# DEVELOPMENT OF A DYNAMIC MODELING TOOL FOR OILED WILDLIFE FACILITY DEVELOPMENT AND OPERATIONS

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## ABSTRACT

*The planning and construction of oiled wildlife facilities can be a daunting task both before and during oil spill responses. The understanding of the general activities involved in such work, in combination with an appreciation for the infrastructure necessary to complete these activities, is necessary in order to develop a care center able to provide adequate care for impacted animals. To address this need, this paper reviews the overall flow of oiled animals through a spill center, and details the requirements (in terms of space and utilities) of each of the defined areas in a facility. It also presents a recently-created dynamic modeling tool designed to better plan and establish such facilities, and tests this model by presenting the results of three separate scenarios where changes to care protocols and available resources were included to test how such alterations impact the overall success of an oiled wildlife response.*

## INTRODUCTION

Rehabilitative care of oil-affected wildlife is an integral part of spill operations due to many reasons, including (but not limited to) public relations, legislative mandates, and the desire by the responsible party to repair damage done to the environment (which includes appropriately caring for and releasing animals back into this environment). However, in the contingency plans for many areas and for many potential responsible parties, pre-established or pre-identified permanent or temporary facilities that can provide adequate care of oiled wildlife are either non-existent or limited in scope. The reasons for these planning limitations vary, from lack of funding for construction of such buildings to lack of experience in oiled wildlife rehabilitation on which to base such projects.

Challenges in the development of wildlife care facilities include understanding the scope of the required facility, the infrastructure (such as utilities) necessary to conduct adequate care, and the staging of when different parts of the facility are needed at what time in the care process. Oiled wildlife rehabilitation facilities can be either permanent (established structures that are either dedicated to supporting oiled wildlife during a spill or have the innate capacity to quickly be converted over to the use of treating oiled animals) or temporary buildings (those that are not specifically dedicated to or modified to allow, oiled wildlife rehabilitation). In most situations, a permanent facility dedicated to oiled wildlife care is considered to be the best approach to a successful response. This is due to the elimination of the chaotic search for a building that contains the specific infrastructure necessary for such activities, as well as the rapid modification necessary to meet these needs. Timing is critical, as lengthy delays in moving oiled birds through the rehabilitation process decreases their chance for survival (Mazet, et al., 2002). In the absence of a permanent purpose-built facility, pre-identification of appropriate sized buildings that can be modified rapidly, or modular units/trailers that can be activated quickly, can provide good support for animal care operations *if* careful thought and planning is invested in the process *and* the facility can be rapidly deployed for rehabilitation *and* if infrastructure in place (i.e. electrical, HVAC) is sufficient to support operations at the level necessary for the severity of the spill.

In order to plan an appropriate facility, one must understand the flow of oiled wildlife care within, and prior to arrival at, the center, as the facility should utilize a design that maximizes the efficient flow of animals and people through the process while minimizing the possible spread of disease. Impacted animals are first identified in the field, captured, handled and transported to the care center by search and collection personnel. The goal of this effort is the immediate and safe capture of the highest percentage of impacted animals so that they may be treated when the effects of the contamination are in the earliest stages. Animals may need to have initial "first aid" provided to them in the field or at a temporary facility close to the spill area if they are not transported within 2-3 hours of capture. Once animals arrive at a facility, they are delivered to an intake area, where they are admitted into the rehabilitation facility and pertinent field and species information, as well as a thorough animal evaluation, biomedical sample collection, and individual animal identification, is collected and performed. Animals are then moved to a pre-cleaning area, where nutritional and hydration support is given until the animal is deemed stable enough for cleaning. Stabilization usually requires 24-48 hours of indoor care, and pre-wash assessment must indicate a fairly normal health evaluation before washing takes place, as animals that are not medical stable prior to wash often die (Mazet, et al., 2002). Animals are then cleaned, which entails the removal of contaminants from the integument (skin and fur/feathers) to allow restoration of that animal's normal thermoregulatory process and to minimize the time spent in captivity due to waterproofing issues. After cleaning, animals are either dried by warming the ambient air temperature in drying pens or, for smaller species, under a heat lamp (Tseng, 1999). Post-cleaning care is the process of caring for the animals after wash and allowing them time and nourishment to reestablish normal and ecological health parameters that are required for release. Prior to release, all animals should be 100 percent waterproof, have normal swimming and diving behaviors, show fear of humans, and have a normal physical examination, which shows no active disease states, all injuries healed (or at a stage that will not interfere with normal foraging), and have normal blood values (Oiled Wildlife Care Network, 2000; Tseng, 1999).

California's Oiled Wildlife Care Network (OWCN), using its experience in spill response and facility construction, has developed a dynamic modeling tool to assist national and international organizations in planning for the rapid and efficient construction and/or establishment of wildlife care facilities. Input variables in the model include animal-related and facility-related information, and animal recovery dynamics. Output in the model (on a daily basis) includes numbers of animals at all stages of rehabilitation, survival and release statistics, space requirements, utilities required, and the amount of animal-related equipment (i.e. pools, holding pens) needed to house the impacted animals. Most parameters can then be altered to determine how, and to what degree, changes in animal care practices can impact personnel and success estimates. This paper, therefore, presents this model, the output from several scenarios, and discusses the uses of this information in planning for spill responses involving wildlife

## MATERIALS AND METHODS

### Facility Requirements

In order to develop a dynamic modeling tool for planning oiled bird rehabilitation facilities, the OWCN conducted an intensive evaluation of the requirements of such a facility (in terms of space and infrastructure) based on its experience in spill response and facility construction. It should be noted that this evaluation (except where mentioned) was based on providing the best possible care to oiled wildlife without regards to cost, space, materials, or utility limitations, therefore the output from this model should always be temporized with the realities existing during emergency responses. It should also be noted that, in order to simplify the analysis and to match the information seen in most spill events, only those requirements needed for an oiled bird response was included in the model. Spills impacting marine mammals or other species may have much different space and infrastructure needs to provide adequate care. Lastly, to allow for more accurate comparisons with changes in facility design and care protocols, most of the following requirements were based on the needs for seabirds in the Alcid family. Spills impacting other families may need greater (or lesser) space and utilities than noted, however, based on the historical spills in California and elsewhere, these assumptions generally hold for most spill events responded to in the past ten years.

Dedicated wildlife areas can be separated into three main groups: dynamic areas (areas that directly change in requirements with the number of birds impacted); semi-static areas (areas where requirements increase not directly with animal numbers but in a stepwise manner with the severity of the spill); and static areas (areas where requirements do not change with the number of birds impacted). Dynamic areas and the requirements of each are as follows:

- Intake: Heat control (65-85°F), ventilation (10-15 air exchanges per hour), electricity, lights, water, waste disposal, one intake station (requiring 40 sq. ft.) per 60 birds per day.
- Pre-cleaning care: Heat control (65-85°F), ventilation (10-15 air exchanges per hour), electricity, lights, water, waste disposal, a minimum of one 4'X 8' X 4' net-bottomed pen (requiring 96 sq. ft.) per 20 birds per day.
- Cleaning: Delivery of 100-300 gallons of softened water (tested at 2-3 grains of hardness) consistently heated to 104-106°F at 40-60 psi per bird cleaned, ventilation (10-15 air exchanges per hour), electricity, lights, waste disposal, one wash/rinse station (requiring 100 sq. ft.) per 16 birds per day.
- Drying: Commercial pet dryers or other heat sources, ventilation (10-15 air exchanges per hour), electricity, lights, waste disposal, one drying pen (requiring 96 sq. ft.) per 12 birds.
- Post-cleaning care: Pools (12 ft. diameter, 4 ft. deep pools requiring 200 sq. ft. of yard space) per 15 birds housed, water (to fill pools, maintain an overflow of at least 10 gallons per minute, and, when possible, softened for the first 24 hours after cleaning), electricity, lights, and waste disposal.

Areas within a rehabilitation facility where space requirements do not increase directly with animal numbers include semi-static, static, and human use areas. For semi-static areas, space needs might double or even triple in significant events, but could be augmented through temporary additions. These areas (based on a square foot need per 1,0001,500 birds affected) include food preparation (300 sq. ft.), morgue/necropsy (250 sq. ft.), storage (100 sq. ft.), and freezers (100 sq. ft.). Static areas are usually dedicated to support of the overall response, and space requirements are dictated by the physical size of the needed equipment, rather than impacts of the spill on wildlife populations. The static facility areas include isolation/ICU (200 sq. ft.), medical laboratory (200 sq. ft.), laundry (200 sq. ft.), electrical (100 sq. ft.) and mechanical (250 sq. ft.). Space for human needs should always be taken into consideration and planned for when developing spill contingency plans. The approximate minimum space needs for these areas are training (500 sq. ft.), rest and relaxation (500 sq. ft.), office (500 sq. ft.), and restrooms (200 sq. ft.). Human space areas will need to increase in size as the number of personnel increase, and will vary significantly with many factors, including but not limited to the remoteness of the rehabilitation facility, the accessibility of other buildings, and facilities available to conduct non-hands-on animal rehabilitation tasks (i.e. trainings). Therefore, direct application of incremental size increases is difficult to address.

It should be noted that many of these requirements will be directly influenced by the size of the spill. In most circumstances, the space and man-power necessary to support a massive spill response using these criteria would most likely be unfeasible. Decreasing the rigor of some requirements (such as decreasing the intensity of the intake evaluation) can increase the amount of animals moving through the system, thereby reducing infrastructure needs. Such an increase in throughput, however must take into account the potential increase in mortality due to less intensive care. That being said, this increase may be more than offset by an increased survival in birds that are evaluated and cared for versus those waiting for intake examinations.

### Model Development

Taking these space and utility requirements into account, a dynamic modeling tool developed by the OWCN was used to estimate facility and personnel needs. This tool is a Microsoft Excel spreadsheet that is composed of: 1) static data pertaining to the flow of animals through the rehabilitation process, 2) imbedded formulas to calculate output values, and 3) dynamic estimators that can be altered to determine how differences in facility, animal and staffing availability, quality and training impacts the outcome of a spill response. Real spill intake data from several large events in California were used to create as realistic a model as possible, with particular attention given to the staging of animals within each area of the facility over time, estimating normal mortality levels within each area during the spill response, and allowing for the success of only a certain proportion of animals to progress through the rehabilitation process. Also modeled was the projection of how the number of affected birds would arrive at a facility during an acute (rapid onset with a short, but often times severe, course) versus a chronic (lasts for a long period of time, or marked by frequent recurrence) spill.

Within the model, animal-related variables that can be changed to help predict the impact of changing animal care protocols on the overall success of the response include: total number of live oiled birds transported to the facility; the type of spill (acute vs. chronic); the percent of viable intake birds; the percent daily survival of oiled birds; the percent daily survival of washed birds; percent of birds that are stable for wash on a given day; the number of birds washed per day; and the percent of clean birds that live to be released. For the purposes of the output to be discussed in this paper, the following variables were held constant based on the author's best professional judgment: 90% viable birds at intake, 90% daily survivability of oiled birds, 97% daily survivability of washed birds, 75% assessed birds stable for wash on each wash day, and 60% of all assessed clean birds released.

Adjustable variables that relate to facilities development and planning include: number of bird intakes/station/day; maximum number of intake stations available; number of oiled birds/pen; number of birds washed/station/day; maximum number of wash stations available; number of clean birds/pen; pool overflow rate; pool size; and maximum number of birds/pool. While these facility-related variables were adjusted to determine their sensitivity to the overall response, the default variables used match what was described in the previous dynamic area section.

### Model Testing

In order to test the model to determine effectiveness for planning purposes and sensitivity of variables in the overall success of the response, several scenarios were tested using three different size oil spills (those where 100, 1,000 and 6,000 birds were collected). This exercise assumed that utilities and human-related issues were not limiting factors (i.e. enough water and electricity would be available to provide animal care). These scenarios included:

- No limits (space, funding, materials or personnel) associated with the response, and established guidelines for animal care (as described above) were followed (i.e., 60 intakes/station/day, 20 oiled birds/pen, 16 washed/station/day, 12 clean birds/pen, 15 birds/pool).
- Limits within the facility in those areas most likely to have "bottlenecks" of animals moving through the process (i.e., only having space and personnel to man 10 intake and wash stations), but following the established guidelines described in scenario 1.
- Facility limits (10 intake and wash stations), and modifying guidelines to allow for more rapid assessment/cleaning and compensating for limited space (150 intakes/station/day, 40 oiled birds/pen, 30 washed/station/day, 24 clean birds/pen, 25 birds/pool).
- Facility limits (10 intake and wash stations), following established guidelines described in Scenario 1, but changing the start-up time until establishment of wash capability at the facility (Note: This scenario only evaluates a single size spill to allow better comparison).

## RESULTS

When there is no limits to space, personnel and finances, relatively successful responses can occur no matter what the severity of the spill (illustrated by a greater that 50% release percentage in all scenarios; Table 1) because ultimate mortality of animals is solely dependent on the minimum time in care (e.g. there is no back-log in any area within the response). However, the results of this analysis show the extraordinary amount of infrastructure needed to be in place for larger events; most clearly illustrated by the need of almost 80 wash stations, almost 200 12' pools and in excess of 3.2 million gallons of water per day at peak response. Clearly, in the case of massive spill events, established protocols and policies will need to be closely evaluated in respect to personnel, space and facility limitations.

In order to evaluate how such limitations might impact response success, the results of limiting intake and wash/rinse stations to 10 each were examined, keeping the underlying animal care and husbandry procedures at the optimal level (Table 2). As is seen, the larger response has a decreased release percentage as compared with Scenario 1 but uses much less in the way of utilities and infrastructure (pools and water needs are reduced by two-thirds). The needs for oiled bird holding areas, however, increase somewhat due to a back-log in intake and wash. The two smaller spills show very similar results to the non-limited response due to those areas not needing much beyond the 10 stations.

To further evaluate the impact of space- and personnel-limited situations, this "limited stations" scenario was repeated, however, this time the underlying protocols and procedures were also changed to increase the throughput of animals (Table 3). These changes included increasing the number of animals assessed per station to 150, putting 40 oiled birds per pen, washing 30 birds per station per day, placing 24 clean birds in each drying pen, and allowing 25 birds to be in each pool. The results of this run show, surprisingly, an improvement in overall release percent for the large spill and further reductions in the size of a facility needed to conduct the response, with only slight increases in pools and water use realized. However, it should be noted that, should such changes to underlying protocols be made, previously described assumptions of daily survivability, percentage ready for wash and percent assessed birds able to be released would probably change to the detriment of the animals. Thus, there may not be significant improvements to ultimate release numbers due to increased time (and therefore mortality) during the rehabilitation process.



**Table 1: Results of OWCN Planning Model based on no facility limits (utilities or space), and following established guidelines for animal care space (60 intakes/station/day, 20 oiled birds/pen, 16 washed/station/day, 12 clean birds/pen, 15 birds/pool).**

| Number of Birds | Birds Released | Intake Stations (#) | Oiled Bird Pens (#) | Wash/ Rinse Stations (Max #) | Drying Pens (#) | Pools (#) | Water Use (g.) | Indoor Space (sq. ft.) | Outdoor Space (sq. ft.) |
|---|---|---|---|---|---|---|---|---|---|
| 6,000 | 3337 (55.6%) | 38 | 131 | 78 | 104 | 199 | 3,215,055 | 30,102 | 39,991 |
| 1,000 | 556 (55.7%) | 7 | 22 | 13 | 18 | 34 | 545,874 | 6,222 | 6,833 |
| 100 | 55 (55.2%) | 1 | 3 | 2 | 2 | 4 | 76,202 | 2,434 | 804 |

**Table 2: Results of OWCN Planning Model based on facility limits (10 intake and wash stations), and following established guidelines (60 intakes/station/day, 20 oiled birds/pen, 16 washed/station/day, 12 clean birds/pen, 15 birds/pool).**

| Number of Birds | Birds Released | Intake Stations (#) | Oiled Bird Pens (#) | Wash/ Rinse Stations (Max #) | Drying Pens (#) | Pools (#) | Water Use (g.) | Indoor Space (sq. ft.) | Outdoor Space (sq. ft.) |
|---|---|---|---|---|---|---|---|---|---|
| 6,000 | 2025 (33.8%) | 10 | 168 | 10 | 14 | 65 | 1,064,012 | 22,072 | 13,062 |
| 1,000 | 551 (55.2%) | 7 | 22 | 10 | 14 | 34 | 545,874 | 5,730 | 6,833 |
| 100 | 55 (55.2%) | 1 | 3 | 2 | 2 | 4 | 76,202 | 2,434 | 804 |

**Table 3: Results of OWCN Planning Model based on facility limits (10 intake and wash stations), and modifying guidelines to allow for more rapid assessment/cleaning and compensating for limited space (150 intakes/station/day, 40 oiled birds/pen, 30 washed/station/day, 24 clean birds/pen, 25 birds/pool).**

| Number of Birds | Birds Released | Intake Stations (#) | Oiled Bird Pens (#) | Wash/ Rinse Stations (Max #) | Drying Pens (#) | Pools (#) | Water Use (g.) | Indoor Space (sq. ft.) | Outdoor Space (sq. ft.) |
|---|---|---|---|---|---|---|---|---|---|
| 6,000 | 2638 (44.0%) | 10 | 71 | 10 | 13 | 70 | 1,144,514 | 13.414 | 14,067 |
| 1,000 | 556 (55.7%) | 3 | 11 | 7 | 9 | 20 | 334,426 | 4,086 | 4,019 |
| 100 | 55 (55.2%) | 1 | 2 | 1 | 1 | 2 | 48,202 | 2.238 | 402 |

**Table 4: Results of OWCN Planning Model based on facility limits (10 intake and wash stations), following established guidelines (60 intakes/station/day, 20 oiled birds/pen, 16 washed/station/day, 12 clean birds/pen, 15 birds/pool), and changing time to establishment of wash capability.**

| Number of Birds | Birds Released | Days to Wash | Oiled Bird Pens (#) | Drying Pens (#) | Pools (#) | Water Use (g.) | Indoor Space (sq. ft.) | Outdoor Space (sq. ft.) |
|---|---|---|---|---|---|---|---|---|
| 6,000 | 2025 (33.8%) | 2 | 168 | 14 | 65 | 1,064,012 | 22,648 | 13,062 |
| 6,000 | 1741 (29%) | 7 | 184 | 14 | 64 | 1.034,512 | 21,880 | 12,861 |
| 6,000 | 1122 (18.7%) | 14 | 184 | 14 | 60 | 978,459 | 21,264 | 12,058 |
| 6,000 | 658 (11.0%) | 21 | 184 | 14 | 49 | 810,109 | 21,264 | 9,847 |

Finally, to assess how the speed of developing wash capabilities can impact a large spill, several different delay times in wash readiness were evaluated (Table 4), keeping numbers of wash/intake stations constant and following optimal care protocols. In short, successful release of birds is almost halved (2,025 vs. 1,122) by the increase of two weeks (2 vs. 14 days) in the development of wash capabilities. Additionally, only slight changes in facility parameters are seen with such delays. Therefore, the rapid establishment of wash capabilities in oiled bird facilities is critical to the overall success of the rehabilitation effort.

## CONCLUSIONS

Planning for and developing oiled wildlife facilities can be a challenging and frustrating experience, due to the dynamic nature of spill response, the need to plan for small and large number of animals to be collected, and the often hurried construction of such care centers during spill responses. Facilities can require such enormous amounts of equipment that logistics and finance sections of the incident command system may be challenged to provide the necessary support, and the unified command may be hesitant to approve such allocations without strong justification. Through understanding the needs of oiled wildlife care providers for space, utilities and manpower (as is provided through the use of this interactive planning tool), better and more rapid decisions can be made during initial facility development, and communication between wildlife professionals and the management agencies and organizations as to animal needs can be better realized. Additionally, by using this planning tool during non-spill periods (in concert with resource-at-risk information for the area in question), facility design and/or identification of appropriate buildings and equipment that can be rapidly mobilized, can be accomplished to provide the best achievable to oiled wildlife during spill events.

## BIOGRAPHY

Dr. Ziccardi received his DVM and PhD in epidemiology from UC Davis, emphasizing wildlife health and the effects of petroleum exposure in wildlife. His current position is Director of California's Oiled Wildlife Care Network and Assistant Adjunct Professor/Senior Wildlife Veterinarian at the Wildlife Health Center, UC Davis.

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