Journal of Marine Animals and Their Ecology
Vol 3, No 1, 2010
Printed in Canada

Revisiting the correlation between estimated seabird mortality and oil spill size

Luke Tan[1], Michael Belanger[1] and Carin Wittnich[1]
[1]Oceanographic Environmental Research Society
Barrie, Ontario, Canada

Abstract

Scientific publications from 1993 and 2002 found no correlation between the size of an oil spill and the number of estimated seabird mortalities. If this could be updated to confirm a correlation, it could make a profound effect on the outcome of animal fatalities through faster deployment response times. Organizations that respond to disasters (natural or man-made) must organize and deploy massive resources, including supplies and personnel. The movement of these resources to a disaster site depends upon the location, type, and size of the disaster. Additional factors that affect how quickly and effectively resources are deployed include government allowance for response, time available for preparation, amount of funds available, and weather conditions. Establishing a correlation between estimated bird mortalities to oil spill size based on previous data, would provide organizations with vital information, allowing a quicker and more efficient response. Estimated bird mortalities from oil spills from 1937 to 1991 (n= 21) was compared with updated data from1955-2001 (n= 18). No correlation was found when looking at estimated bird mortalities versus oil spills between 10-225,000 tonnes (R^2= 0.016). However, when considering oil spills under 50,000 tonnes, there was a strong correlation between oil spill size and estimated bird mortality (R^2= 0.87).

Most oil spills worldwide are less than seven tonnes, therefore, increasing the relevance of our findings. Responding to any disaster requires reliable data, which is crucial to the quick arrival of adequate support to start the care of affected animals.
[JMATE. 2010;3(1):20-26]

Keywords: Disaster, Response, Seabirds, Mortality, Oil Spill

Introduction

Since 1980 there has been over 2.5 million tonnes of oil spilled from tankers worldwide usually from routine operations such as discharging, bunkering, and loading oil.[13] Generally, these types of oil spills involve smaller quantities (less than 7 tonnes), but occur more frequently. The other major tanker-related oil spills are a result of accidental causes, including collisions or groundings. These spills are typically larger in size, with spills exceeding 700 tonnes occurring at least 84% of the time.[13] Regardless of the size or cause for an oil spill, the result will undoubtedly have short term and long term impacts on the environment and the animals living within it.

The most obvious short term effect is the physiological damage and/or death of many local wildlife, especially the wide variety of seabirds. The extent of these short term effects are based upon many factors including: amount and type of oil (light or heavy), the wildlife species involved (birds, marine or terrestrial mammals), environmental conditions (temperature, wind, currents, etc), the timing of breeding cycles, and how quickly a response can be organized and arrive on the scene. For example, spills near the coastline will have a larger impact on the more densely populated and diversified populations of marine species than in the open ocean.[3] Seabirds are arguably the most vulnerable to oil spills as they are usually found in dense population numbers and may die from drowning, starvation, hypothermia (due to oil-coated feathers), and poisoning. Long term, their reproductive capabilities may be affected by sub-lethal doses of oil ingested from contaminated food. Despite the fact that seabirds are directly affected by oil spills, the data regarding the short term versus long term affects on estimated mortality of various seabird species varies depending on the literature source.[8]

The amount of time required for the environment to recover following an oil spill remains controversial. However, it is generally accepted that removing the oil as quickly as possible leads to swifter environmental recovery and possibly save endangered species.[8] As well, although it is generally accepted that there is no correlation between oil spill size and estimated wildlife mortality, more accurate calculations of the amount of spilled oil, better responses to oil spills and more accurate measurements of mortalities may now lead to that belief being untrue. Therefore, data

Received February 15, 2010; Accepted May 6, 2010
Correspondence: Michael Belanger
12 Burton Ave, Barrie, Ontario Canada L4N 2R2
Email: Michael.belanger@utoronto.ca

showing a correlation between oil spill size and estimated seabird mortality would allow for quicker, more efficient, and more effective responses thereby mitigating the environmental damage and potentially saving a lot more animals.

Methods

The latest scientific literature and reports from the various government or private agencies who were involved in oil spill response were examined for data with respect to dates of an oil spill (n=18), number of tonnes spilled per event, numbers of estimated animal mortality. This data was entered and tabulated in *Microsoft Excel 2007 Professional Edition*, and correlated via a best fitting linear regression line of ordinary least squares (OLS) that was used to correlate the data between estimated seabird mortality and oil spill size (tonnes). All data is expressed as a correlation coefficient (R^2) value.

The authors used the data from a 1993 paper by Burger[6] that has been accepted as proof that there is no correlation between oil spill size and estimated mortality of seabirds and performed the same calculations as described above to compare more updated data from oil spills dating from 1955 to 2007. All efforts were made to make the data equal in all aspects such as the removal of unknown number of tonnes spilled or estimations of bird mortalities.

Results

The data from Table 1 showed the following:

Burger`s Data

The Burger data alone, from 1937 to 1991, revealed no correlation ($R^2 < 0.001$) much like reported in 1993. However, when the data was broken down to look at oil spills under 50,000 tonnes there was a correlation ($R^2 = 0.40$) between oil spill size and estimated seabird mortalities (Figures 1a, 1b). However, when the data was broken down to look at oil spills under 50,000 tonnes there was a correlation ($R^2 = 0.40$) between oil spill size and estimated seabird mortalities (Figures 1a, 1b).

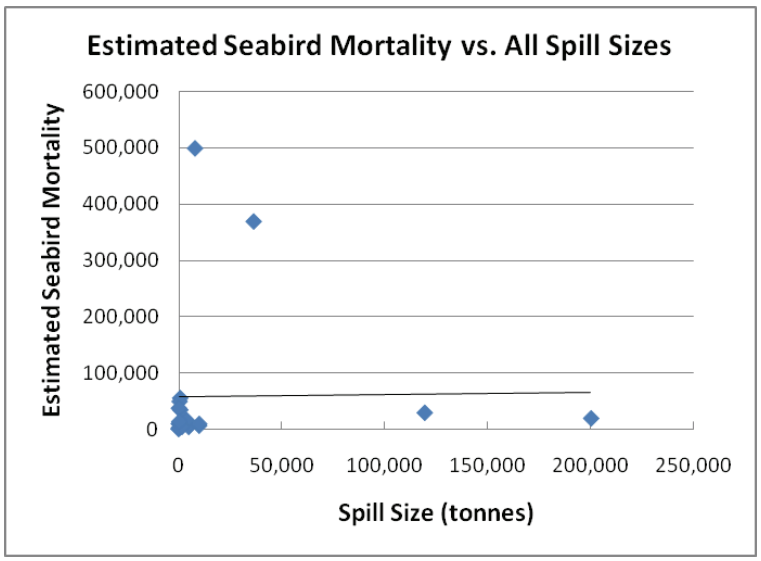

Figure 1a. Burger's data of estimated seabird mortality vs. oil spill size (n = 21). The solid line shown is the best fitting (ordinary least squares) OLS. The linear regression line equation is $y = 0.0452x + 57100$, with an $R^2 < 0.001$. This demonstrates no correlation

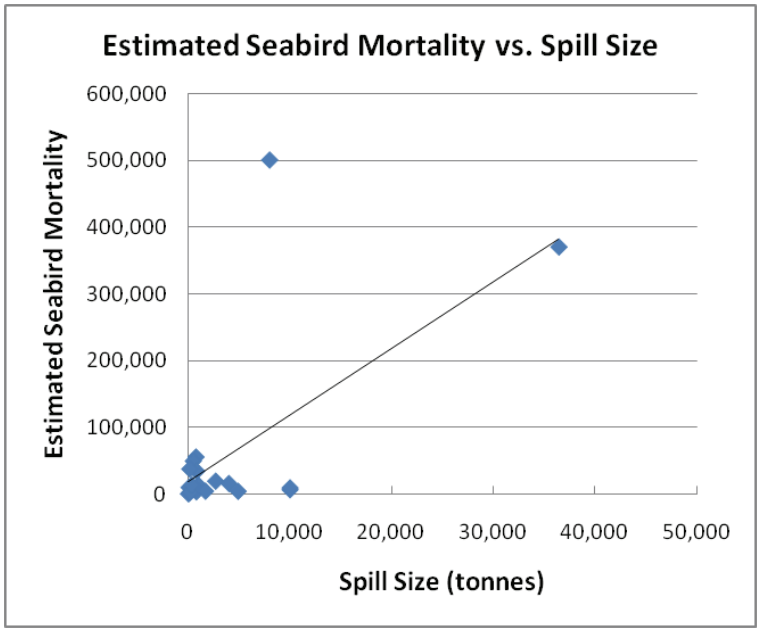

Figure 1b. Burger's data of estimated seabird mortality vs. oil spill size 0-50,000 tonnes (n = 19). The solid line shown is the best fitting OLS. The linear regression line equation is $y = 10.017x + 17637$, with an $R^2 = 0.40$. This demonstrates a positive correlation.

Source (Year)	Name of Tanker	Year of Spill	Spill Size (Tonnes)	Estimated Seabird Mortality
British Marine Life Study Society (2008)[5]	Torrey Canyon	1967	117,000	75,000
O'Sullivan, A.J. & Jacques, T.G. (2001)[11]	Hamilton Trader	1969	700	6,000
British Marine Life Study Society (2008)[5]	San Francisco	1971	2,775	13,500
Carter, H.R. (2003)[7]	Arizona + Oregon Standard	1971	10,000	20,000
British Marine Life Study Society (2008)[5]	Amoco Cadiz	1978	223,000	300,000
Oil Spill Intelligence Report (1999)[12]	Puerto Rican	1984	4,282	4,815
Oil Spill Intelligence Report (1999)[12]	ARCO Achorage	1985	819	4,000
Oil Spill Intelligence Report (1999)[12]	Apex Houston	1986	90	9,856
Post Gazette (1998)[14]	Monogahela River	1988	2,200	2,000
Oil Spill Intelligence Report (1999)[12]	Nestucca	1988	790	65,000
Oil Spill Intelligence Report (1999)[12]	Exxon Valdez	1989	37,000	350,000
Oil Spill Intelligence Report (1999)[12]	American Trader	1990	1,427	3,400
British Marine Life Study Society (2008)[5]	Braer	1993	85,000	6,500
Ypte.org (2008)[16]	Sea Empress	1996	72,000	32,000
Mustoe, S. (2004)[10]	Erika	1999	20,000	120,000
Science Communication (2007)[2]	Prestige	2002	63,000	250,000
Kees, C.J. et al. (Jul 2005)[15]	TriColor	2003	170	40,000
Telegraph.co.uk (Nov 2007)[1]	Black Sea Oil Spill	2007	4,800	30,000

Table 1 – Oil Spill Size and Estimated Seabird Mortality

Updated Data

The updated data, ranging from 1955 to 2007, when all combined together revealed the same as Burger, that there was no correlation (R^2= 0.016) (Figure 2a). However, when the updated data was examined for oil spills under 50,000 tonnes, there was a strong correlation (R^2 = 0.87) to estimated seabird mortality (Figure 2b).

Combining Burger`s Data with Updated Data

When both the Burger and the updated data were combined, the oil spill size had no correlation (R^2= 0.04) but once again, under 50,000 tonnes, the combined oil spill size showed a strong correlation to estimated bird mortalities (R^2= 0.76) (Figures 3a, 3b).

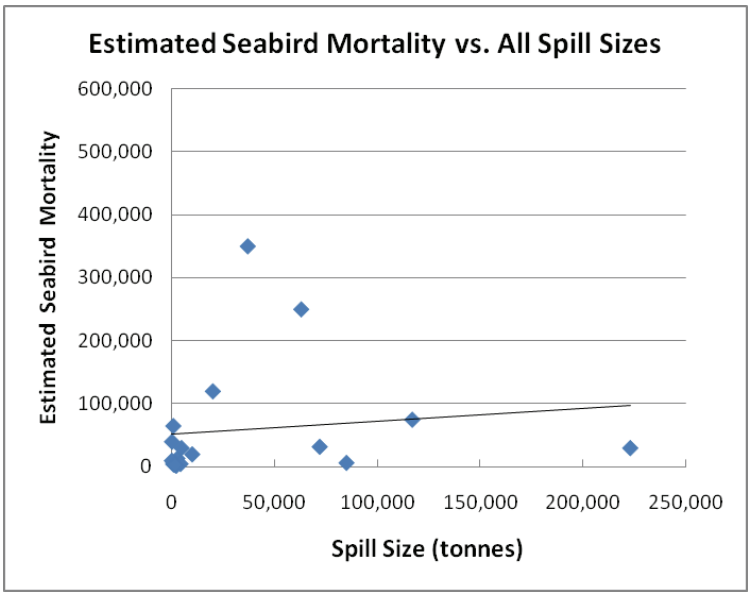

Figure 2a. Updated estimated seabird mortality vs. all oil spill sizes (n = 18). The solid line shown is the best fitting (ordinary least squares) OLS. The linear regression line equation is y = 0.202x + 51765, with an R^2 = 0.016. This demonstrates no correlation.

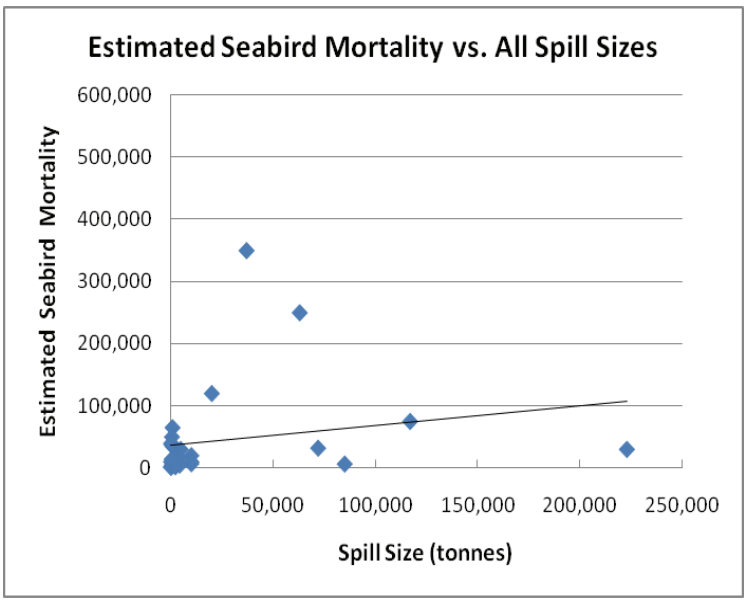

Figure 3a. Estimated seabird mortality vs. all oil spill sizes (n = 29). The solid line shown is the best fitting (ordinary least squares) OLS. The linear regression line equation is y = 0.3119x + 36613, with an R^2 = 0.04. This demonstrates no correlation.

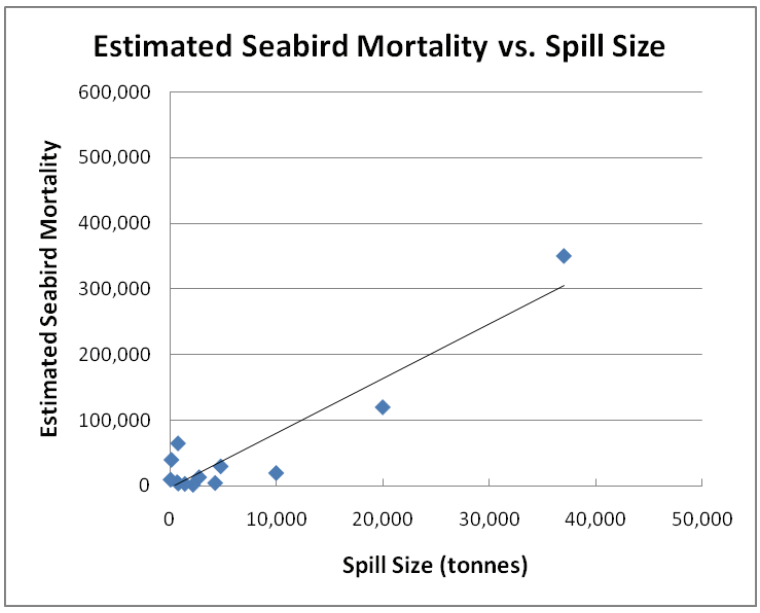

Figure 2b. Updated estimated seabird mortality vs. oil spill size between 0-50,000 tonnes (n = 13). The solid line shown is the best fitting (ordinary least squares) OLS. The linear regression line equation is y = 8.3585x - 3257, with an R^2 = 0.87. This demonstrates a very strong positive correlation.

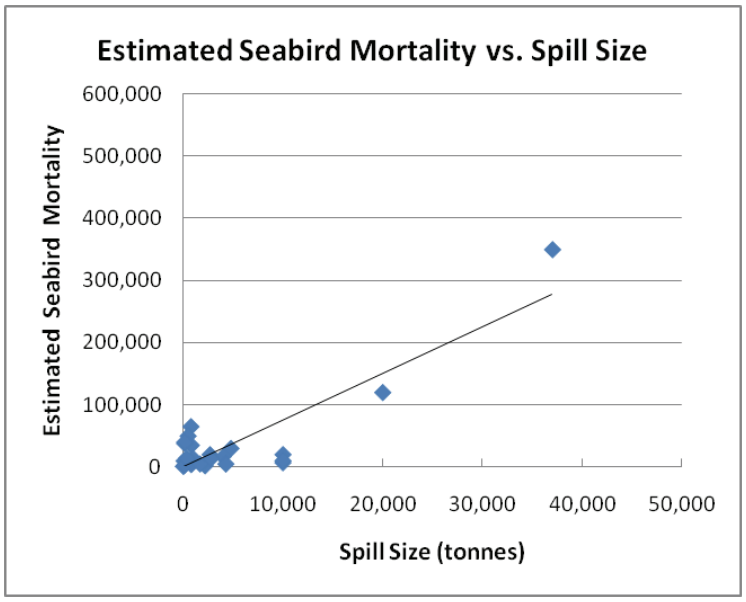

Figure 3b. Estimated seabird mortality vs. oil spill size 0-50,000 tonnes (n = 24). The solid line shown is the best fitting (ordinary least squares) OLS. The linear regression line equation is y = 7.4855x + 733.59, with an R^2 = 0.76. This demonstrates a strong positive

Discussion

The accuracy of data from oil spills and estimated seabird mortality depends on many variables such as the weather conditions at and after the spill, the time of year, currents, geographical location, type of oil spilled, density of birds in the area, etc.[6] Another confounding variable is the exact number of dead birds that were a result of the spill may not be known as huge numbers of bird carcasses cannot be recovered, again for various reasons. This was confirmed in 2008 by Banks et al, who showed that actual numbers of deaths by an oil spill may be as high as 3 times the estimated or actual bird carcass count.[4]

In 2002, Kingston published a review paper that said that there was "little relation between the size of an oil spill and the number of seabird mortalities".[8] The author used two examples to prove his claim- the Exxon Valdez oil spill (35,000 tonnes) with over 35,000 seabird carcasses versus the Braer oil spill (85,000 tonnes) with only 1,536 dead birds counted. In reality the number of birds killed in the Exxon Valdez has been revised to be as high as 250,000 birds which substantiates what Banks et al reported in 2008.[9] In 1993, Burger used data going as far back as 1937 to show that there was no or only a weak correlation between oil spill size and estimated bird mortality which might have had data that seriously under estimates the number of bird mortalities as shown by Banks.

Using updated and possibly more accurate data, this paper confirms that there is a correlation between oil spill size and the estimated number of bird mortalities especially when responding to oil spills that are less than 50,000 tonnes. In essence, by establishing this correlation between oil spill size and estimated number of bird mortalities, provides the framework to better organize the number of personnel required and more efficiently deploy the materials needed to save other wildlife that may be involved. Some of these wildlife species might possibly be on the endangered or threatened list and an oil spill could seriously cause the extinction of these species or hamper efforts to restore these species to a less critical level.

The 'science' behind oil spills, response efforts, and success of animal rehabilitation is based mostly on estimations due to a wide number of unknowns. Often times, the final mortality count may not exactly reflect the initial estimation. Therefore, moving forward it may be worthwhile exploring the correlation between estimated and actual seabird mortality. As is, no concrete correlation exists between the two. However, if we take a more in-depth analysis including all variables such as amount/type of oil (light or heavy), species involved (birds, marine or terrestrial animals), environmental conditions (temperature, wind, currents, etc), and the timing of breeding cycles, it may be possible to discover a link. In addition, it is vital to establish a standardized estimation technique, which will have a strong correlation to actual mortality. Once a correlation is established, the hope is that response teams will be able to make quicker and more accurate seabird mortality estimations, thereby being able to plan a swift and appropriate response. Ultimately, the goal is to minimize the environmental effects that are caused by oil spills. Therefore any knowledge that can assist responders and animal rehabilitation groups to care for and treat the various species of animals caught within an oil spill in a timelier manner, will decrease the number of mortalities and increase the likelihood of successful releases.

References

1. Agencies (2007). *30,000 birds dead after Black Sea oil spill*. Retrieved on September 9, 2008, from http:// www.telegraph.co.uk/earth/ earth news/3314269/30000-birds- dead-after-Black-Sea -oil-spill.html
2. Anderson A, Slick PR. The Media Politics of the Prestige Oil Spill. *Science Communication* 29: 96-115. 2007.
3. Baird S. Environmental Costs of Energy Use. *Oil Spills.* Retrieved on November 3, 2008, from http://www.spec.bc.ca/textfiles/Oil%20Spills.pdf, edited by Hayhoe D.
4. Banks AN, Sanderson WG, Hughes B, Cranswick PA, Smith LE, Whitehead S, Musgrove AJ, Haycock B, Fairney NP. The Sea Empress oil spill (Wales, UK): Effect on common scoter *Melanitta nigra* in Carmarthen Bay and status ten years later. *Marine Pollution Bulletin* 56:895-902. 2008.
5. British Marine Life Study Society (2008). *Oil Tanker Disasters: Oiled Bird Count.* Retrieved on November 1, 2008, from

http://www.glaucus.org.uk/oilbirds.htm
6. Burger AE. Estimating the mortality of seabirds following oil spills: effects of spill volume. *Marine Pollution Bulletin* 26(3):140-143. 1993.
7. Carter HR. Oil and California's Seabirds: An Overview. *Marine Ornithology* 31:1-7. 2003.
8. Kingston PF. Long term environmental impact of oil spills. *Spill Science & Technology Bulletin* 7(1-2):53-61. 2002.
9. Mazet JAK, Newman SH, Gilardi KVK, Tseng FS, Holcomb JB, Jessup DA, Ziccardi MH. Advances in oiled bird emergency medicine and management. *Journal of Avian Medicine and Surgery* 16(2):146-149. 2002.
10. Mustoe S (2004). *The Erika Oil Spill*. Retrieved on September 7, 2008, from www.orcaweb.org.uk/downloads/Erikaoilspill.doc
11. O'Sullivan AJ, Jacques TG. Effects of Oil in the Marine Environment: Impact of Hydrocarbons on Fauna and Flora. *Impact Reference System* 1-79. 2001.
12. Oil Spill Intelligence, Report (1999). *Largest tanker spills, International oil spill statistics.* Retrieved on October 11, 2008, from http://www.coltoncompany.com/shipping/statistics/spillstanker.htm
13. Oil Tanker Spill Statistics (2006). ITOPF: International Tanker Owners Pollution Federation Ltd. Retrieved from http://www.itopf.com/information-services/data-and-statistics/statistics/
14. Post-Gazette News. (1998). *Fish return after '88 oil spill, study says.* Retrieved on October 3, 2008, from http://www.post-gazette.com/regionstate/19981009rivers5.asp
15. The Institute of Petroleum. (1994). *Oil – A Natural Resource.* Retrieved on September 9, 2008, from http://www.energyinst.org.uk/education/natural/7.htm
16. Young Peoples Trust for the Environment. (2008). *Oil Pollution case Study – The Sea Empress.* Retrieved on October 3, 2008, from http://www.ypte.org.uk/environmental/oil-pollution-case-study-the-sea-empress/37