Challenges and lessons learned during a wildlife response after an oil spill of national significance in Peru

Valeria Ruoppolo
Aiuká Consultoria em Soluções Ambientais
Av. do Trabalhador 1799, Praia Grande, 11725-000 SP, Brazil and Lima, Peru.

Yovana Murillo
Proyecto Golondrina de la Tempestad de Collar (PGTC), Lima, Peru.

Luis Alberto Delgado Alburqueque
Aiuká Consultoria em Soluções Ambientais
Av. do Trabalhador 1799, Praia Grande, 11725-000 SP, Brazil and Lima, Peru.
Proyecto Golondrina de la Tempestad de Collar (PGTC), Lima, Peru.
Ricardo Palma University (URP), Lima, Peru.

Rodrigo del Rio do Valle
Aiuká Consultoria em Soluções Ambientais
Av. do Trabalhador 1799, Praia Grande, 11725-000 SP, Brazil and Lima, Peru.
Universidade Paulista, Faculdade de Medicina Veterinária, São Paulo, Brazil.

Brígida C. C. Gandini
Aiuká Consultoria em Soluções Ambientais
Av. do Trabalhador 1799, Praia Grande, 11725-000 SP, Brazil and Lima, Peru.

Marco Cardeña
Aiuká Consultoria em Soluções Ambientais
Av. do Trabalhador 1799, Praia Grande, 11725-000 SP, Brazil and Lima, Peru.

Rodolfo Pinho da Silva Filho
Aiuká Consultoria em Soluções Ambientais
Av. do Trabalhador 1799, Praia Grande, 11725-000 SP, Brazil and Lima, Peru.

J. D. Bergeron
International Bird Rescue
4369 Cordelia Road, Fairfield, CA 94534, USA

Barbara Callahan
International Bird Rescue
4369 Cordelia Road, Fairfield, CA 94534, USA

ABSTRACT PAPER290

Peru is a country with spectacular marine biodiversity, most of which is located in natural protected areas. On January 15, 2022, an oil spill occurred during offloading operations from the Crude Oil Tanker Mare Doricum to a refinery in Ventanilla, a district north of Lima. Aiuká was called to assist in setting up the wildlife response. To expand response capacity, Aiuká had the initial support of Proyecto Golondrina de La Tempestad de Collar (Peru), International Bird Rescue (USA), Centro de Recuperação de Animais Marinhos (Brazil), and Fundación Mundo Marino (Argentina). The activities developed by the Aiuká team included: Wildlife Branch Operations as part of the Incident Management Team (IMT) at the Command Post, field operations, and wildlife rehabilitation. The field operations were divided into boat and beach surveys, seeking to document and find oiled and/or debilitated animals and to collect carcasses. All activities were developed in coordination with the wildlife management authorities and followed international best practices for oiled wildlife response.

From the beginning of the response, it was clear that there was a substantial lack of national experience by the authorities with oil spills of this size and complexity. The absence of guidelines for the capture, documentation, and rehabilitation of wildlife impacted by oiling caused unnecessary delays, preventing a fully integrated and successful response. The authorities found challenges in working together and for creating systems that were agreeable to one another.

Concerted efforts must be made for the future to unify and improve the regulatory framework to allow for an efficient and integrated response. During an emergency response, professional wildlife responders must be allowed to safely and immediately access all spill impacted areas, both protected and non-protected areas. Equally important is the authority for

those professional responders to be allowed to collect impacted wildlife as quickly as possible to maximize chances for survival.

The primary lessons learned in Peru include: 1. There is a need for the development of clear mechanisms within the wildlife management legislation and policies to include oiled wildlife response in the existing industry contingency plans (considering dedicated staff, equipment, training, and exercises). 2. Guidelines are needed which cover documentation, response, and release of treated oiled wildlife, including specific needs for infectious disease screening. 3. Local, professional capacity to respond to oiled wildlife needs to be developed. 4. There is a lack of a dedicated rescue center for marine wildlife care.

It is up to the authorities, private companies, academia, and civil society in Peru to prevent and be prepared for future events and to better protect wildlife. This paper will examine the challenges and lessons learned as well as other critical response topics for oiled wildlife preparedness and response in Peru.

INTRODUCTION

Impacts of oil spills in the environment and wildlife

The marine-coastal ecosystem is subject to various threats, and oil and gas extraction, transportation, and consumption represents one of the main anthropogenic threats to the environment. An oil spill can cause environmental contamination and significant wildlife mortality events (Chilvers et al., 2021), and the situation is even more difficult if the spilled oil reaches the coast, as biological productivity is greater in those places and oil stranded on the coast can persist for very long periods (Asif et al., 2022).

Oil spills can cause major seabird mortality events, such as those described in the Deepwater Horizon, Prestige, and Exxon Valdez spills, among others (Haney et al., 2014; Munilla et al., 2011; Wiens et al., 1996).

The contact, ingestion, inhalation, and absorption of oil have direct and indirect effects on birds, marine mammals, and others, including humans (Takeshita et al., 2021). On animals, the most direct effect is loss of thermoregulatory ability in birds and furred mammals due to contact with the oil. Among the indirect effects is being exposed to traces of oil that can be bioaccumulated (Chilvers et al., 2021; Ridoux et al., 2004). Thus, birds are not able to dive or fly, and therefore do not feed. They deplete fat reserves, suffer hypothermia, and die (Troisi et al., 2016). Systemic toxicity and embryo toxicity can also occur (King et al., 2021).

Pollution from spills also affects shorebirds due to contact of oil with their feathers, which can lead to ingesting oil while preening their plumage. Consumption of contaminated prey can cause death or deterioration of health through sublethal damage. Also, the contamination produced by a spill causes a decrease in available prey, so that they do not reach the necessary weight to migrate to breeding grounds (Giner, 2021).

While it is known that bird species that tend to have a high number of individuals stranded in spills and are highly vulnerable to oil spills, there are also underrepresented groups of birds that might otherwise have been overlooked due to the dominance of majority taxa (Waugh et al., 2022). These species became noticeable when the comparison of numbers of birds stranded on beaches in pre- and post-spill periods was carried out. Some seabird species show population recovery up to a decade after the spill (Banks et al., 2008). Among seabirds, penguins are one of the most vulnerable groups as they spend much of their time in the water and can quickly lose their insulation and buoyancy if they come into contact with oil (Goldsworthy et al., 2000). Regarding

shorebirds, the quality of the habitat at stopover sites is critical for their survival, since the ability to replenish energy to continue their migration and complete the annual cycle depends on it (Tan et al., 2018).

Among marine mammals affected by spills, otters have been described as comparable to birds, because they base their insulation from water on their thick, dense fur, which traps air like bird feathers do. (Ridoux et al., 2004). Thus, otters can suffer immediate contamination effects on their fur or chronic effects from grooming their pelage and consuming prey contaminated with oil (Garshelis and Johnson, 2013). Pinnipeds appear to be somewhat externally resistant to oil due to the presence of layers of fat that minimize impacts on their thermoregulation, although other effects such as eye inflammation and infection, decline in population size, kidney failure, destruction of the intestinal lining, neural disorders, and bioaccumulation have been observed in sea lions in the Galapagos (Salazar, 2003). Pinnipeds are also affected due to persistent exposure to oil, which is consumed by their prey, as well as any reduction in prey availability associated with a spill (Helm et al., 2015).

The impact of oil on wildlife without feathers or fur, like cetaceans, fish, amphibians, and reptiles, is most likely to result in death if they cannot get human assistance, due to the contamination by ingestion, inhalation, and absorption through their skin (Helm et al., 2015).

Incident summary and response description

On January 15, 2022, an oil spill occurred during offloading operations from "*Mare Doricum*" ship to a refinery in Ventanilla, a district north of Lima, to Huacho, Province of Huaura, with approximately 10,300 barrels of oil spilled, reaching approximately 70 km of beaches, and therefore the wildlife distributed in the area. In the affected area, there are two Natural Protected Areas: The Ancon Reserved Zone and the Islands of Grupo de Pescadores (RNSIIPG).

The Natural Protected Areas are home to a significant number of resident species such as guano birds such as cormorants, boobies (3700-4600 individuals) and Humboldt penguins (280 - 600 individuals), among others. Likewise, around these reserves it is common to find foraging areas for these birds, which ensures their survival and that of their chicks. According to SERNANP technical reports (SERNANP, 2022-2023), guano birds usually breed between the months of August and January, while Humboldt penguin chicks have been recorded between the months of May to August, with some observations between the months of October to January. The breeding season can be altered by climate anomalies such as an El Niño event or by some other type of impact.

Response team

From the first few days of the response, international experts were involved to develop the best response possible. *Aiuká Consultoria em Soluções Ambientais*, a Brazilian organization specializing in wildlife emergency response, appointed five experts, specializing in oiled wildlife care and management to initiate the response team. In the following days as needed to expand response capacity, veterinarians and biologists of different nationalities joined the team in Peru from organizations and institutions such as: Aiuká, appointed to manage the wildlife response; *Proyecto Golondrina de la Tempestad de Collar* (Lima, Peru); International Bird Rescue (IBR, USA); *Fundación Mundo Marino* (Argentina); and *Centro de Recuperação de Animais Marinhos*, *Universidade Federal de Rio Grande* (CRAM-FURG, Brazil).

From January 2022 to January 2023 in an effort to provide specialized technical assistance and develop all the activities involved in the wildlife response, Aiuká collaborated with numerous professionals and support staff, adding a total of 210 people who participated in one or more areas of the wildlife response, with more than 30 international specialists between the IMT, field

operations, and wildlife rehabilitation. More than 160 local responders and volunteers were trained, including veterinarians, biologists, and authorities from the Peruvian government. In addition, there was also an administrative and technical support team from Aiuká in Brazil.

Wildlife response

Directly after the oil spill, the local authorities and the public began to rescue and admit oiled animals. Given the lack of rehabilitation centers for marine fauna, the authorities decided to carry out the treatment of the oiled and debilitated animals in temporary enclosures built within the existing "zoo hospital" at Patronato del Parque de las Leyendas (PATPAL). The PATPAL is a facility to manage animals in captivity, which is pre-authorized by The National Wildlife Authority (SERFOR). The initial care of the animals was carried out by zoo professionals, with collaboration from the authorities, *Proyecto Golondrina de la Tempestad de Collar* and volunteers. Thereafter, Aiuká recommended the implementation of a temporary facility to admit, clean, and rehabilitate the affected animals, and the facility building was approved at the PATPAL soccer field, away from the zoo collection. In the meantime, while implementing the temporary facility; the cleaning of animals began in areas designated for washing ("washing area") and drying ("drying area") in the existing "zoo hospital" area in the PATPAL. The work was carried out while the zoo allocated certain areas to place the clean animals, so that they could continue with their recovery, reconditioning, and waterproofing process, in preparation for release.

The Temporary Rescue Center with all the necessary areas to care for and rehabilitate seabirds affected by the environmental emergency began operating in February 2022, with the transfer of animals from the "zoo hospital" area, which peaked with a population of 128 animals for recovery in March 2022 (Figure 1).

Figure 1 – Temporary Rescue Center facilities built for the wildlife response on the soccer field at Lima Zoo – Patronato del Parque de las Leyendas (PATPAL). Photo credits: Aiuká/ L. A. Delgado

The strategies and methods used were established in accordance with the best current international practices based on the experience of the Aiuká team and based on scientific literature (IPIECA/IOGP, 2014; IPIECA/ IOGP, 2017).

During the first few weeks, the international professional responders were not allowed to rescue debilitated animals or to collect carcasses in the affected area, and the field team had to inform the authorities and wait for their personnel to rescue animals in need. During this time, the capture, documentation, and first aid was performed by authorized government personnel only at collection points in the field. Then, transportation of the rescued animals to the zoo was also carried out by the authorities. The same protocols were followed for carcass collection.

Rehabilitation

First at the PATPAL zoo hospital and four weeks later at the facilities set up at the soccer field in PATPAL (Temporary Rescue Center), the animals were admitted, evaluated, and

stabilized by highly trained and experienced personnel according to the key principles recommended by IPIECA & IOGP (2014, 2017).

From January 2022 to November 2022, a total of 526 individuals of 27 species of seabirds were admitted to the temporary Rescue Center. The main species treated were Humboldt penguins (*Spheniscus humboldti*), Peruvian pelicans (*Pelecanus thagus*), Peruvian boobies (*Sula variegata*), Guanay cormorants (*Phalacrocorax bougainvillii)*, Peruvian gulls (*Larus belcheri*), and Laughing gulls (*Leucophaeus atricilla*). Of the total animals treated, 30.4% (160/527) presented oil on their plumage (Table 1).

Table 1. Animals admitted at the Temporary Rescue Center in PATPAL.

N°	Species	Oiling			Total
		Oiled	Not oiled	Not recorded	
1	*Actitis macularius*	0	1	0	1
2	*Anas bahamensis*	0	1	0	1
3	*Arenaria interpres*	2	1	0	3
4	*Charadrius semipalmatus*	0	1	0	1
5	*Chroicocephalus maculipennis*	0	1	0	1
6	*Chroicocephalus serranus*	0	1	0	1
7	*Gallinula galeata*	0	1	0	1
8	*Haematopus ater*	0	1	0	1
9	*Haematopus palliatus*	0	2	0	2
10	*Hydrobates hornbyi*	0	3	0	3
11	*Larosterna inca*	1	4	0	5
12	*Larus belcheri*	5	17	0	22
13	*Larus dominicanus*	1	17	0	18

14	*Leucophaeus modestus*	0	4	0	4
15	*Leucophaeus pipixcan*	2	9	0	11
16	*Numenius phaeopus*	0	1	0	1
17	*Nycticorax nycticorax*	0	2	0	2
18	*Pelecanoides garnotii*	0	1	0	1
19	*Pelecanus thagus*	3	12	0	15
20	*Phalacrocorax bougainvillii*	67	127	8	202
21	*Phalacrocorax brasilianus*	9	15	1	25
22	*Phalacrocorax gaimardi*	14	2	2	18
23	*Spheniscus humboldti*	11	3	0	14
24	*Sterna hirundo*	0	1	0	1
25	*Sula nebouxii*	0	21	0	21
26	*Sula variegata*	45	101	5	151
27	*Thalasseus maximus*	0	1	0	1
	Total	**160**	**351**	**16**	**527**

From January 2022 to January 2024, a total of 147 individuals were released back to the wild. The most released species were Peruvian boobies, 49.6% (73/147), then Guanay cormorants with 15.6% (23/147), in addition to other species such as Peruvian gulls and Laughing gulls (Table 2).

Table 2. Released species between January 2022 and January 2024.

N°	Species	Quantity
1	*Actitis macularius*	1

N°	Species	Quantity
2	*Arenaria interpres*	2
3	*Chroicocephalus maculipennis*	1
4	*Hydrobates hornbyi*	2
5	*Larus belcheri*	14
6	*Larus dominicanus*	9
7	*Leucophaeus modestus*	1
8	*Leucophaeus pipixcan*	7
9	*Numenius phaeopus*	1
10	*Nycticorax nycticorax*	1
11	*Pelecanus thagus*	3
12	*Phalacrocorax bougainvillii*	23
13	*Phalacrocorax brasilianus*	5
14	*Phalacrocorax gaimardi*	1
15	*Spheniscus humboldti*	1
16	*Sula nebouxii*	2
17	*Sula variegata*	73
	Total	**147**

Field operations

The field work included a daily monitoring plan for the rescue of fauna in the affected areas and to collect carcasses for necropsy and laboratory analysis, all activities were always

carried out in coordination with the competent authorities and daily reports were delivered throughout the response.

From January 2022 to January 2023, the development of the field operations plan was carried out in two areas: a land area that includes four districts (Zones) including Ventanilla; Santa Rosa; Ancon; and Chancay (70-75 km of route), within which a coastal zone of the National Reserve Ancon Reserved Zone (ZRA) is included; the marine area included the Group of Islands and Islets, belonging to the Islands of Grupo de Pescadores (RNSIIPG). The administration of both reserves is under the National Service of Natural Protected Areas (SERNANP); each of these reserves with its own leadership.

Documentation during rehabilitation

Documentation and data management is essential for efficient and transparent communication; only then is it possible to effectively manage a response. In relation to the flow of processes and documentation from admission to release of the recovered individuals, constant communication was maintained with PATPAL directives, who had custody of the animals, and the Peruvian authorities (SERFOR and SERNANP). Similarly, in the case of mortalities, the necropsies were carried out by PATPAL veterinarians, who were responsible of the animals' custody.

Final considerations

There were many challenges during the Ventanilla oil spill response. The first important aspect was the biological context, as the number of birds from many species occurring in the affected area was extremely high due to the large colonies, with some endangered species being an additional risk factor in the situation.

The primary lessons learned in Peru include:

1. There is a need for the development of clear mechanisms within the national wildlife management legislation and policies to include oiled wildlife response in the existing industry contingency plans (considering dedicated staff, equipment, training, and exercises).

From the beginning of the response, it was clear that there was a substantial lack of national experience by the authorities with oil spills of this size and complexity. The inexistence of guidelines for the capture, documentation, and rehabilitation of wildlife impacted by oiling caused unnecessary delays, which prevented a fully integrated and successful response. The authorities were challenged to work together and to create systems that were mutually agreeable.

It is also critical to have specialized and protective laws regarding potential pollution activities, in order for the government authorities to be prepared to routinely inspect and act during a real event. Although there is an obligation for the industry to have a Wildlife Protection Plan, as stated in the Supreme Decree Nº 5/2021, it is also the industry's responsibility to anticipate and prepare for potential impact on wildlife. Concerted efforts must be made to unify the regulatory framework to allow for an efficient and integrated response. During an emergency response, professional wildlife responders must be allowed to safely and immediately access all spill impacted areas, both protected and non-protected. Equally as important is the authority for those professional responders to be allowed to immediately collect impacted wildlife as quickly as possible after oiling to maximize survival.

2. Guidelines for documentation, response, and release of treated wildlife, including specific needs for infectious disease screening.

Authorities were not willing to work together to create systems that were agreeable to one-another, and this was further complicated by the fact that there were no clear guidelines for the capture, documentation, and rehabilitation of oiled wildlife. After the implementation of a

professional response and training of governmental technicians, the Peruvian authorities published the "Guide for the Management of Wildlife in the Event of Hydrocarbon Spills in the Marine Environment" (In Spanish - *Guía para el manejo de fauna silvestre ante eventos de derrame de hidrocarburos en el ambito marino costero*" SERFOR, 2022) with basic guidelines for a wildlife response after an oil spill in Peru.

3. Development of the local professional capacity.

At the beginning of the response, there were almost no professionals trained to respond to wildlife affected by oil spills, which made it necessary to train the work force during the event. Having trained, local capacity is key to the success of a wildlife response of this type and magnitude.

4. Lack of a dedicated rescue center for marine wildlife care.

The use of temporary facilities was successful and improved the rehabilitation process, resulting in more efficiency and animal welfare. This temporary facility strategy can be adapted and used in different situations and locations, resulting in an efficient response. However, it is not the only efficient strategy and a permanent rescue center for marine wildlife rehabilitation would improve both preparedness and training, while also enabling the care for animals impacted by other conservation threats like fisheries interactions and other human related activities.

Moreover, although most of the necessary resources were available for responding, some specific equipment was not found in Peru and necessary to import from Brazil. Implementing Wildlife Protection Plans for better preparedness and continuous improvement will allow the government and industry to be more effective when needed.

Preparedness is key to a successful response, with planning and exercises to continuously improve actions for wildlife in environmental emergencies. It is extremely necessary to consider

an integrated approach between wildlife response with the industry's existing contingency plans for a full and effective spill response. It is up to the authorities, private companies, academia, and civil society in Peru to be prepared for future events and to better protect wildlife.

REFERENCES

Asif, Z., Chen, Z., An, C., Dong, J. 2022. Environmental Impacts and Challenges Associated with Oil Spills on Shorelines. J. Mar. Sci. Eng. 10, 762. https://doi.org/10.3390/jmse10060762

Banks, A. N., Sanderson, W. G., Hughes, B., Cranswick, P. A., Smith, L. E., Whitehead, S., A.J. Musgrove, A.J., Haycock, B., Fairney, N. P. 2008. *The Sea Empress oil spill (Wales, UK): Effects on Common Scoter Melanitta nigra in Carmarthen Bay and status ten years later. Marine Pollution Bulletin, 56(5), 895–902.* doi.10.1016/j.marpolbul.2008.01.0

Chilvers, B.L., Morgan, K.J., White, B.J. 2021. Sources and reporting of oil spills and impacts on wildlife 1970–2018. Environ. Sci. Pollut. Res. 28, 754–762. https://doi.org/10.1007/s11356-020-10538-0

Garshelis, D.L., Johnson, C.B. 2013. Prolonged recovery of sea otters from the Exxon Valdez oil spill? A re-examination of the evidence. Mar. Pollut. Bull. 71, 7–19. https://doi.org/10.1016/j.marpolbul.2013.03.027

Giner, S. 2021. El impacto de los derrames petroleros sobre las aves playeras y sus sitios de parada en Venezuela. Boletín de la Academia de Ciencias Físicas, Matemáticas y Naturales Vol. LXXXI, n.° 1, pp. 40-44.

Goldsworthy S. D., Giese M., Gales R. P., Brothers N. Hamill J. 2000. Effects of the Iron Baron oil spill on little penguins (*Eudyptula minor*). II. Post-release survival of rehabilitated oiled birds. *Wildlife Research* **27**, 573-582. https://doi.org/10.1071/WR99076

Haney, J., Geiger, H., Short, J. 2014. Bird mortality from the Deepwater Horizon oil spill. II. Carcass sampling and exposure probability in the coastal Gulf of Mexico. Mar. Ecol. Prog. Ser. 513, 239–252. https://doi.org/10.3354/meps10839

Helm, R.C., Costa, D.P., DeBruyn, T.D., O'Shea, T.J., Wells, R.S., Williams, T.M. 2015. Overview of Effects of Oil Spills on Marine Mammals, in: Handbook of Oil Spill Science and Technology. John Wiley & Sons, Inc, Hoboken, NJ, pp. 455–475. https://doi.org/10.1002/9781118989982.ch18

IPIECA. 2014. Wildlife response preparedness good practice guidelines for incident management and emergency response personnel. https://www.ipieca.org/resources/awareness - briefing/Wildlife-response-preparedness-good-practice-guidelines-for-incident-management-and-emergency-response-personnel/. (Last accessed March 2023)

IPIECA. 2017. Key principles for the protection and care of animals in an oiled wildlife response. https://www.ipieca.org/resources/ awareness-briefing/ key-principles-for-the-protection-care-and-rehabilitation-of-oiled-wildlife/. (Last accessed March 2023)

King, M.D., Elliott, J.E., Williams, T.D. 2021. Effects of petroleum exposure on birds: A review. Sci. Total Environ. https://doi.org/10.1016/j.scitotenv.2020.142834

Munilla, I., Arcos, J.M., Oro, D., Álvarez, D., Leyenda, P.M., Velando, A. 2011. Mass mortality of seabirds in the aftermath of the Prestige oil spill. Ecosphere 2. https://doi.org/10.1890/ES11-00020.1

Ridoux, V., Lafontaine, L., Bustamante, P., Caurant, F., Dabin, W., Delcroix, C., Hassani, S., Meynier, L., Da Silva, V.P., Simonin, S., Robert, M., Spitz, J., Van Canneyt, O. 2004. The impact of the "Erika" oil spill on pelagic and coastal marine mammals: Combining demographic, ecological, trace metals and biomarker evidences. Aquat. Living Resour. 17, 379–387. https://doi.org/10.1051/alr:2004031

Salazar, S. 2003. Impacts of the Jessica oil spill on sea lion (*Zalophus wollebaeki*) populations. Mar. Pollut. Bull. 47, 313–318. https://doi.org/10.1016/S0025-326X(03)00160-7

SERFOR. 2022. Guía para el manejo de fauna silvestre ante eventos de derrame de hidrocarburos en el ámbito marino costero. 51pp. https://cdn.www.gob.pe/uploads/document/file/3823600/GUÍA_PARA_MANEJO_DE_FAUNA_RDE_N__D000258-2022-MIDAGRI-SERFOR-DE.pdf.pdf?v=1668012359 (Last accessed March 2024)

SERNANP. 2022-2023. Compendio de Reportes Técnicos https://www.gob.pe/institucion/sernanp/colecciones/3099-reportes-tecnicos (Last accessed March 2024)

Takeshita, R., S. J. Bursian, K. M. Colegrove, T. K. Collier, K. Deak, K. M. Dean, S. De Guise, L. M. DiPinto, C. J. Elferink, A. J. Esbaugh, et al. 2021. A review of the toxicology of oil in vertebrates: what we have learned following the *Deepwater Horizon* oil spill. Journal of Toxicology and Environmental Health Part B 24:355–394. https://doi.org/10.1080/10937404.2021.1975182

Tan, K., Choi, CY., Peng, H. *et al.* 2018. Migration departure strategies of shorebirds at a final pre-breeding stopover site. *Avian Res* **9**, 15. https://doi.org/10.1186/s40657-018-0108-7

Troisi, G., Barton, S., Bexton, S. 2016. Impacts of oil spills on seabirds: Unsustainable impacts of non-renewable energy. Int. J. Hydrogen Energy 41, 16549–16555. https://doi.org/10.1016/j.ijhydene.2016.04.011

Waugh, J.K., Jones, T., Parrish, J.K. 2022. Using beached bird data to assess seabird oiling susceptibility, Marine Pollution Bulletin, Volume 176. ISSN 0025-326X. https://doi.org/10.1016/j.marpolbul.2022.113437.

Wiens, J.A., Crist, T.O., Day, R.H., Murphy, S.M., Hayward, G.D. 1996. Effects of the Exxon Valdez Oil Spill on Marine Bird Communities in Prince William Sound, Alaska. Ecol. Appl. 6, 828–841. https://doi.org/10.2307/2269488