if there is limited habitat available for breeding, populations will decline.

What could a Flamingo One Plan Approach look like?

Capacity for effective conservation action can be enabled by providing a platform for the wider dissemination of information and opportunities for knowledge acquisition, gaining of new skills, and sharing of good practice enhances animal care, including implementation of best practice (Melfi & Hosey, 2011; Rose et al., 2016). This could be the foundation of a flamingo One Plan Approach- encouraging zoos holding flamingos to partner with field-based conservation and management organisations to actively engage in development of conservation work that includes birds in all populations of that species (Figure 3).

Ideas for mutual conservation action that integrate zoo and wild flamingos could include:

- Skills training and sharing of information
- Shared information on monitoring techniques, marking, and catching birds
- Developing new technology, and trialling how such technology could work, to estimate where flamingos go and how often they move
- Capacity building within stakeholders
- Storytelling and wider outreach
- Engagement opportunities that directly involve the birds and their audiences
- Conservation action planning involving all experts and stakeholders
- Opportunities for research outputs to be used directly in conservation work
- Management of insurance populations
- Dissemination of knowledge and key information
- Evolution and evaluation of conservation planning and practical management
- Trialling habitat management techniques
- Collection planning and promotion of sustainable populations
- Exhibit and enclosure design to enhance natural behaviours
- Environmental enrichment and improving behavioural diversity in zoo-housed birds
- Collaborative management of insurance populations to increase viability and sustainability
- Animal welfare assessment and measurement to evaluate biologically relevant ex situ management regimes
- Advocacy on the part of ex situ facilities for in situ conservation needs.

Promoting conservation initiatives at the habitat level is crucial to species-level conservation, both for flagship species as well as for other threatened taxa within the same range (IUCN, 2017). Protection of wetland systems that are important to flamingos ensures the survival of other species within the habitat too, ensuring the continued functioning of the ecosystem and the services that it provides. Providing explanation and educational messaging that link the species to its habitat is crucial for long-term survival of wild places, by raising awareness of the role that healthy ecosystems play to the conservation of biodiversity as well as to the survival of human populations.

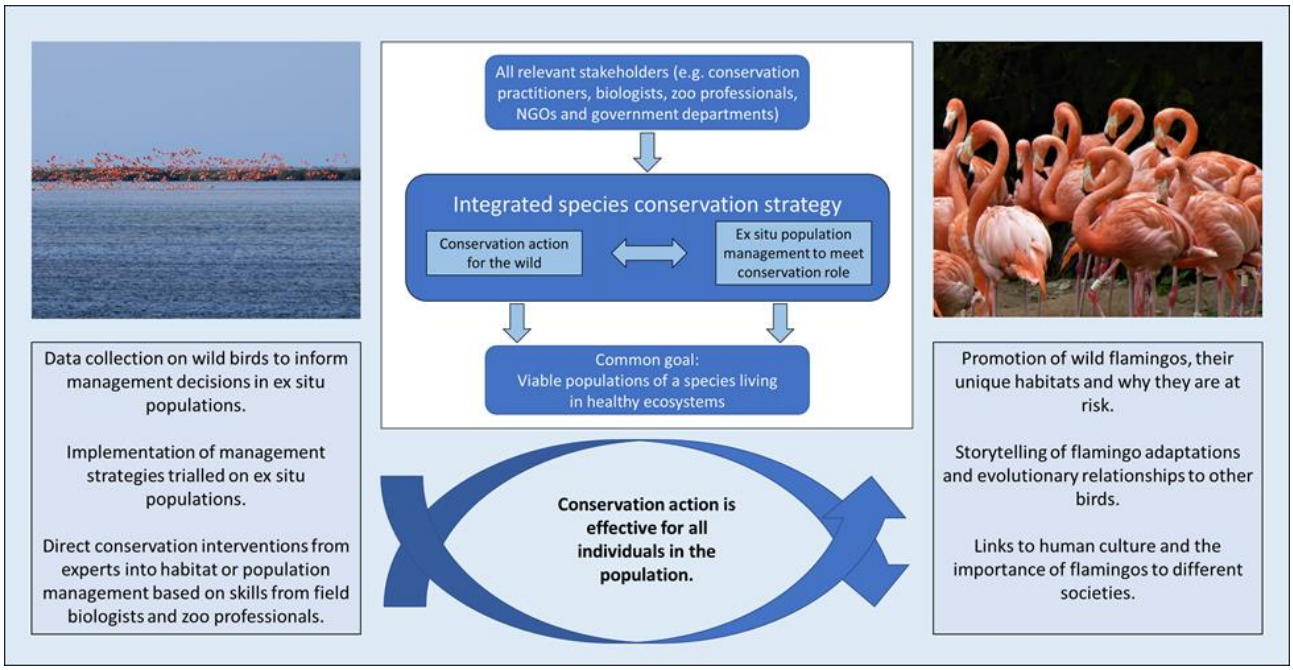


Figure 3: The key principles of the One Plan Approach, adapted from AWCSG (2021) and Rose (2021) showing how integration of all individuals in all populations, wherever they are globally, can result in effective conservation outputs. Promoting wild birds by using zoo-housed birds and gathering data from the wild to inform management of insurance populations under human care (for example) provide added value to all flamingos.

Organisations actively involved in flamingo conservation that have links between multiple stakeholders and experts from different areas of flamingo management are already apparent. These links have led to the collection of data, or the monitoring and tracking of flamingo movements, or the implementation of research programmes, or public engagement events that all support flamingo conservation efforts, including:

Association of Zoos and Aquariums (AZA) Saving Animals From Extinction (SAFE) Andean Highland Flamingo programme. https://www.aza.org/safe-species#andeanhighlandflamingo

American Museum of Natural History, Developing a regional conservation strategy for flamingos in the Americas. https://www.amnh.org/research/center-for-biodiversity--conservation/research-and-conservation/biodiversity-exploration-and-monitoring/flamingos-in-the-americas

BirdLife South Africa lesser flamingo conservation work. https://www.birdlife.org.za/what-we-do/landscape-conservation/what-we-do/wetlands-grasslands/lesser-flamingo/

El Grupo de Conservación Flamencos Altoandinos (GCFA) Red Flamingos conservation work. http://www.redflamencos-gcfa.org/gcfa.html

Public engagement works, research outputs and data generated from such organisations and institutions is vitally important to the continued implementation and evaluation of field-based conservation action across flamingo range states, as well as to the development and rationalisation of husbandry and management programmes for insurance populations of flamingos in ex situ facilities.

Table 2: Ideas for integrated conservation for each flamingo species

Flamingo species	**State in the wild**	**One Plan integrated ideas**
Greater flamingo	Least Concern. Increasing wild population. Increasing number of birds in ex situ populations. Can be disturbed in breeding colonies due to tourist activities. Suffers from illegal shooting on flyways (e.g. Malta) when travelling between breeding and wintering grounds. Human-animal conflict when foraging in flooded fields.	Engagement opportunities with visitors. Strong research potential due to large captive population (e.g. for answering questions pertinent to conservation needs for free-living flamingos). Viable insurance population as breeds readily in the zoo. Data collection to test management plans or ways to implement best practice care. Explain the conflicts that can arise between humans and flamingos and how habitat management can reduce this.
Caribbean flamingo	Least Concern. Increasing wild population. Increasing number of birds in ex situ populations. Extreme weather events (e.g. tropical storms and hurricanes) can destroy colonies and kill/injury adult birds. Disturbance to nesting areas can cause flamingos to desert their eggs.	Similar ideas as per the greater flamingo. Visual spectacle (e.g. bright colour) lends itself to public engagement. Important ex situ role as insurance population to reduce pressures on wild birds for collection for the animal trade. Collaboration between zoological organisations to ensure species is managed sustainably in ex situ facilities. Promote links to countries where this species is the National Bird (e.g. Bahamas).
Chilean flamingo	Near threatened in the wild. Potential further decreasing in habitat range due to climatic change and human activity. Hunting, human disturbance and pollution can reduce habitat quality and suitable areas for breeding.	Direct management of ex situ populations to provide safety net as a prevention of extinction. Story telling about the specialist nature of high mountain flamingos (promoting the conservation needs of the Andean and puna flamingo). Managed breeding programme between zoos to ensure long term population viability and sustainability. Mixed species display with other South America wetland species from the same high mountain wetlands to exhibit the diversity and specialism of life in such wetlands.
Andean flamingo	Vulnerable. Probable declining population trend but tricky to accurately assess population number. Further population declines may be caused by	The threats to this species from climatic change as well as from human pressures (such as hunting, egg collection and mining activities) can be

	human activities (e.g. lithium mining) and climatic change.	told by captive populations of Chilean flamingos. Interpretation of the unique features of the Andean flamingo (three toes, varied colouration) can be compared to the features of other flamingos to show how each flamingo species is unique.
Puna flamingo	Near Threatened. The current stable population prediction may mask future declines caused by long generation time of the birds (past poor reproductive output may be hidden by long lifespan of birds). Difficult to accurately estimate overall population number.	Similar suggestions as per Andean flamingo-Chilean flamingo links. Habitat needs and population threats can be explained using the Chilean flamingo. Deep-keeled bill for collecting microscopic aquatic material similar to the lesser flamingo and zoos that hold lesser flamingos can promote the adaptations of the puna flamingo. Comparison of the three South American species can be explained via interpretation at Chilean flamingo enclosures to show how and why the three South American flamingos live together.
Lesser flamingo	Near Threatened. Although the wild population numbers millions of birds, their dependence on a handful of wetland sites makes them very susceptible to habitat degradation and anthropogenic impacts. Mass die-offs of birds and birds recovered in poor body condition are linked to decline in the quality of food items in East African soda lakes. Potential reduced habitat availability of lesser flamingos in and around Indian cities. Predation or attacks on birds by feral /stray dogs is a problem in some parts of the flamingo's range.	Populations are managed ex situ but poor reproductive outputs. Encourage closer collaboration with zoological institutions to combine flocks to increase numbers of (potentially) breeding birds. Work on best practice guidelines for lesser flamingo husbandry to improve quality of care across ex situ facilities. Build wild evidence into husbandry regimes and housing facilities. Explain the story of other specialised flamingos from specialised wetlands (e.g. puna flamingo) with zoo-housed lesser flamingos. Compare the lesser flamingo with the greater flamingo to explain why these two species can live in the same habitat without competition.

Table 2 provides examples of how a One Plan Approach could include a specific flamingo species directly (e.g. key conservation outcomes generated by these birds) as well as example of soft conservation action or engagement- using one flamingo species to highlight the needs of others. Educational and engagement resources for zoos holding flamingos can be centred around comparisons and contrasts between species, to explain to visitors why each of the six flamingo species are so unique. Monitoring and counting of individual flamingos in groups, to estimate population sizes, developed for one species in

one habitat are useful to use for other flamingo species in similar habitats (where challenges of accurately counting the numbers of birds in a flock may be the same). Similarly, expertise in flamingo catching and banding can be shared between organisations to help mark and monitor individuals to find out their movement patterns and preferred ways of utilising wetland areas. Development of remote technology, e.g. harnesses for the fitting of GPS software, can be conducted based on partnerships between field-based organisations and zoological institutions, and the testing and trialling of such technology on captive flamingos enables refinement of equipment before it is used on wild birds. The use of zoo-housed birds also allows for calibration of remote data collection equipment and the comparison of behaviour patterns between ex situ and in situ individuals (Nuijten et al., 2020). These data can help inform changes to management practices to further support conservation goals.

Rational decision-making procedures (Figure 4) can help identify which challenges are most in need of attention and how a collective effort (involving all or some parties or populations of animals) can be most useful in meeting this challenge. For example, Figure 4 provides ideas for deciphering poor breeding success in lesser flamingos in ex situ flocks as the wild status of this species suggests effective zoo-based conservation efforts may be beneficial in the long term.

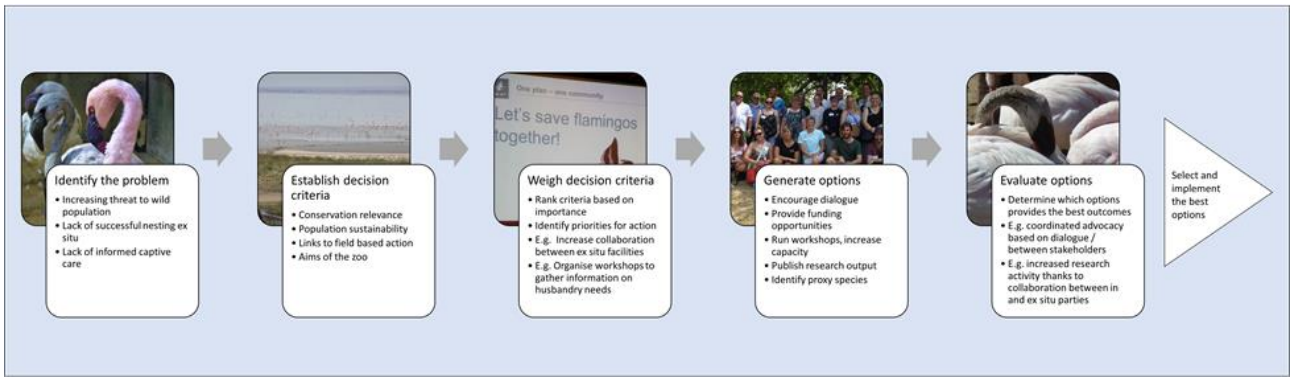


Figure 4: Taken from Rose (2021), a rational decision making process (Lumen Learning, 2021) for conservation action based on the needs of wild and captive flamingos to promote best practice. Identification of a specific problem or challenge that needs to be resolved as it may be a barrier to effective conservation work is the first step. Establishing decision criteria and ranking these criteria based on their importance to solving the challenge, considering options to meet the challenge, evaluating these options and then implementing the best options to support conservation action can work for specific flamingo species or for general challenges to all six species.

Conclusions

The One Plan Approach to conservation aims to reduce the boundaries that may be present (physically and psychologically) when the terms *in situ* conservation and *ex situ* conservation are used. i.e. Conservation is only taking place in the wild and this is separate from the zoo, and zoo-based conservation is different to that needed for wild populations. The strong presence of flamingos in zoos, their wide appeal with visitors and the public, the experience that avicultural experts and conservationists have with their management and care, and our knowledge of their habitat needs and ecological niches in the wild would seem like solid foundations for species-level One Plan Approaches to be created.

Consideration of how useful all individuals within a population are to conservation action (e.g. direct conservation action such as augmenting wild populations, conservation

breeding programmes or habitat restoration and management or “soft” conservation, such as advocacy and engagement, educational outputs and ambassador species within a regional collection plan) is important to the development of a One Plan Approach to conservation for the various flamingo species.

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