# The effect of submersion time on the amount of oil cleaned from mallard duck feathers

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# Table of Contents

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Last spring, an oil spill took place in the Gulf of Mexico and had a detrimental effect on marine life in the area. The purpose of this study was to determine whether the time a mallard duck feather is exposed to oil has any effect on the ability to clean the feather. It was hypothesized that the longer a feather remained in the oil, the less oil could be removed from the feather. The null hypothesis was that the amount of time a feather was exposed to Valvoline® Non Detergent® Motor Oil would have no effect on the ability to remove the oil from the feather. This ability was measured by determining the percent of the oil that got on the feather that was removed by cleaning. To conduct this experiment, 10 feathers were exposed to oil for 24 hours, 10 feathers for 48 hours, and 10 feathers for 72 hours. The feathers were weighed on an analytical balance to +/- 0.001g before placed in oil. Once the allotted time had elapsed, the feathers were removed and weighed again to determine the amount of oil on each feather. The feathers were cleaned using a solution of Dawn™ dishwashing detergent and water (as suggested in the International Bird Rescue Research Center's article on removing oil from rescued birds) on a sponge. The feathers were allowed to air dry over night and their mass was recorded again to determine how much oil was cleaned off. After completing calculations to determine the percentage of oil left on each feather for all three trials, ANOVA statistical analysis was assessed and because the p-value was greater than .05, it was determined that the time that the feathers were exposed did not have an effect on the amount of oil that was able to be removed, and therefore, the data results failed to reject the null hypothesis.

# Introduction

Oil is formed when single cell plants and microscopic creatures die and sink to the bottom of the ocean, where after spending millions of years in a high pressure, airless environment they become crude oil (1). The crude oil is then refined through fractional distillation, a process in which the crude oil is heated, and the compounds boil at different temperatures, changing to gasses and eventually into liquids. Crude oil, also known as petroleum, is a mixture of carbon and hydrogen and is a liquid in the earth's crust (2). After refinement, oil is almost pure methane. The molecular formula for methane is $CH_4$, its boiling point is -164$^{o}$C and it is a gas at room temperature (3). Methane is an important factor in natural gas and is a greenhouse gas. Methane remains in the atmosphere for nine to fifteen years and traps more heat in the atmosphere than carbon dioxide (4).

To collect oil from underwater locations, drills are used. A sharp tip cracks the rock that the oil is under, and water is pumped down through drilling pipes to push chips of rock to the surface, and the oil is pumped out onto the rig (5). Sometimes, these machines malfunction, and oil can be spilled into the ocean. Leakage of crude oil into water contaminates water supplies and can kill animals if they come in contact with or ingest the oil. Oil contaminates water in several different ways. As well as sitting on the surface and mixing in with the water, spilled oil can form into tar balls, which can sink to the bottom of the ocean, where they remain for years, gradually releasing hydrocarbons into the water. It is very difficult to remove oil from the water once it has been spilled, and cleanup is expensive and time consuming.

On April 20, 2010 the British Petroleum (BP) oilrig Deepwater Horizon exploded in the Gulf of Mexico, leading to the largest accidental oil spill in history. This spill has come ashore in Louisiana, Mississippi, Alabama, and Florida, and spread over a large portion of the Gulf. The leak was finally stopped in August, but oil had already spread through much of the Gulf of Mexico, killing wildlife, contaminating marine life, and harming local industry (7).

Water birds can be harmed by oil either by ingesting it or by being coated in the oil. When oil coats a bird's feathers, it separates the feathers, which can lead to hypothermia since the bird's skin is more exposed to the elements. Birds attempt to clean the oil off of their feathers by preening, through which the oil is ingested, causing internal organ damage (8).

When birds are exposed to oil in the water, the oil coats their feathers and steps must be taken to remove the oil before too much harm is done to the birds. Oiled birds should be washed in a 1% Dawn dishwashing liquid solution. The bird is moved to a new pan of solution each time the water gets dirty, and is considered clean once there is not any oil in the water after a wash. After the bird is washed, it is rinsed and dried, and then placed under veterinary care until it has exhibited that it is healthy enough to be re-released into the wild (9). Dawn dishwashing detergent has been determined to be the best cleanser for birds because it is effective in removing oil while also being gentle on the sensitive animals. Stronger cleansers are difficult to wash off, and Dawn has proven to be steadily effective over many years (10).

The purpose of this study is to draw from what happened in the BP oil spill with regard to the effect of spilled oil on aquatic birds. This experiment will simulate the

exposure of birds to oil by placing Mallard duck feathers in a solution of oil and water and then cleaning them in a 1% Dawn dishwashing liquid solution. . It was hypothesized that the longer a feather remained in the oil and water mixture the less oil could be removed from the feather. The null hypothesis was that the amount of time a feather was exposed to Valvoline® Non Detergent® Motor Oil would have no effect on the ability to remove the oil from the feather.

# Materials

- Dawn Dishwashing™ Soap
- Beakers
- Valvoline® Non Detergent Motor Oil
- Water
- Sponges
- Gloves
- Mallard Duck bird feathers

# Methods

Thirty Mallard duck feathers were collected and weighed to +/- .001 grams using an analytical balance. Ten of these feathers were soaked in a solution of oil and water and left alone for twenty-four hours. After this time period, the feathers were taken out and weighed with the oil solution still on them. Then, a solution of water and Dawn™ dishwashing detergent solution was made and sponged onto the feathers to clean them. The feathers were cleaned with this solution until no oil was visible or tangible on the surface, and then the Dawn™ solution was rinsed off using tap water. Once the oil was completely removed, the feathers were set to dry for a day. The following day, after the feathers were completely dried, their mass was taken and recorded. Ten more feathers were exposed to oil for forty-eight hours, and the final set of ten were exposed to oil for seventy-two hours. The same procedures were repeated in regards to the cleaning and the weighing of the feathers. The difference between the mass before cleaning and after cleaning was determined.

After the data was collected for all thirty feathers, the mean (average) for each data set was determined. A one-way ANOVA statistical analysis was run to determine whether or not there was statistically significant differences in the average percentages of oil that remained on each feather after cleaning.

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| **Title:** The effect of submersion time on the amount of oil cleaned from mallard duck feathers. |
| **Hypothesis:** The longer a mallard duck feather remains exposed to oil, the lesser the amount of oil will be removed from the feather using a Dawn™ dishwashing detergent solution.<br>**Null Hypothesis:** The amount of time a feather is exposed to oil will have no effect on the ability to remove the oil from the feather. |
| **IV:** Time feathers remained in the oil |
| **DV:** Average percentage of oil remaining on each feather after cleaning. |
| **Constants:** Amount of oil each feather was exposed to, type of feather, type of oil, type of cleaning solution (Dawn™ and tap water), conditions in which the experiment was conducted (lab setting), number of trials: ten 24-hour trials, ten 48-hour trials, and ten 72-hour trials. |

# Results

**Table I: 24-Hour Exposure of Feathers To Oil**

| 24 hour feathers | Mass Before | Mass After | Oil Removed | % Oil Remaining |
|---|---|---|---|---|
| feather a | .022g | 1.449g | .040g | 1.00% |
| feather b | .025g | 1.556g | .034g | 1.00% |
| feather c | .013g | 1.145g | .035g | 1.00% |
| feather d | .014g | 1.039g | .038g | 2.00% |
| feather e | .021g | 1.443g | .033g | 0.80% |
| feather f | .013g | 1.145g | .018g | 0.40% |
| feather g | .020g | 1.033g | .024g | 0.40% |
| feather h | .019g | 1.032g | .020g | 0.10% |
| feather i | .021g | 1.022g | .028g | 0.70% |
| feather j | .019g | 1.071g | .021g | 0.20% |

Table I shows the masses of ten feathers before they were exposed to oil for 24 hours, their masses immediately after being removed from the oil, their masses once cleaned and dried, and finally the percentage of oil that remained on each feather after cleaning. Most of the feathers had similar percentages of oil removed. The range of the data was +/-1.90 percent oil remaining and the mean percentage was .76% for the percent oil remaining on feathers.

**Table II: 48-Hour Exposure of Feathers To Oil**

| 48 hour feather | Mass Before | Mass After | Oil Removed | % Oil Remaining |
|---|---|---|---|---|
| 1 | .025g | 1.268g | .064g | 3.0% |
| 2 | .016g | 1.318g | .016g | 0.0% |
| 3 | .025g | 1.200g | .100g | 6.0% |
| 4 | .019g | 1.084g | .029g | 0.90% |
| 5 | .015g | 1.319g | .022g | 0.50% |
| 6 | .016g | 1.412g | .020g | 0.02% |
| 7 | .022g | 1.222g | .028g | 0.50% |
| 8 | .014g | 1.212g | .020g | 0.50% |
| 9 | .017g | 1.215g | .020g | 0.30% |
| 10 | .018g | 1.158g | .020g | 0.30% |

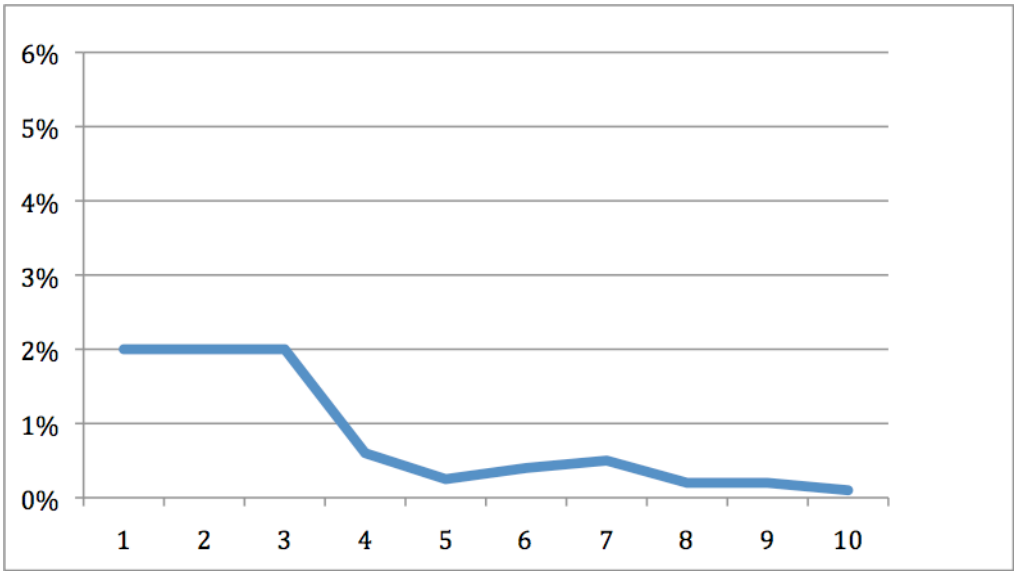
Table II shows the masses of ten feathers before they were exposed to oil for 48 hours, their masses immediately after being removed from the oil, their masses once cleaned and dried, and finally the percentage of oil that remained on each feather after it was cleaned. In this trial the range of the data was +/-6 and the mean percentage of oil remaining was 1.20.

**Table III: 72-Hour Exposure of Feathers To Oil**

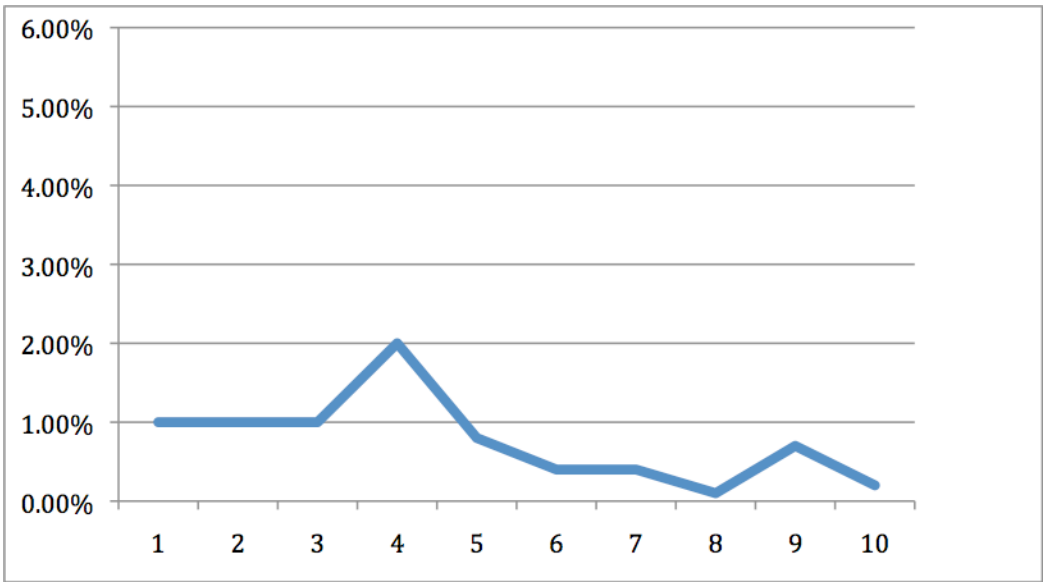
| 72 hour feather | Mass Before | Mass After | Oil Removed | % Oil Remaining |
|---|---|---|---|---|
| A | .023g | 1.974g | .068g | 2.0% |
| B | .022g | 1.305g | .025g | 2.00% |
| C | .021g | 1.765g | .049g | 2.0% |
| D | .011g | 1.256g | .018g | 0.60% |
| E | .020g | 1.227g | .023g | 0.25% |
| F | .014g | 1.522g | .020g | 0.40% |
| G | .011g | 1.403g | .018g | 0.50% |
| H | .025g | 1.403g | .028g | 0.20% |
| I | .018g | 1.349g | .020g | 0.20% |
| J | .025g | 1.321g | .026g | 0.10% |

Table III shows the masses of ten feathers before they were exposed to oil for 72 hours, their masses immediately after being removed from the oil, their masses once cleaned and dried, and finally the percentage of oil that remained on each feather after it was cleaned. In this trial the range of the data was +/-1.9 and the mean percentage of oil remaining was .83.

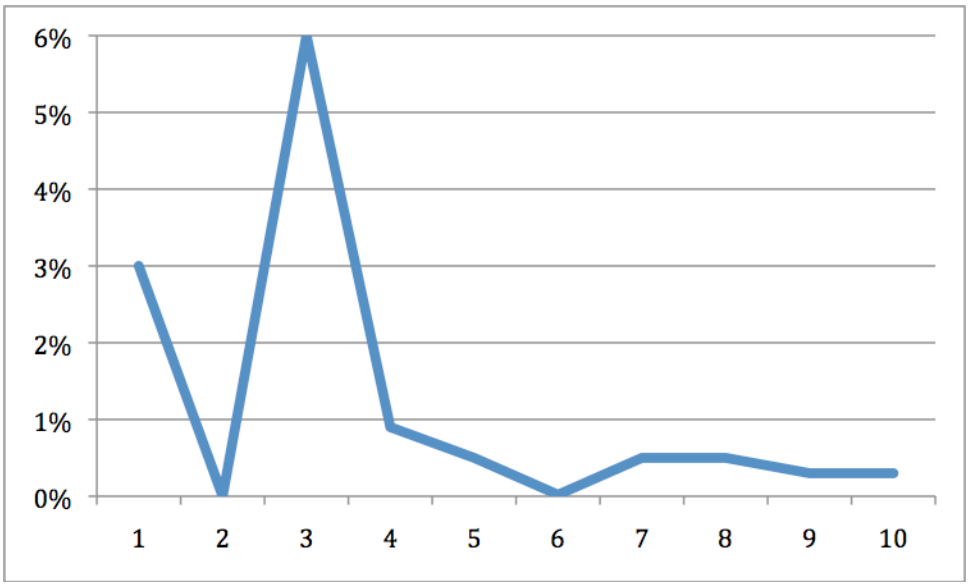
**Percent Oil Remaining 24 Hours**



**Percent Oil Remaining 48 Hours**




**Percent Oil Remaining 72 Hours**



# ANOVA

**Analysis of Variance (One-Way)**

**Summary**

| *Groups* | *Sample size* | *Sum* | *Mean* | *Variance* |
|---|---|---|---|---|
| *% Oil Remaining A* | 10 | 0.076 | 0.0076 | 0.00003 |
| *% Oil Remaining B* | 10 | 0.1202 | 0.01202 | 0.00036 |
| *% Oil Remaining C* | 10 | 0.0825 | 0.00825 | 0.00007 |

**ANOVA**

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *p-level* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 0.00011 | 2 | 0.00006 | 0.37385 | 0.69159 | 4.53779 |
| Within Groups | 0.00411 | 27 | 0.00015 | | | |
| *Total* | 0.00423 | 29 | | | | |

# Discussion

This experiment was designed to determine whether the time feathers are exposed to oil has an effect on the ability to remove the oil from the feathers using a Dawn dishwashing detergent solution. It was hypothesized that the longer a feather is exposed to oil, the larger the percentage of oil remaining on the feather after it is cleaned will be. The null hypothesis was that the time a feather is exposed to oil would have no effect on the percentage of oil remaining on the feather after it was cleaned. Through ANOVA statistical analysis, because the p-value in a comparison of the percentages of oil remaining on the feathers in each trial was greater than .05, it was determined that the difference in the average percentage of oil remaining between the trials was not statistically significant. Therefore, the experimental hypothesis was rejected because the feathers that stayed in oil longer had approximately the same average percentage of oil remaining after cleaning as the feathers that were exposed for a shorter time period. One major limitation of this study was the short amount of time in which it was conducted. If a longer time was available in which to conduct the trial, more analysis could have been carried out to determine whether or not there is a point in time of exposure to oil at which the oil could no longer be removed from the feathers.

In conclusion, this study compared the average percentages of oil remaining on mallard duck feathers after being exposed to oil for one, two, and three days and then cleaned using a Dawn™ dishwashing detergent solution. The results of the study showed that the time the feathers were exposed to oil, in the context of this study, had no effect on the ability to clean them.

# Acknowledgements

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