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TITLE: Modelling the dynamics of a facility for understanding critical resource use in oiled seabird rehabilitation

AUTHORS

Hugo Nijkamp[1], Jasper van der Werff-Ten Bosch[2], Claude Velter[3]

[1]Sea Alarm Foundation

Rue de Cypres 7 B10

1000 Brussels, Belgium

nijkamp@sea-alarm.org

[2]Nieuwe Keizersgracht 38[Bis]

3514 TZ Utrecht

The Netherlands

jasper.v.d.werff@xs4all.nl

[3]Wildlife Rescue Centre Ostend

Nieuwpoortsesteenweg 642

8400 Oostende

claude.velter@vogelbescherming.be

ABSTRACT

The rehabilitation of oiled birds in a large scale event can be a challenging undertaking, especially because of emergency dynamics which make it difficult to predict when, and how many animals will be arriving at a facility from day to day. Scenarios from past spill events

demonstrate that even a small oil spill in a vulnerable area or season can produce hundreds of live oiled birds washing ashore, every day, for many days or weeks in a row.

Any facility (permanent or temporary) or a network of facilities near the incident site would have difficulty to admit and process streams of hundreds of birds per day while continuing to try and guarantee mimumum care standards in every stage of the rehabilitation process. Guaranteeing these minimum standards during the whole of the response needs a thorough understanding of the many functional relationships between available resources (people, equipment, consumables, foods etc), the quality and size of the facility set-up, and the maximum number of animals that each department in the facility can treat per time unit, according to these standards.

The mathematical model “Birds in Rehab (BiR version 1.0)” was developed between 2012 and 2015 as a simulation tool for facility managers to understand the dynamics of animals of one species (guillemot/murre) flowing through a facility according to realistic decision making of experts on the work floor. Recently, thanks to funds from the Netherlands authorities, the tool was updated (current version: BiR 2.2) in order to be able to simulate multiple species that are admitted to a facility. Different species need different resources, which have been included in the updated model. A new functionality is a calculator, which runs a given scenario in a few seconds, and allow the user to compare the results (survival, release of species) of alternative treatment strategies.

This paper will describe the BiR 2.2 model and its applications. One of the useful features is that it provides quantitative overviews of how many animals are in care at any time, and in which phase of treatment they are. This allows a useful assessment of the feasibility of such numbers in relation to available resources, space, and other natural limits of the facility that is simulated. The model can help to explore the capacity limits of a given facility setup and see where bottlenecks may appear.

The new version will be used for training and planning purposes, and is guaranteed to assist experts who are interested in deepening their insights in dynamic processes on the work floor of a facility that are impossible to exercise and in reality hard to unravel.

INTRODUCTION

Oil spills in the marine environment can lead to impacts to wildlife. Animals that are most vulnerable are air-breathing vertebrates such as seabirds, marine mammals and sea turtles (IPIECA, 2015). Of these, marine birds (sea and coastal birds) can be impacted in large numbers if the oil is spreading into areas where they are seasonally abundant. Some past oil spill incidents have demonstrated that oiled birds may arrive in large numbers on the shore every day during many days or weeks. The impact of these arrivals on media and public has lead to spontaneous, self-organised and well intended but not-professional responses, in an attempt to collect wash and release the de-oiled animals back into the environment.

In the course of the last decades, leading professional organisations from across the globe have joined their forces, in order to write down good practices and protocols for the cleaning and rehabilitation of oiled seabirds. Networks such as the Global Oiled Wildlife Response Service (GOWRS-global) and EURopean Oiled Wildlife Assistance (EUROWA-Europe) have published these good practices (IPIECA, 2016; EUROWA, 2016), and are offering training and emergency support services to stakeholders such as NGOs, Industry and Governments.

The EUROWA good practices include guidelines to emergency management and facility management (EUROWA 2016). Especially the potentially overwhelming challenges that a facility can be facing in a scenario where many tens if not hundreds of oiled birds are admitted to the facility every day have been captured in a management philosophy called Quantitative Management (QM). This philosophy recognises the time factor in an average

rehabilitation procedure that a single bird is going through from day to day when exposed to the good practice treatment protocol after capture (Nijkamp, 2011). It also recognises that a challenging incident scenario with tens to hundreds of animals admitted to a facility requires the facility to:

- be optimally designed into "departments",
- have enough trained and experienced personnel as well as specialised equipment in each department,
- allow that animals are being cared for in "herds" or "cohorts" rather than as individual patients,
- be well managed to ensure that the departments are optimally working together to allow "waves" of animals moving through smoothly,
- have an strict triage procedure "at the door" to select those animals to which the always limited available resources are best assigned to, maximising the number of lives that can be saved
- be prepared to mass-euthanise animals as a management tool in order not to overwhelm resources.

all to allow each admitted animal to receive at least a minimum standard of care in order to maximise its probability to be successfully released.

Whereas in the past attempts had been made to plan and simulate the working of a rehabilitation facility using EXCEL as the best possible platform available to specialists, it was realised that a model in EXCEL could never simulate the true dynamics of real animal flows and resource needs in the course of many days or weeks. In order to better understand these dynamics a model had to be developed on a professional platform, that allowed interactive and progressive simulation. The first version of Birds in Rehab (BiR 1.0) was released in 2015, and already gave a huge impulse to a deeper critical understanding of

facility dynamics. Although it was limited to a single species scenario (simulating guillemots/murres), and did not include a resource management, the tool provided highly credible results of animals moving through the facility using various scenarios. The recently developed Birds in Rehab (BiR 2.2) is a considerable upgrade, enabled by funding from the Dutch government. The new tool aims to provide a multi-species decision support tool in support of the national wildlife response plan. The tool can also be used internationally for training and exercise purposes.

DESCRIPTION OF BiR 2.2

Flow of animals

The backbone of BiR 2.2 is a flow diagram of the route that oiled birds will follow on arrival in a wildlife hospital, which was constructed via numerous interviews and discussions with global experts (rehabilitators and veterinarians). The flow diagram (published in POSOW, 2013) not only identified the phases in the rehabilitation process, but also the distinct physical environments in which these phases would take place (later defined as “departments”), the criteria that implicitly or explicitly would be used to move an animal to a next department, and the average time that a bird would spend in any department, based on its relative fitness. This flow diagram, and the time indicators for each stage, were used to develop the algorithms that make the birds move through the facility. Figure 2 provides the visualisation of this health care management system that is incorporated in the programme.

User interface

The user interface of BiR 2.2 consists of two screens: a Trainer screen and Player screen.

The Trainer screen has general settings to initialize the simulation, such as the choice of a scenario, animal fitness upon arrival, specifying animal species and initial values for facility resources. Such settings can be saved.

The tool can divide any optional scenario into a relative appearance of 6 different types of seabird species (see table 2). A mono-species spill still can be simulated by choosing 100% of one group. The programme can simulate two different housing types (net bottom or pen), and two different types of pools (deep pool for diving species; shallow pool with haul-out ramp for pelicans or swans).

The Player screen (see fig 1) is dashboard/control panel where the player (acting as the facility manager) can oversee what is happening in the facility. Central is an overview of the different departments and the player can see animals moving through (automatic mode) or move animals by hand (active mode). The player has to keep the departments "healthy" by preventing they get over-populated, or increase their capacity by adding resources (people, food, pens, or pools). Additional resources can be ordered and dragged into to the departments if shortages occur.

Setting a simulation

Before any simulation run, the facilitator uses the Trainer screen to set the initial conditions, including the scenario that will be applied. There a large number of historic and fictitious scenarios available to choose from (see table 1). A scenario will define numbers of birds being admitted to the facility in the course of days (short scenario) or months (e.g. Prestige, Macondo). In the Player screen the scenario cannot be anticipated, as the birds will come in from hour to hour and from day to day. A trainer can inform the player about the scenario that could be expected. A scenario could also be played several times, e.g. to study alternative strategies by comparing the results.

Realistic behaviour

In the algorithms of the tool each single ficticious bird has its own identity number and will react to treatments it receives moving from department to department, as it would do in reality.

While each bird follows the same trajectory in principle, the relative fitness of the animals on arrival varies according to the settings defined in the Trainer screen. The programme creates a population of individual birds that have a fitness distribution that matches the chosen average ("fit", "not fit", or "critical"), but also creates a micro-variation on top of this general fitness distribution. Also when moving through the electronic facility each bird will be given a small stochastic variation in any department, to give a realistic touch in the way that the department affects the condition per animal. While this makes that runs of the same scenario never will have the same exact outcome, the programme allows a user to run the same scenario over over and over again, in order to study and compare the results under a variety of pre-set conditions.

Via statistical information the player sees on the interface screen the whereabouts of the population of admitted birds divided over departments and see birds moving through.

If a department is well resourced (food, staff) and not overpopulated, the algorithms will make the an animal benefit and improve its condition while being there. However, if there is a deficiency, the probability of improving its condition for any animal will be lower. If the deficiency is not corrected, the programme will "punish" the player by lowering the probability that animals will improvement. Below a critical health level the animal will die in the department.

The relative condition of all animals in any department is visualised with colours: green for "fit", yellow for "not fit" and red for "critical". Based on these indicators a player can take a

decision at any time to let a single animal move to the next department, or take it to "intensive care", or to euthanise it. A player at all times can also take action to optimise the resources of the department, to ensure that all animals that are there are receiving minimum standard care. Overall, the player oversees all the departments and their resourcing, and can take overall management decisions to optimise the functionality of the facility as a whole.

Manual operations, automatic, or calculate

The Player screen contains the all the management controls to run the instrument. The user has the choice between three ways of running a scenario:

- Completely manually
- Automatic according to a pre-set decision making strategy
- As a calculator

The manual modus is the standard. After the "start" button, the scenario starts unfolding and animals will arrive in the facility. Day by day decisions can be taken by moving individual birds from department to department, and move resources into or between departments. Eventual deficiencies in departments are flagging up immediately (department colours "red"). The user can use the "stop" button to take time for analysis at any time.

In automatic modus the algorithms are running freely, and aim to optimise the facility according to a pre-set management strategy. In this way, the user can follow the animal flows, see how departments are used, and how the results from the chosen strategy are developing over time. At any time, the user can stop the automated modus and intervene manually. The user can switch back to automated modus after the intervention.

The calculator modus will run the whole scenario rapidly, and the programme optimises the facility according to a chosen management strategy. The end result is available within 10-20 seconds and can be studied and analysed. This modus allows testing the robustness of a

certain facility preset that was chosen in the Trainer screen. Therefore the calculator modus allows a manager to compare the anticipated results of different scenarios in the timeframe of minutes.

Quantitative and graphical outputs

In the Player screen the user has various options to access the numerical data that are running in the background, and have these data plotted in a graphic representation. These options are available at all times. In the automatic modus, a user can monitor the graphical representation of the operational facility, while the scenario is unfolding.

DISCUSSION

While the use of the simulation tool requires a short training, BiR will quickly demonstrate its benefits for an aspirant facility manager, or any oil spill manager who is interested in the operational dynamics of an oiled bird facility.

While a large number of different historic and ficticious scenarios can be run, the programme also allows to run the same scenario over and over again, while testing different management strategies and comparing the results. For instance a scenario can be chosen to not euthanise any bird on the work floor. Especially in scenarios that will completely overwhelm a chosen facility size, it will demonstrate that a large number of animals will die on the work floor, suffering from not receiving minimum standard care. One can compare this outcome with a re-run of the scenario while choosing to euthanise all birds that are “unfit” or “critical”. It will demonstrate that while many animals are euthanised (not suffering for days), a larger group of animals will be able to be released, because all the limited resources were reserved for the the animals that needed relatively little care.

A user will be able to recognise the differences in results quickly, and will therefore get trained in making strategic decisions from day to day if the tool was run manually.

The versatility of BiR 2.2 is large, and scenarios can be exercised in a relatively simple setting, e.g. a one species incident, or a complicated multi-species incident. The tool can quickly calculate and present the result of a complex setting, but also allows a user to run the scenario from day to day, taking manual decisions on the fate of each individual bird. These features alone provide a huge value in training and exercise facility managers. The tool also will help to give depth to discussions with responsible authorities or anyone who has the responsibility to oversee an oiled wildlife response and must learn to understand the functional contribution of facilities.

CONCLUSIONS

The rehabilitation of oiled birds is often considered as a relatively simple set of operations, from capture on the beach, washing off the oil, and releasing the de-oiled animals in the wild. The true rehabilitation of oiled birds in a facility requires the use of skilled personnel, a protocol that prescribes a number of sequential treatments and the provision of a lot of rest and quiet isolation before the animals are washed, put on pools, where they can continue their recovery process for days. If a scenario is bringing in tens or hundreds of animals into a facility for days in a row, the management of that facility becomes a highly complex undertaking. The dynamic of such scenarios, and the effects of decisions that managers could take from time to time are very hard to simulate, if one could only use models built with applications such as EXCEL.

The objective in developing BiR was to provide a dynamic and interactive model that can be used to educate and refine some management skills with candidate and experienced facility managers. With the model they can learn how to recognise patterns in the complexity of

population management and appreciate the importance of collecting and monitoring quantitative data from the work floor in a real facility. By running scenarios and try out some alternative strategies, a facility manager can learn to anticipate and avoid the clogging of departments by taking precautionary measures. A manager will appreciate the value of generating the key statistical information from the work every day, in order to provide the quantitative oversight that is needed to manage the facility successfully.

BiR is not a model that can predict the facility performance in any given scenario, and be close to the truth when it happens. But it helps to reveal and understand the undelaying mechanisms that are at play in a complex and dynamic rehabilitation facility that aims to rescue as many birds as possible within the limitations of space and resources. In that capacity, the tool may add a interesting component to both training and exercises..

REFERENCES

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FIGURES

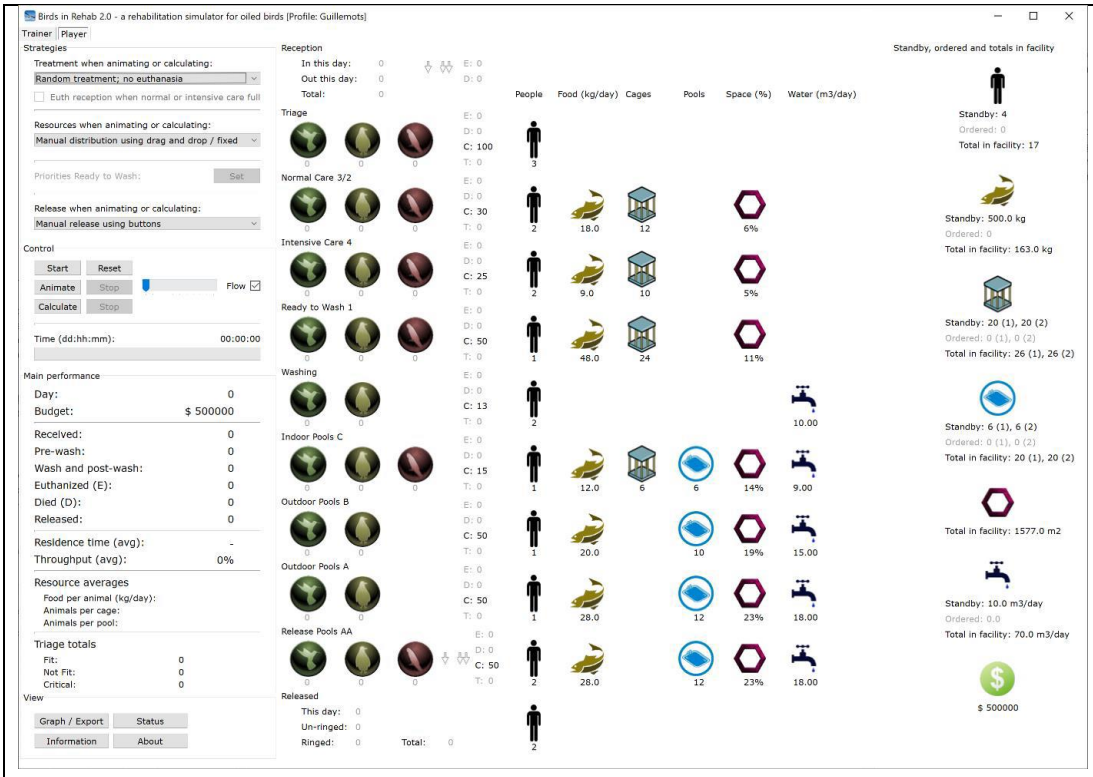

Figure 1: Screenshot of the player's screen.

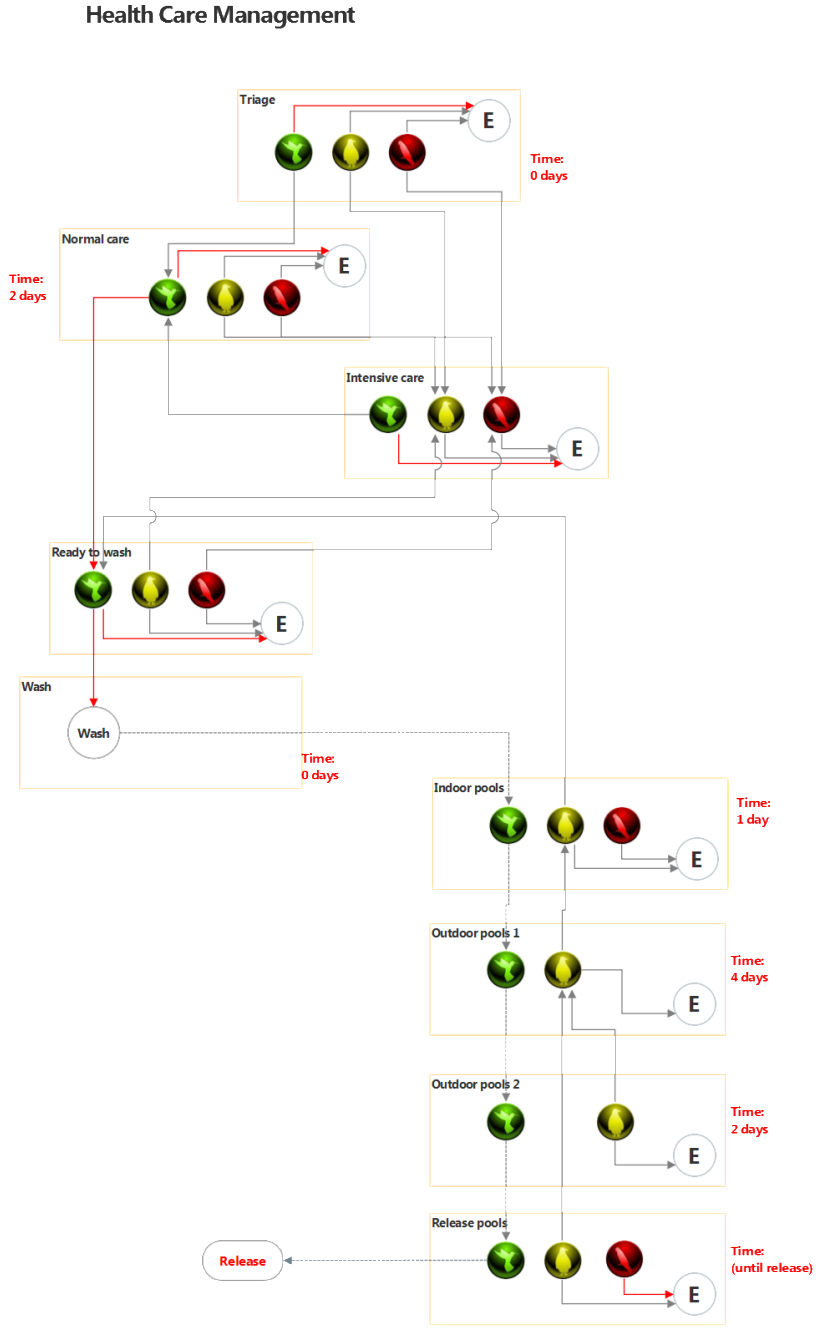

Figure 2: Health care management flow diagramme that is used by the programme.

Table 1: Historic and ficticious scenarios that the facilitator can choose from.

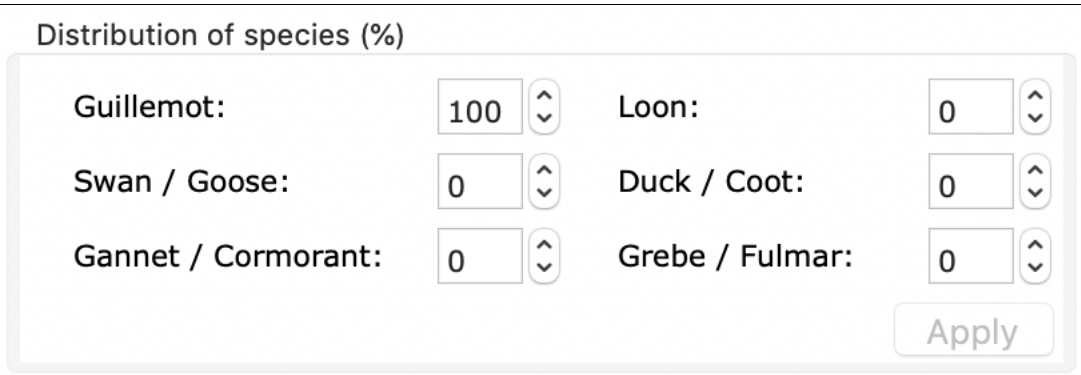

Table 2: In the Trainer screen, the composition of the affected bird species can be set by setting the percentage in which the species should appear. Species types are selected rather than species. Each species type is defined on the basis of their resource use.