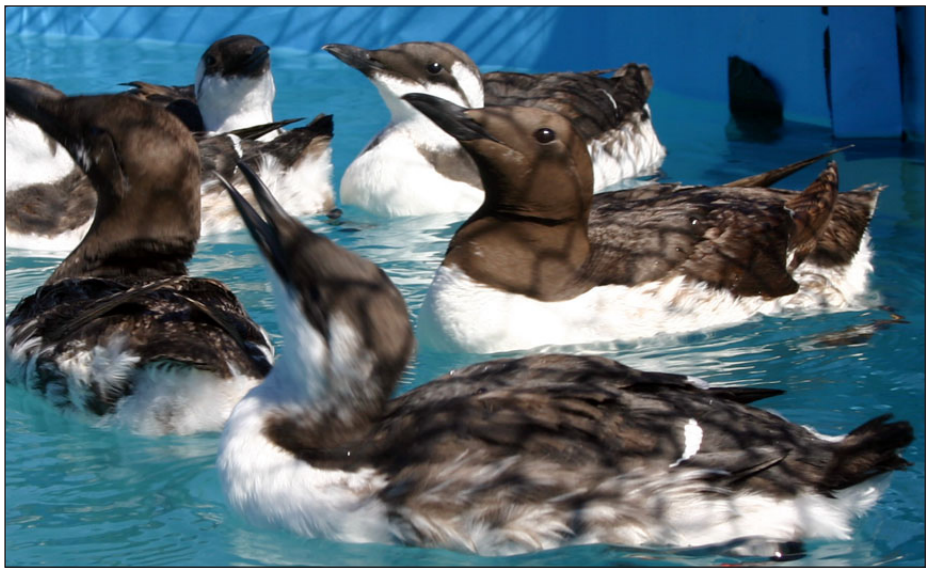
TESTING REMOVAL OF FISH OIL FROM REHABILITATION POOLS USING A PORTABLE WATER FILTRATION SYSTEM



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INTRODUCTION:

During the pre-release conditioning phase of the rehabilitation process, previously oiled seabirds are housed in pools to prevent husbandry-related secondary injuries. Birds are fed an ad libitum diet of previously frozen whole fish. Digested fish oils excreted by the birds rise to the water's surface and, if not properly removed, contaminate feathers and impair waterproofing. Traditionally these oils are removed by continually overflowing the pool's surface water at an estimated rate of 10 gallons per minute. This project tested a commercially available filter to determine its effectiveness at removing fish oil from a closed water system.

Common murres (*Uria aalge*) were used as test subjects because the species is one of the most frequently affected by oil spills in California coastal waters and must be housed in rehabilitation pools during the pre-release conditioning process.

MATERIALS AND METHODS:

Fig 1. A sample is collected from the water return inlet during trial 1.

FILTER: X100 filter bag housing and polypropylene microfiber filter bags (Filter Specialists, Inc., Alameda, CA).

TRIAL 1: An eight-foot diameter fiberglass rehabilitation pool was used for the initial test. Rectangular holes were cut in the pool wall on opposite sides to allow surface water to overflow. This overflow water collected in rectangular shaped weirs that were plumbed to two filters. The X100 filter housing was connected as a pre-filter in series with a sand filter. A sand filter is connected to the permanent rehabilitation pools at the two largest oiled bird rehabilitation facilities in California. Water was pushed through both filters using a ¾ hp pump and then returned to the pool.

To begin the experiment, 400 ml of herring oil were added to the water surface at the center of the pool. Water samples were simultaneously collected at the pool's water return inlet (1 liter) and the two overflow weirs (0.5 liter each) 0 (immediately before adding oil), 5, 15, and 30 minutes, and 1, 2, 4, and 24 hours after the oil was added. Other data collected at these time points included: pressure in the X100 and sand filter housings, and water temperature. The California Department of Fish and Game Petroleum Chemistry Laboratory (PCL) measured total extractable hydrocarbons (TEH) from each water sample to assess filter performance.

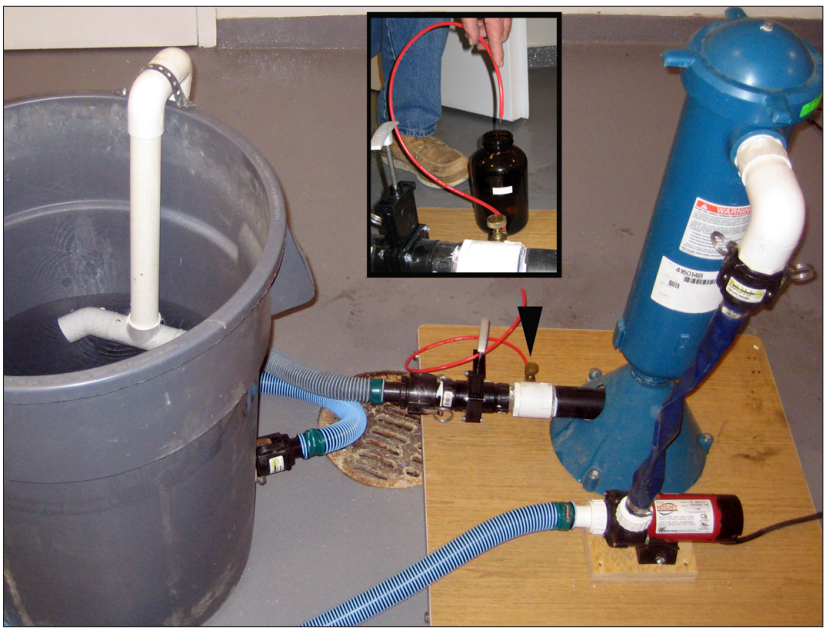

Fig 2. In trials 2 and 3, water samples were collected (see insert) using a small brass valve (black arrow).

TRIAL 2: A smaller closed system model was created using a 45 gal receptacle and a 1/10th hp pump that pushed water through the polypropylene filter only. Herring oil (158 ml) was added to the center of the water surface immediately after the 0 minute sample was collected. Water samples were collected after passing through the filter from a side stream sampling valve (Fig. 2). Water samples (1 liter each) were collected 0, 5, 10, 15, and 30 minutes, and 1, 2, 4, 8, and 24 hours after oil was added. Samples were analyzed by the California PCL for TEH levels. Water temperature was also measured at each time point.

TRIAL 3: The closed system from trial 2 was also used for trial 3. In this trial, the inside of the polypropylene filter bag was filled with Absorbent W particulate material (Absorption Corp, Ferndale, WA). Herring oil (158 ml) was added in the same manner as trial 2. Water samples and temperature were collected at the same time points as trial 2. All water samples were analyzed to determine TEH levels.

FIELD TRIAL: A 12' diameter temporary rehabilitation pool (KD Pools, Zodiac Marine and Pool) erected at the San Francisco Bay Oiled Wildlife Care and Education Center was used to house waterproof common murres (*Uria aalge*) being rehabilitated for the duration of the trial. In lieu of cutting a hole in the side of the pool to allow surface water to overflow, the pool was fitted with a small skimmer with a 4.5" diameter opening (Lilly pad type – 750, Aladdin Equipment Company) (Fig. 4) that collected surface water for filtering. Water was pushed through the polypropylene filter by the same 1/10th HP pump used in trials 2 and 3. No chlorine was added to the pool.

Fig 3. X100 filter connected to temporary rehabilitation pool.

Birds were housed in the pool over a 3-day period and fed an ad libitum diet of thawed previously frozen smelt. Visual observations of each bird were made to document any behaviors indicative of poor feather waterproofing. Birds were physically examined each morning and at the end of the study to check for changes in waterproofing. Polypropylene filter bags were changed every morning. This project was approved by the UC Davis Institutional Animal Care and Use Committee (Protocol No. 08-13408).

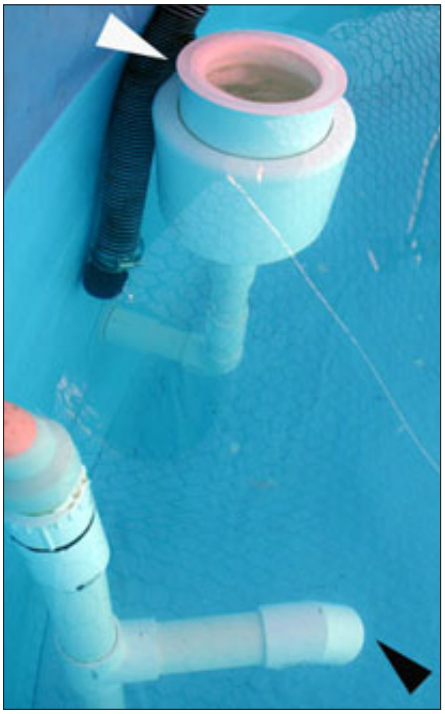

Fig 4. Skimmer (white arrow) and returning water inlet (black arrow).

Fig 5. Common murres in rehabilitation pool.

RESULTS:

TRIAL 1

There was no recorded change in water temperature throughout the trial. The pressure within the X100 housing increased 1 PSI between the 4 and 24-hour samples. The pressure in the sand filter housing decreased 2 PSI in the same time period.

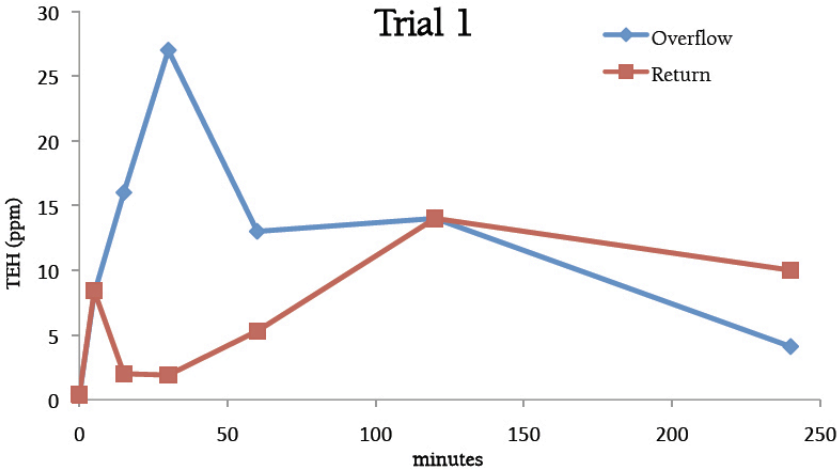

Fig 6. TEH levels in water samples collected from the overflow weirs (pre-filter) and return inlet (post-filter). To improve legibility, the results from the final 24-hour sample were not included.

Large areas of golden sheen were evident on the water surface and brown mousse was noted in both overflow weirs 15 minutes after the herring oil was added. When the 4-hour sample was collected, the water in the overflow wiers was clear. At that time the surface water also appeared to be clear, but when the pump was momentarily turned off and the water settled, small areas of thin brown sheen were noted on the water surface. The deeper water was markedly turbid. When the 24-hour sample was collected, the pool water was clear, but there was a very light sheen noted on the water surface inside the X100 housing.

TEH levels in the samples of overflow water peaked in the 30-minute sample (**27.0 ppm**). After 24 hours the TEH value (**0.53 ppm**) approached the initial background level (**0.32 ppm**). TEH levels in the water collected at the return outlet initially peaked in the 5 minute sample (**8.40 ppm**), declined to **1.90 ppm** over the next two samples, and then peaked a second time at 2 hours (**14.0 ppm**) before declining to **1.20 ppm** in the 24 hour sample.

TRIAL 2

The water temperature rose 2°F between the 1 and 2-hour samples and another 2°F between the 4 and 24-hour samples. The TEH level peaked in the 5 minute sample at **220 ppm**. In the 24-hour sample, the TEH value had decreased to **21 ppm**. The water was markedly turbid when the 4-hour sample was collected, and there were very small broken patches of sheen visible on the water's surface. When the 24-hour sample was collected, the water in the container was visibly clear with no evidence of sheen on the water surface. There was a small amount of sheen noted on the water surface inside the X100 housing.

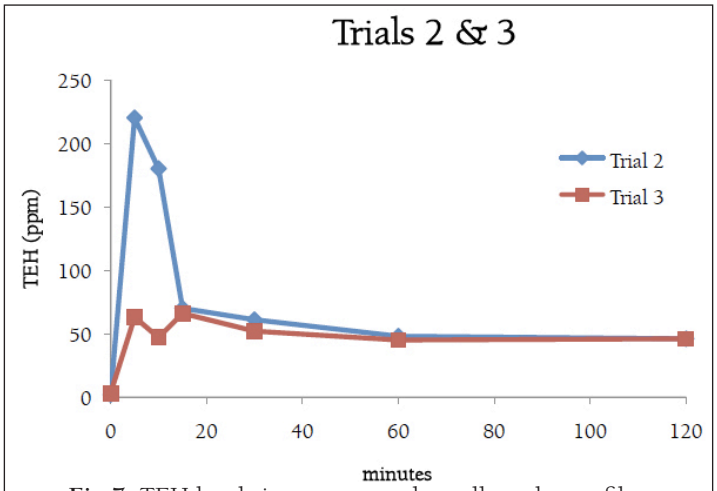

Fig 7. TEH levels in water samples collected post-filter from trials 2 and 3. To improve legibility, the 4, 8, and 24-hour samples were not included.

TRIAL 3

The water temperature rose 2°F between the 1 and 2-hour samples and another 2°F between the 2 and 4-hour samples. The TEH level peaked in the 15-minute sample at **66.0 ppm**. In the 24-hour sample, the TEH value had declined to **14.0 ppm**. The water was only slightly turbid when the 2-hour sample was collected, and there was a thin sheen on the water surface containing small well-defined oil droplets. When the 4-hour sample was collected, the water in the container was visibly clear with a very light sheen present on its surface.

FIELD TRIAL

Day 1 began with 8 birds in the pool. An additional bird was added on the morning of day 2. Water was becoming turbid on day 2, but there was no change in any bird's waterproofing. Feather waterproofing remained unchanged for all birds throughout day 3 and the termination of the study. The pool water was very turbid by the close of day 3. On that day water temperatures ranged from 66°F at 1045 to 77°F at 1645.

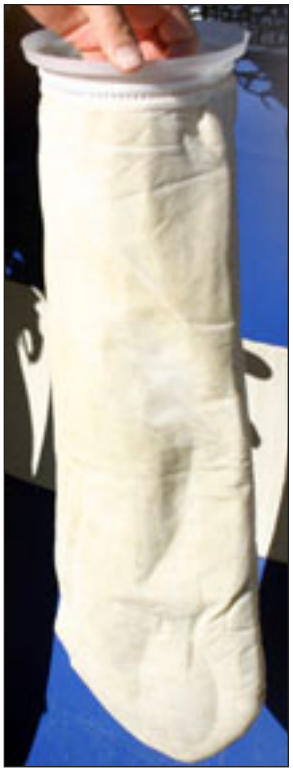

Fig 8. After 24 hrs the polypropylene filter became discolored so we chose to change the filter daily,.

DISCUSSION AND OBSERVATIONS:

Experimental methods were changed between trials 1 and 2 in an effort to establish greater control of sampling variables. During trial 1, TEH values in the water returning to the pool began climbing again after the 30-minute sample. This may have been due to saturation of the polypropylene filter, but the levels declined again after the 2-hour sample and suggested this was not the case. Because the return inlet was located under water, it was necessary to hold a lid over the sample jar mouth until it was positioned in front of the water inlet. Then the lid was removed and a sample collected from the water rushing through the opening (Fig. 1). We theorize it is likely there was unequal mixing of recently filtered water from the return inlet with unfiltered water in the pool. This resulted in the second measured spike in TEH levels.

The amount of oil added to the test system during the first trial was calculated to approximate the maximum potential fish oil excreted during a 24-hour period by a typical common murre. Three experienced seabird rehabilitators were asked to estimate the amount of fish fed to a single bird in a 24-hour period. The mean weight of fish estimated by the rehabilitators was approximately 1.0kg. Herring have been shown to contain up to 40% of body mass as fish oil (Adeniyi, 2006). Therefore, 1kg of fish might contain as much as 400g of oil. If the bird absorbed none of the oil, this would approximate 400ml. Based upon observations during the experiment, this volume appeared to be a gross over-estimation. This was confirmed during the field trial when 8 birds together consumed a total of only 1.365kg of whole smelt. In spite of the high volume of oil used in this study, the filter succeeded in removing it from the system.

During trial 1, pressure in the X100 housing only increased by 1 PSI over the 24-hour study period. This suggests water continued to flow easily through the filter and the filter was not saturated. Water temperature increased slightly (max = 4°F) in trials 2 and 3. This temperature increase was small and most likely due to heat transfer from the water pump. It did not appear to

markedly affect filter function. The greater water volume used in trial 1, combined with housing the water pump out of doors, most likely prevented any temperature increase.

Addition of sorbent material in trial 3 resulted in a much lower peak level of TEH (Fig. 7). This suggests the combination of sorbent material and polypropylene filter removed oil more efficiently when water passed through the filter during the first 10 minutes of the experiment. From the 15-minute sample onward, the TEH levels from both trials were very similar. In fact, there was a significant positive correlation ($p=0.042$) between all TEH values from trials 2 and 3. In circumstances where there may be a large sudden influx of fish oil, adding sorbent material may benefit the initial filtration process. Under typical conditions it should not be necessary. For this reason it was not used in the field trial.

The field trial demonstrated the polypropylene filter maintains feather waterproofing in a closed system under conditions typical of an oiled wildlife response. Water quality deteriorated over the 3-day trial, but this was not related to filter function. Chlorine was not added to deter microbial growth because anecdotal evidence suggests excess chlorine can damage feather waterproofing, and we did not want to introduce an additional confounding factor that might interfere with interpreting filter performance. We hypothesize the high water temperature resulted in accelerated bacterial growth and increased water turbidity. Experience has shown that maintaining feather waterproofing in warm water is challenging. Because most California oiled wildlife responses take place in the winter, it is unlikely rehabilitation pool water temperatures will approach those documented in this study. Consequently, water temperature should not be a factor in filter performance during actual responses.

In this study we quantitatively demonstrated the polypropylene filter will remove fish oil from rehabilitation pool water with no detectable qualitative changes in feather waterproofing over a 3-day period when used in a typical seabird rehabilitation setting. This equipment appears to be a promising tool for enhancing oiled bird rehabilitation during California oiled wildlife responses.

LITERATURE CITED:

Adeniyi, O.D. Herring fish (*Clupea harengus*) oil production and evaluation for industrial uses. J Disp Sci & Tech. 2006;27:537-541.