Data Integration for the One Plan Approach

Exploring the potential of Species360 in synergy with other biodiversity databases to serve Species Specialist Groups

Participants

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Background

Data on species life history traits, such as their reproductive and survival rates, age at first reproduction, number of offspring, maximum lifespan etc. are essential for conservation planning. However, the lack of such data for many of the described species is overwhelming. In this workshop, we explored how to use Species360's global data on more than 21,000 species, 10 million individuals, and 170 million medical and husbandry records in a One Plan Approach (Byers et al. 2013) to biodiversity conservation. Species360 is a global, non-profit organization with over 1070 zoological institution members in over 90 countries worldwide, dedicated to gathering, sharing, and standardizing information of the animals under their members' care. Species360 offers the Zoological Information Management System (ZIMS), a centralized web-based information system used to pool life history, behavior and health data and facilitate animal husbandry, health, and breeding management processes for zoological institutions.

Data from Species360's members have been used to answer different questions in species life history and evolution (i.e.Tidière *et al*. 2016). Furthermore, there are examples of the utilization of the data for species conservation planning. These range from estimating the potential of threatened species in zoos to act as insurance populations or as a source of information for species when there is a lack of data (Conde *et al*. 2011). For example, we have been able to estimate opportunities and costs to protect species either in the wild and captivity by merging Species360 with other databases, such as World Bank social indicators, urbanization projections, and the IUCN Red List. Projects to fight the illegal species trade are being developed by using more detailed data from Species360 (Conde *et al*. 2015, Funk *et al*. 2017). A notable example is the use of our members' data to unveil the laundering of individuals as "captive bred" in the international markets. Wild Life Reserves of Singapore (WRS), with the

aim to stop the laundering of pangolins as "captive bred", used Species360 members' pangolin data on reproduction. With this information, they were able to challenge the assertion that they were all captive bred. Together with WRS, Chris Shepherd, and the Asian Species Action Partnership (ASAP), Species360 is pursuing a similar project with 40 species of turtles and tortoises that are being laundered as "captive bred." Data, such as maximum reported lifespan, or age at first reproduction have already been used to fill knowledge gaps in widely accessed databases such as the Animal and Longevity Database (AnAge).

Furthermore, data from Species360 could serve, in some cases, to improve generation length estimates. Generation length, a measure of the time for a population to renew itself (the average age of parents of the current cohort), is widely used for the development of IUCN Red List assessments. However, measures from closely related species or imputation analyses are applied to fill the data gaps in Red List assessments for a high percentage of the species. Species360 has data on medical records (such as anesthesia, pathology, physiological normal value ranges) and husbandry records can have applications for the conservation of wild species. Since the inception of Species360, 44 years ago, the idea of integrating data from wild and populations under human care has existed. Working with IUCN Specialist Groups (SGs) and regional zoo association Taxon Advisory Groups (TAGs) is an essential step to be able to find opportunities to start such a project. An essential step for Species360's members to support the One Plan Approach of Conservation Planning (OPA).

Data Integration Working Group Objectives and Results

Aim:
The goal of this working group was to find the best ways to leverage data on more than 21,000 species from members of Species360 and improve access to the data for decision making processes for conservation planning. IUCN Specialist Group Chairs or representatives and regional zoo association Taxon Advisory Group representatives worked on identifying data needs and possibilities of data exchange with the goal of managing populations under a One Plan Approach to conservation planning.

Outcomes:
1. To assess the main challenges and opportunities to leverage the wealth of data in Species360 for conservation under the One Plan approach.
2. To find ways in which Species360 can facilitate the exchange of data between Specialist Groups and Taxon Advisory Groups.
3. Identify reservations and concerns about using Species360 data.

Process and Results:

I. First, it was important for all participants to understand how Taxon Advisory Groups are organized in the zoo community and how they function within the regional zoo associations.

Kim Skalborg Simonsen, Vice Chair of the EAZA (European Association of Zoos and Aquaria) Antelope and Giraffid TAG (with 30 institutional members) presented a talk on his TAG's organization and species prioritization process.

Species in regional zoo associations can be intensively managed, for example EAZA has the European Endangered Species Programmes (EEP), European Studbooks (ESB) and the Regional Collection Plans (RCP). All of these are breeding programs, with the objective to maintain demographically and genetically healthy populations of animals under their member's care (http://www.eaza.net/conservation/programmes). In many cases, although not quantified yet, these programs aim to support the conservation of the world's most vulnerable species. The impact of these programs can range from public awareness to education towards *in situ* conservation work. Because not all the species can be in an EEP or ESB, EAZA member institutions have established Taxon Advisory Groups for all the different species of animals that are kept in zoos and aquariums. One of the main tasks of the TAGs is to develop Regional Collection Plans that describe which species are recommended to be kept, why, and how these species should be managed. The Regional Collection Plans also identify which species need to be managed in European Endangered Species Programmes and European Studbooks (http://www.eaza.net/conservation/programmes).

EEP

The EEP is the most intensive type of population management for a species kept in EAZA zoos. Each EEP has a coordinator (someone with a special interest in and knowledge of the species concerned, who is working in an EAZA zoo or aquarium). He or she is assisted by a Species Committee. The coordinator collects information on the status of all the animals of the species, produces a studbook, carries out demographic and genetic analyses, and produces a plan for the future management of the species. Together with the Species Committee, recommendations are made each year on which animals should breed or not breed, which individual animals should go from one zoo to another, and so on.

ESB

The ESB (European Studbook) is less intensive than the EEP. The studbook keeper collects all the data on births, deaths, transfers, etc., from all the EAZA zoos and aquariums that keep the species in question. These data are entered in special computer software programs, which allow the studbook keeper to carry out analyses of the population of that species. EAZA zoos may ask the studbook keepers for recommendations on breeding or transfers. By collecting and analyzing all the relevant information on the species, the studbook keeper can judge if it is doing well in EAZA zoos and aquariums, or if maybe a more rigid management is needed to maintain a healthy population over the long term. In that case, the studbook keeper may propose that the species be managed as an EEP.

For those species that do not have a management program is still possible to monitor the populations, and to identify species for which an intensive management under a Studbook may be needed in the future.

RCP

One of the main functions of the TAG is to develop a Regional Collection Plan (RCP) with the following components:

- Develop a plan for EVERY single species and subspecies in the TAG
- Use a process to prioritize species in need of management. For each species it is determined, whether the species needs upgraded or a downgraded management, and whether to create a new studbook.

The EAZA Antelope and Giraffid TAG uses a point system to prioritize species for management within the RCP. The criteria and points assigned are as follows:

1. IUCN Red List Status

EW	10
CR	9
EN	8
VU	5
NT	3
LC	0

2. *In situ* population trend

Decreasing	4
Stable	1
Increasing	0

3. EAZA *ex situ* population

>200 =0
151-199 = 1
101 - 149 = 2
51 - 99 = 4
<50 = 3

4. % of *ex situ* population in EAZA years

0-25% = 0
26-50% = 1
51-75% = 2
76-100% = 3

5. Births in the last 12 months

<1 = 3
= 1 = 2
1 - 1,24 = 1
> 1,25 = 0

6. EAZA trend last 5 number of breeders

Increasing	0
Stable	1
Decreasing	2

The scores for the 6 categories of criteria are totaled and those with the highest scores are on the top of the prioritization list. ZIMS data is heavily utilized to monitor the populations within EAZA and to provide the parameters necessary to implement the point system for prioritization of TAG species. There may be circumstances where the scoring system alone does not work and there are other considerations that must be evaluated. For example, in the AZA Canid TAG, the Island fox (*Urocyon littoralis*) would be high priority according to this scoring system but the

political situation in the Channel Islands (the range for this species) would prevent AZA intervention to collect these foxes to establish an *ex situ* breeding program. Thus, the Canid TAG sent staff to the island rather than bringing foxes into captivity. Another consideration would be the Genetic Diversity (GD) of a population and knowledge of the identity of founders. Genetic status may not have been completely developed for some species and thus the population assessment should include this parameter and where to go to get the answers.

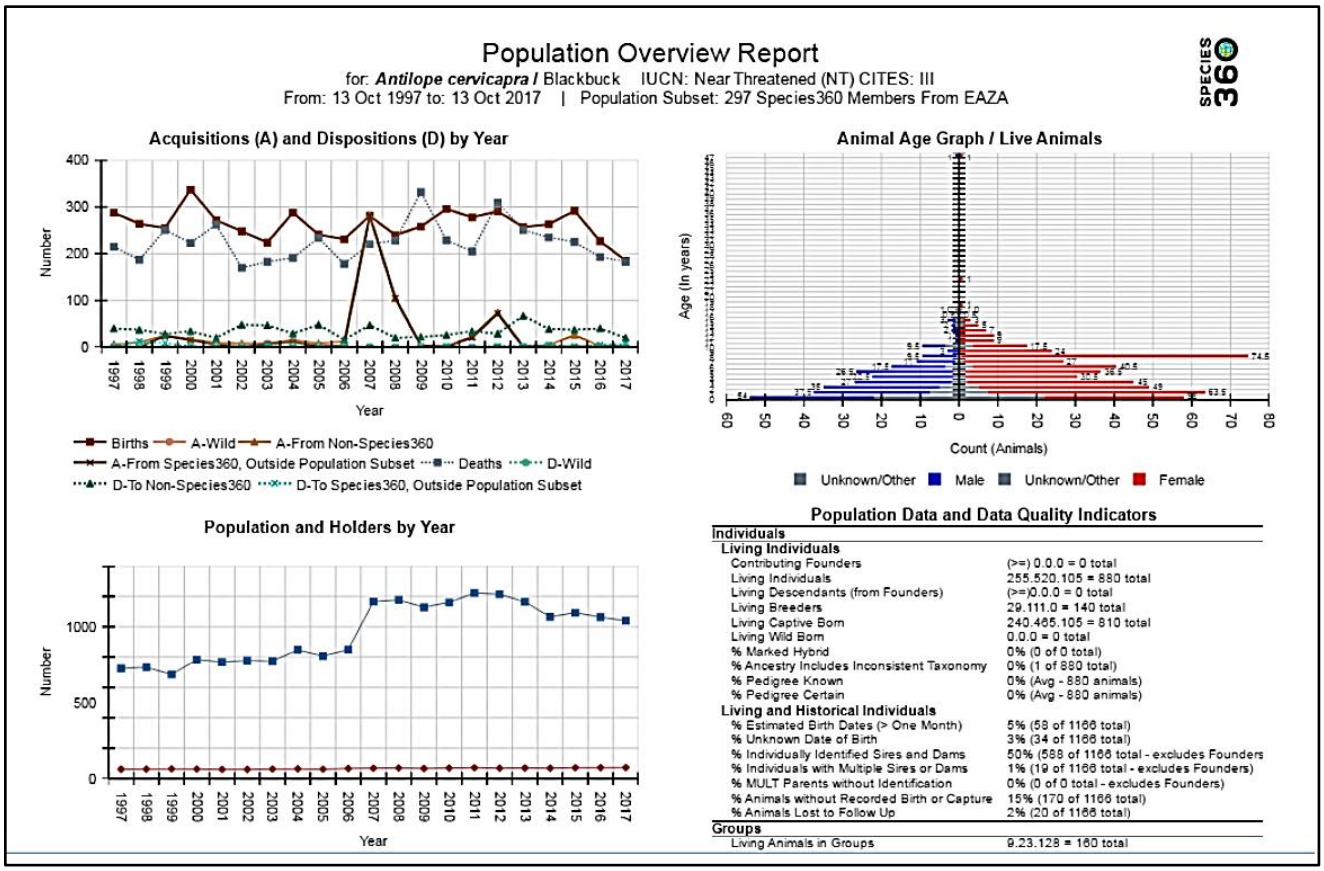
II. Species 360, a non-profit organization, can help with data science to improve access to data for decision-making processes. But how can Species360 help connect SGs and TAGs and provide the data needed for these prioritization processes? The Data Integration working group members were divided into 4 groups. To get an overview of the data in ZIMS, each group was handed a ZIMS Population Management report as an example of the data that can be obtained through ZIMS:

ZIMS Population Management reports:

ZIMS Population Management reports assist in evaluating each species' populations either regionally or globally. ZIMS Population overview report (see Figure 1) identifies:

- **The individuals Acquisitions/Dispositions by year**
- **The Population size and the number of Holders by year**
- **Animal Age Graph/Live Animals**
- **Population Data and Data Quality Indicators**

Figure 1. ZIMS Population Overview Report for EAZA population of Blackbuck (*Antilope cervicapra*)



Next, the groups brainstormed on the questions: What data do both SGs and TAGs need from each other in an ideal world? What data are important to share to facilitate a One Plan Approach to species conservation? What data are currently available through Species360 (designated with an *) and what functionality needs further development or linkage with other databases (designated with a ‡)?

<u>Specialist Groups</u>

- **Ex situ* population status (including ‡those outside of zoo associations), trends, and structure, population demographics (does an insurance population exist?), feasibility of having an *ex situ* population
- *Number and identity of holding institutions, in what region?
- *‡Genetic status, successful growth, reproduction parameters
- *Husbandry data, development data, lifespan, mortality
- ‡*Ex situ* research that is going on with this species
- *‡Diagnostic data/ genetic samples (where, ownership)
- ‡Spatially explicit threat data

- *Physiological normal value ranges – global species reference intervals (for 925 species)
- *Health and disease trends – morbidity and mortality analysis
- *Veterinary procedures (anesthesia, injury treatment, illness diagnostics)
- *‡Drug sensitivity data
- *Individual, husbandry, health, behavioral history data and methods for animals that are to be released to the wild.

` Taxon Advisory Groups

- **In situ* status – Red List, CITES, national listings
- ‡Threats to *in situ* population
- ‡Origin, lifespan, breeding
- ‡Data for confiscated animals (where from, health status)
- ‡Field research going on and results
- ‡Diet data
- ‡Availability of samples, collaborative research
- ‡Share genetic markers
- ‡Early indications of outbreaks (e.g. Avian influenza)
- ‡Linking medical/health data with other databases
- *‡Potential for transfers – policies, permitting
- ‡Reintroductions, supplementations, head-starting, conservation translocations: follow-up communication and monitoring data from the field (survivability, health, reproduction, mortality)

Integrated Information Management System Integrated conservation – combining and sharing *in situ* and *ex situ* data across the population management spectrum.

Participants proposed somewhat fanciful nomenclature for a combined information management system – (possible name WIMS) facilitated by integrated data from populations in the wild at different levels of management, and populations in Zoos and Aquariums. Both SGs and TAGs would need these data:

- ‡Status of *in situ* and *ex situ* populations as a whole
- *‡Red List, Green List status
- ‡EDGE, AZE, SAFE, Durrell Index
- *‡Valid Taxonomy designation
- *‡Reintroductions and other conservation translocations:
    - Both *ex situ* and *in situ* partners utilize ZIMS for animal records or to connect with other data management systems.
    - Individual data in ZIMS throughout the life of the animal
    - Document Methods: Pre-release *ex situ* husbandry, health, reproduction
        - Release – soft/hard, location,
        - Post-release – monitoring, health, reproduction, survivability, food provisioning

- ‡Species360 to develop a communication tool between SGs and TAGs

III. Johanna Stärk presented the work the Species360 science team is working on towards developing a framework for the decision making process: "Making decisions in support of integrated conservation planning of threatened species in the European Union (EU)". The proposed framework is based on decision science and incorporates information on extinction risk, vulnerability to climate change, the species evolutionary value, management benefits and costs to decide whether captive breeding, habitat conservation, or both can be an effective conservation strategy for species in the EU. This framework could be helpful in identifying priority species for RCP's and uses ZIMS data to estimate species breeding probabilities in the zoos.

In summary:
Conservation planning Is about prioritizing species and decision science can inform decisions by incorporating conservation benefits, likelihood of success of alternative actions, values and costs (e.g. Bottrill et. al, 2008). Smart decisions consider the following:

1. Be clear on actions, for example: *in situ*, *ex situ, both or no actions*.
2. Consider success probability of an action – can lead to better decisions
3. Consider stakeholder values (e.g. value towards each outcome, this can be for example is we value a specie's evolutionary distinctiveness, or its role as a flagship species)
4. Consider the benefit from that action (reduction of extinction risk).
5. Consider cost of action (cost effectiveness)

Objective: Reduce extinction risk of as many threatened species as possible while maximizing taxonomic uniqueness with limited resources

Actions:

- Protection of the species habitat in the wild by determining gaps in the species protected area (based on Maiorano et al., 2015,)
- Establish insurance population in zoo with >100 individuals for a population that is genetically and demographically secure
- Both actions or nothing (doesn't need action)

A decision tree was presented that incorporates probability models of species survival in the zoo and/or in the wild and calculates expected benefits for the different management options. Probabilities for the species survival in the wild include the species extinction risk based on IUCN categories and the species vulnerability to climate change. Probabilities for *ex situ* breeding were based on the number of individuals in ZIMS or, if the species is not in the zoo, whether there is a related species of the same genus for which management experience can be transferred. The decision with the maximum benefit is chosen. Benefits can be multiplied by the species evolutionary distinctiveness scores, but other stakeholder values can be incorporated. Cost-effectiveness was calculated by dividing benefits by the cost of *ex situ*

breeding or the cost of buying and managing protected areas. Costs for maintaining animals under human care were estimated based on regression models of bodyweight for mammals and birds and the Amphibian Conservation Action Plan for reptiles and amphibians.

Results:

- Decision framework for 275 EU species
- Recommendations for conservation actions (*in-situ* & *ex-situ*)
- Prioritization of species by benefits
- Taxonomic standardization of data bases
- Sensitivity analysis incorporates uncertainty by showing the sensitivity of the benefits to changes in probabilities and stakeholder values.

One idea is to use the Species Conservation Toolkit Initiative tools for decision output and to incorporate estimated survival probabilities from PMx into a decision tool. Data were used from Species360 showing that through data integration and output from other models, decision processes can be simplified.

IV. Discussion continued to identify reservations and concerns about using Species360 data.

<u>General issues</u>

- A big hurdle to overcome is that ZIMS contains data from zoological institutions. Zoological institutions within the regional zoo associations have ownership of their data, even though it is shared between Species360 members and access to the data is difficult for those organizations (such as *in situ* specialists) outside of the *ex situ* community.
- For many threatened species, data from private holders (non-Species360 members) are not included in ZIMS and would be important to access for holistic conservation action planning. It was noted that data from private holders, in many cases, are included in the studbooks even if the holders do not use ZIMS. With the new ZIMS Studbook Tool, studbooks will be developed from institutional data and studbook keepers will be able to manually add data from non-Species360 member holders of those species. The studbook module will replace studbook software applications including SPARKS and PopLink. There remains the issue of accessing data for those species that are maintained by private holders as this data may not be included in considerations for current population management or conservation action programs.
- Access to Species360 data for researchers may now be limited as Species360 is unable to extract data in a format that researchers want: data cleaning is needed to confirm data quality. Species360 response: This will require developer time by Species360 which is not yet possible but this is something that is being looked into for the future.
- Although ZIMS may be attractive for use to cover collection information, the cost of Species360 membership may be unattainable for private organizations or small zoological institutions (e.g. in Latin America). Species360 response: Identify those organizations that would like to join but cannot due to cost. Possibilities for the

Species360 Membership Director to consider, such as sponsorship by other Species360 members or through funding supporters.

- Use of ZIMS can be extended to include maintenance of an animal record after release to the wild for animals that spend a part of their lives in a zoological facility and part in the wild (i.e. for reintroductions, head-starting, and other conservation translocations). Methods and monitoring data would be important to include. This integration of data management processes will serve as a communication tool between *ex situ* and *in situ* components of these threatened species recovery programs. Species360 would identify membership business rules for *in situ* partners.

<u>Specific issues</u>

- There are questions about what data are used for the reports (such as the Population Overview Report, Age Distribution, Weight Comparison Reports, Medical Resources – Anesthesia Summaries, Drug Use Extracts, Test Results, etc.) – are outliers included, estimated values? It would be helpful to have an interpretation report to indicate definitions, data included and excluded, data quality indicators, how current is the data, etc.
  Species360 response: Each report has a Disclaimer that identifies the data source for that report.
  Example 1 – Population Overview Disclaimer: Tables and figures are based on submitted institutional data and not studbook data.
  Example 2 – Expected Test Results report (gives reference intervals for physiological values) indicates the number of records included in the analysis, the currentness of the data (date of last update) and a whole paragraph to identify the source of the values and an explanation containing definitions of parameters in the report:

"Reference intervals are health-associated benchmarks essential for the interpretation of quantitative laboratory test results by medical practitioners. An interval is formally defined as a statistically derived range of values determined from a reference interval study encompassing the central 95% of values from a healthy reference population. Biomarker test results lying outside of the reference interval suggest an abnormal result and as such, establishing accurate reference intervals is crucial to informed clinical decision-making."

- Data filters should be available to customize the reports (i.e., Mortality Report – unnatural vs natural death, injuries etc.). Species360 response: the reports do have various filters to search by scope (global community, regional zoo association, country, etc.), by date range, by transactions, etc. The Morbidity/Mortality report has several levels of filters for death analysis – you can filter by global, continent, your own institution, for a specific date range, and Relevant Death Information is broken down into cause categories with further breakdown for each category. For example: Useful Relevant Death Information for cheetah (*Acinonyx jubatus*) shows a graph for number of individuals that died from infectious disease, trauma, neonatal issues, non-infectious disease, restraint complications, and four other minor categories. If you click on the bar

for Trauma, you can see further breakdown to self-inflicted, malicious, dam inflicted, accidental, predator, parental behavior, intraspecific, and reproductive encounter and a percentage of the total for each category. Each graph can be downloaded as an Excel file which gives the Raw Data, or to a PNG, JPG, PDF.

- For some of the reports (such as the Age Distribution Report), it would be beneficial to be able to change the scale of the axes to take into account the differing short or long lifespans of each species. For example, some insects may only live days or months whereas some large mammals such as elephants are very long-lived. Along the same lines, the data visualization through graphs could be customized for different species with varying parameters.
- When animals are sexed, the sexing method should be identified. Species360: this is a data entry training issue. When sex is entered, the category for general methods for sexing should be selected and a note with the specific method (DNA analysis, laparascope, etc.).
- New reports could be developed to improve the ability to unlock the data required for integrated species conservation. For example: TAG level review reports then species level reports that can be shared. Access to these reports would be needed for non-Species360 members (SGs and *in situ* conservation organizations).

Conclusions: Close communication between the *in situ* and *ex situ* conservation communities is imperative. SG + TAG involvement and data sharing is required for holistic conservation action planning.

<u>Actions:</u>

- Specialist Groups and Taxon Advisory Groups for specific taxa collaborate with Species360 to identify data exchange processes (what data is needed, how will the exchange process be facilitated?)

Who: KRS suggestion – Martin Zordan as WAZA Conservation Coordinator, Jon Paul Rodriguez as SSC Chair, and Dalia Conde as Species360 Director of Science act as liaisons between regional zoo association TAG chairs and associated SG chairs to coordinate an opening of discussions.

- It will be ideal that Species360,takes the lead to establish a communication portal for exchange of information between SGs and TAGs in the future. This can include a directory of *ex situ* professionals and their areas of expertise. However, financial support will be needed to develop such platform

- Species360 to work with interested SGs and researchers for access to ZIMS data, however the queries for these data access need to be developed and financial support for this is scarce at the moment.

- Species360 (or other knowledgeable ZIMS users) offer ZIMS training to *in situ* partners to identify functionality and data that can be mined to facilitate conservation action planning.

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