POST-RELEASE MONITORING OF OILED BROWN PELICANS FROM THE 2015 REFUGIO OIL SPILL

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ABSTRACT
A great deal of effort and resources is expended on the cleaning and rehabilitation of oiled wildlife, but the ultimate fate of these animals is often unknown. Post-release monitoring is essential for improving methodology and directing resources to those animals most likely to survive after release. The Refugio oil spill occurred in May 2015, spilling approximately 100,000 gallons of oil on the California coast near Santa Barbara. Brown pelicans were the most common avian species affected. We instrumented 12 oiled pelicans with solar-powered satellite GPS tags at the time of their release following cleaning and rehabilitation. An additional 8 control (unoiled) pelicans from a nearby area were similarly instrumented and released immediately. All birds survived for at least 12 weeks. In the first 6 months after release, distance traveled and movements were similar between rehabilitated and control pelicans. Several individuals traveled >5000 km, migrating to northern California or central Oregon in the late summer and early fall. In the spring, most birds traveled south, some as far as southern Baja California. Mortality was documented among both rehabilitated and control birds; however, the majority of birds that stopped transmitting were never found. Lack of transmission could represent mortality, tag or battery failure, or tag loss. After at least 40 weeks of tracking, 5 birds (3 rehabilitated and 2 control) were still transmitting. Based on presence in breeding colonies, none of the birds appeared to breed. These results demonstrate that brown pelicans can survive and travel long distances following oiling and rehabilitation.

INTRODUCTION

Anthropogenic marine oil spills are a major threat to seabirds and other marine species, but there is a paucity of knowledge on the efficacy of rehabilitating these animals (Barros et al. 2014; Haney et al. 2014). A great deal of effort and resources is expended on the cleaning and rehabilitation of oiled wildlife, but the ultimate fate of these animals is often unknown. In most cases, the responsible party supports wildlife rescue and rehabilitation efforts, for both ethical and public relations reasons. In California, the rescue and rehabilitation of oiled animals is legislatively mandated, and so will occur regardless of whether it is successful. However, for both habitat management and Natural Resources Damage Assessment, there is great value in understanding the value of these activities on populations that are affected by oiling. In addition, the scientific community has questioned the conservation benefit of rehabilitation of oiled wildlife (Estes 1991; Jessup 1997; Jessup and Mazet 1999).

Decades of post-release monitoring data on penguins have shown that most tend to survive, reproduce, and reintegrate into the wild population after oiling and rehabilitation (Wolfaardt et al. 2009; Chilvers et al. 2015). Other seabirds, however, have high mortality, based on the few studies that are available. For example, a review of banding records in the US from 1969 to 1994 found poor survival of alcids, grebes, and seaducks after oiling and rehabilitation (Sharp 1996). Similarly, brown pelicans (*Pelecanus occidentalis*) oiled in the 1990 American Trader tanker spill off the coast of Santa Barbara, California had lower survival rates than unoiled control pelicans (Anderson et al. 1996). However, wildlife rehabilitation methods and wildlife medicine have advanced in the past two decades, and there are few recent studies available (Massey 2006; Jessup et al. 2012). For example, a study of rehabilitated Western gulls after oiling in the 1997 Torch/Platform Irene Pipeline spill found 100% survival until transmitter failure, which was 3 to 4 months after release (Golightly et al 2002). After the 2010 Deepwater Horizon spill, a short-term post-release study of oiled and rehabilitated brown pelicans did not record any mortality in a 6 week time frame; however, birds were not instrumented and supplemental feeding was performed (Selman et al. 2012). More long-term, rigorous post-release monitoring studies are needed to evaluate the efficacy of current rehabilitation methods.

After the Refugio oil spill occurred in May 2015, we initiated a post-release monitoring study of brown pelicans. Prior to release, and after undergoing cleaning, rehabilitation, and a pre-release health examination, some pelicans were color-banded with uniquely numbered bands, and instrumented with satellite transmitters. A control group of unoiled pelicans was captured and similarly instrumented. Here we report results of survival and a summary of movements of these birds.

MATERIALS AND METHODS

On May 19, 2015, Plains Pipeline 901 spilled >100,000 gallons of crude oil near Refugio State Beach in central California. Capture and rehabilitation efforts began the next day, and continued for several weeks. Fifty oiled pelicans were captured; 4 of these were euthanized and 46 survived to release. Capture and rehabilitation procedures followed written Oiled Wildlife Care Network (OWCN) protocols (Fiorello et al. 2014; Mills-Parker 2015).

All oiled, washed, and rehabilitated pelicans were candidates for inclusion in the study. At the time of the release evaluation, all pelicans were fitted with a Federal band on one leg and a plastic, green, uniquely-numbered band on the contralateral leg. Birds were evaluated via veterinary examination, complete blood count (CBC), chemistry panels, and protein electrophoresis (EPH). Twelve adult pelicans were selected for satellite tagging based on apparent health and the absence of compounding factors, such as previous illness, severe pododermatitis, or presence of healed fractures. The birds selected for tagging included 6 males and 6 females (sex was determined using culmen length). Capture dates of tagged birds spanned the entire 24 days during which oiled pelicans were collected from the field, with the exception of the first day. This was done to avoid biasing the sample; heavily oiled birds are typically captured at the very beginning of the spill. As time passes, birds that were less heavily oiled, and were therefore able to survive and evade capture for a longer time, are eventually captured. Our sample included representative birds from the entire period of capture.

We affixed solar-powered GPS satellite Platform Terminal Transmitters (PTT) with a Teflon ribbon harness (Lamb et al 2016). Birds also were fitted with a federal band and a uniquely numbered plastic green band. Birds were observed and filmed in aviaries for about an hour after PTT attachment to ensure that they were able to ambulate and swim (Lamb et al. 2016). All instrumented birds were released the day after transmitter attachment, on either June 12 or June 27.

On July 7 and 8, seven adult unoiled control pelicans were captured by first baiting them with fish and dip-netting from a boat. One pelican was captured in a bait station. These birds were fitted with a federal band on one leg and a plastic, blue, uniquely-numbered band on the other leg, with the exception of one bird that had only a federal band placed. Four female, 3 male, and 1 bird of unknown sex were captured, examined, bled, and instrumented as for the rehabilitated birds; they were released within 2 hours of capture and observed until they flew out of sight.

Statistics

Data were collected for the purposes of this manuscript up until July 9, 2016. Statistical analyses were performed using R version 3.1.2. Significance was accepted at 0.05. Comparisons between means were made with Welch's unequal variances t-tests.

RESULTS

Data on body weights, PCV, and TS were available for 43 oiled and rehabilitated pelicans that survived to release. Thirty of these had EPH data, 26 had CBC data, and 25 had plasma chemistry data.

The oiled and rehabilitated birds chosen for tagging (n=12) did not differ from the general population of oiled and rehabilitated birds (n=31) in intake or release weights, intake and release PCV and TS, or any parameters on the CBCs or chemistry panels. On EPH, tagged birds had a significantly smaller mean beta globulin fraction compared to the general population (1.02 ± 0.16 vs. 1.28 ± 0.29, p=0.01123, n=30). This was not unexpected, however, as the EPH profile was one of the factors considered in determining overall health. Based on previous experience with brown pelicans, all the values for beta globulin fractions were slightly increased (C. Cray, personal communication, 2015).

The release weights of rehabilitated (RHB) pelicans did not differ from those of control (CON) birds of the same sex (Table 1). Hematocrit, lymphocyte, monocyte, and basophil counts did not differ between RHB and CON birds, but RHB pelicans had significantly higher mean heterophil counts, heterophil to lymphocyte ratios (H:L), and total protein levels than CON (Table 1). Eosinophil counts were significantly higher for CON birds (Table 1).

Two RHB and two CON birds survived to one year of tracking. However, the RHB birds transmitted, on average, 13 days longer than CON birds. This did not vary between sexes, either for all birds combined or for RHB and CON birds considered separated. The RHB pelicans traveled significantly greater distances during the one-year period (RHB=8827.9 ±3984.6 km vs CON 3799.2 ±2115.1 km, p=0.0019). Again, there was no difference in total distance traveled by sex, either among all birds or when examined by RHB or CON status. To estimate a daily travel distance, the total distance traveled at one year was divided by the number of days of transmission (capped at one year). Again, RHB birds had a significantly greater average daily travel distance than CON birds, with RHB birds traveling an average of 36 ± 13 km a day and CON birds traveling an average of 18 ±13 km a day (p=0.0101).

Value	Rehabilitated (n)	Control (n)	p–value
Weight (males) (kg)	4168.8 ± 173.1 (6)	3822.0 ± 534.4 (3)	0.28930
Weight (females) (kg)	3789.3 ± 193.6 (6)	3610 ± 183.8 (2)	0.36940
Hematocrit (%)	46.4 ± 2.3 (12)	46.0 ± 2.2 (8)	0.7807
White blood cell count	15541.7 ± 2835.2 (12)	13728.3 ± 4362.0 (8)	0.3842
Heterophil count	**10989.8 ± 2867.7 (12)**	**6310.8 ± 3713.0 (8)**	**0.0104**
Lymphocyte count	2777.5 ± 1099.9 (12)	3446.0 ± 1803.8 (8)	0.3692
Monocyte count	1484.4 ± 843.1 (12)	1484.4 ± 422.4 (8)	0.9609
Eosinophil count	**851.8 ± 564.3 (12)**	**1971.8 ± 1281.7 (12)**	**0.0456**
Basophil count	559.9 ± 331.3 (12)	649.8 ± 360.1 (8)	0.5814
Heterophil: Lymphocyte	**4.7 ± 2.4 (11)**	**2.5 ± 2.0 (8)**	**0.03825**
Total protein (mg/dl)	**4.9 ± 0.3 (12)**	**4.1 ± 0.4 (8)**	**0.00043**
Fibrinogen (hp) (mg/dl)	391.7 ± 79.3 (12)	312.5 ± 112.6 (8)	0.1113
Fibrinogen (C) (mg/dl)	226.2 ± 71.8 (10)	173.3 ± 51.3 (8)	0.1037

Table 1. Means and standard deviations of body weights and blood values of oiled and rehabilitated (n=12) vs. control (n=8) brown pelicans prior to release with satellite tags. hp=heat precipitation; C=modified Clauss method for fibrinogen quantification

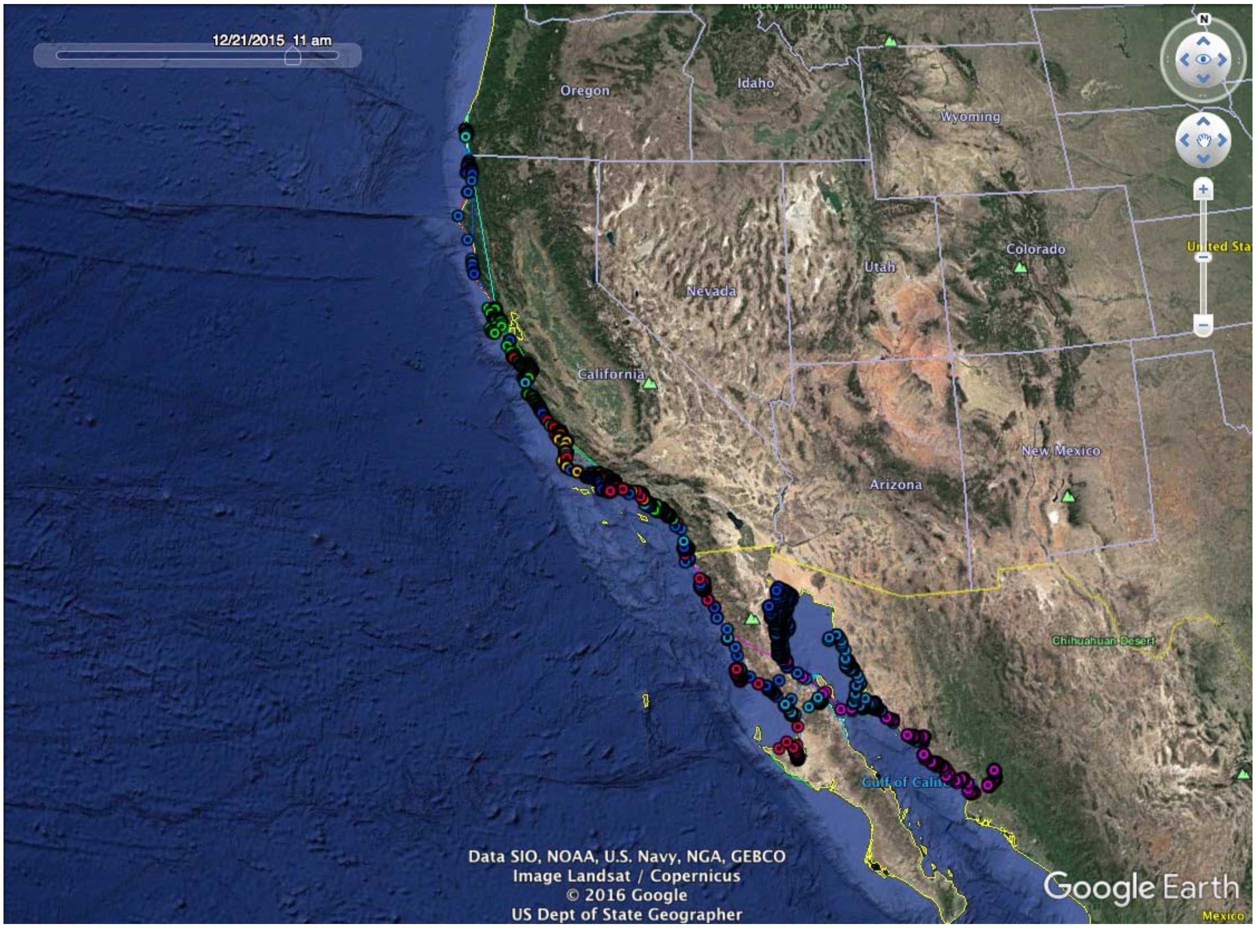

Figure 1. Locations of all control and rehab pelicans in November-December 2016. Note extensive distribution from Oregon to Baja and mainland Mexico.

DISCUSSION

The oiled and rehabilitated pelicans from the Refugio spill appeared to be healthy at the time of release. There was some evidence, based on mildly elevated beta globulins, that some degree of systemic inflammation was present in most birds. The birds selected for satellite tracking, however, closely resembled those who were not; they appear to be representative of the rehabilitated pelican population.

The control pelicans used in this study had somewhat different hematologic and biochemical profiles when compared with the oiled, rehabilitated birds. The higher mean heterophil counts and H:L seen in the rehabilitated birds likely reflect a higher stress level. These animals had been oiled, captured, and in captivity for at least one week, all of which are expected to cause physiological and psychological stress. The higher mean total protein of the rehabilitated birds may be due to the unnatural and aggressive feeding regimen these birds were subjected to during rehabilitation. They were fed exclusively capelin, and food was provided ad libitum to encourage birds to eat as much as possible to promote health and address weight and condition loss that occurred after oiling. On the other hand, the higher protein levels could indicate higher levels of acute phase proteins, indicating systemic inflammation.

The lower eosinophil count in the rehabilitated birds may be related to parasite load, reproductive status, inflammation, or other, unknown factor (Samour J. 2008; Clark et al. 2009; Schumann et al. 2014). A difference is reproductive status is unlikely, as none of the tagged birds were present in breeding colonies for long enough to have nested. Although the control birds may have had some unknown source of inflammation, given that their mean heterophil count was significantly lower, and their mean leukocyte count and fibrinogen level were lower (although not significantly so), this seems unlikely. It is possible that the rehabilitated pelicans had lower parasite burdens than the controls. The former were treated for parasites, but the control pelicans were neither evaluated nor treated for parasites. Pouch lice were observed on control pelicans during their physical exams, but burdens were low, ranging from zero to 2. However, they may have had high burdens of internal parasites.

Although a higher percentage of CON birds (2/8) compared to RHB birds (2/12) continued to transmit locations at one year, on average, the RHB birds transmitted for more days. The RHB birds also made more long distance trips and traveled much greater total distances and average daily distances than the CON birds, indicating that the two groups of birds might have come from slightly different subpopulations. This was clear when looking at the movement data, which revealed that most RHB birds migrated to central Oregon in the fall/winter, while most CON birds stayed in central and southern California (Fig. 1). This confounds the interpretation of the survival data when comparing the RHB and CON birds, given that the key alternate hypothesis we are interested in is that RHB would transmit (i.e., survive) for less time than birds that were not oiled and rehabilitated. Instead, they have transmitted for longer and seem to be in more robust health than the CON birds.

Although data analysis is just beginning, our data show that RHB pelicans can travel long distances after oiling, capture, washing, and rehabilitation. We did not observe movements documenting breeding activity, which is similar to what previous studies have seen. However, pelicans are long-lived species, and it is possible that they may survive to breed in subsequent years. We also show that RHB pelicans can survive for over one year after oiling and rehabilitation.

A major limitation of this study was the unreliability of the technology. Thanks to an adjunctive study of color-band field observations, we have documented that at least five of the satellite transmitters that stopped transmitting did not do so because of mortality. In several cases, the birds were seen without any evidence of a harness or transmitter, and in at least one case, the bird was seen with a harness in place, despite no transmissions for several weeks. Based on satellite telemetry, therefore, we have certainly underestimated survival of RHB birds. While encouraging from the standpoint of the potential for RHB birds to survive and reintegrate into their population, it is disappointing to find that the devices (or attachment methods) we employed were suboptimal.

Data analysis from this study is ongoing, and we expect to present additional results in the next few years.

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