Aquatic Mammals 2009, *35*(4), 435-444, DOI 10.1578/AM.35.4.2009.435

Correlating Military Sonar Use with Beaked Whale Mass Strandings: What Do the Historical Data Show?

Ronald Filadelfo,[1] Jonathon Mintz,[1] Edward Michlovich,[1] Angela D'Amico,[2] Peter L. Tyack,[3] and Darlene R. Ketten[4]

[1]*Center for Naval Analyses, 4825 Mark Center Drive, Alexandria, VA 22151, USA; E-mail: filadelr@cna.org*
[2]*Space and Naval Warfare Systems Center Pacific, 53560 Hull Street, San Diego, CA 92152-5001, USA*
[3]*Woods Hole Oceanographic Institution, Biology Department, 266 Woods Hole Road, Woods Hole, MA 02543-1049, USA*
[4]*Woods Hole Oceanographic Institution, Biology Department, 266 Woods Hole Road, Woods Hole, MA 02543-1049, USA, and Harvard Medical School, Department of Otology and Laryngology, 243 Charles Street, Boston, MA 02114, USA*

Abstract

There have been several incidents in which U.S. Navy sonar operations at sea coincided in time and location with a mass stranding of marine mammals, particularly beaked whales. Although a conclusive cause-and-effect relationship has not been established, there is strong evidence and scientific concern that use of military sonar has resulted in beaked whale mass strandings. Most previous attempts to determine whether military sonar use and whale strandings are correlated have looked at mass stranding records of beaked whales and have singled out those instances in which military operations appear to coincide in time and location with a mass stranding event. In this study, historical data on beaked whale mass strandings and military exercises that were likely to include active sonar use were compiled, and statistical analyses were performed to determine the level of correlation between these events for four geographic regions. Strandings were significantly correlated with naval activity in the Mediterranean and Caribbean Seas, but not off the coasts of Japan and southern California.

Key Words: beaked whales, Ziphiidae, *Ziphius*, *Mesoplodon*, *Stenella*, *Balaenoptera*, mass strandings, military sonar, bootstrap reiterative estimation, correlation analysis

Introduction

Concern about the effects of anthropogenic noise on marine life has grown over the last decade. Early concerns about ocean noise focused on an increase in the low-frequency noise from increased shipping traffic (Payne & Webb, 1971) as well as increased speed and size of large commercial vessels impacting large whales (National Research Council [NRC], 2003). In the 1990s, the debate about ocean noise changed markedly to focus on military sonars, beginning with a mass stranding event in the Mediterranean Sea (Frantzis, 1998, 2004; D'Amico & Verboom, 1998). The NATO Undersea Research Centre (NURC), formerly known as SACLANT Undersea Research Centre, is a NATO oceanographic research center in La Spezia, Italy. NURC conducted a Shallow Water Acoustic Classification (SWAC) research trial in the Kiparissiakos Bay in western Greece in May 1996, using the Towed Vertically Directive Source (TVDS). The TVDS sound source had two individual source arrays tuned to low and mid frequencies (centered at 600 Hz and 3 kHz, maximum source levels of 228 and 226 dB re 1μPa at 1 m, respectively). Soon after one set of these trials began, a mass stranding of Cuvier's beaked whales (*Ziphius cavirostris*) occurred in the vicinity of the sonar test. Beaked whale mass strandings are relatively rare events. Simmonds & Lopez-Jurado (1991) noted a concern for a possible link between naval operations and whale mass strandings, but Frantzis (1998) was the first published paper citing specific military sonar use in relation to a beaked whale stranding, bringing concern about the possible impacts of military sonars into sharp focus for both the public and marine mammal research community.

The first major stranding event known to be associated with a U.S. Navy sonar exercise occurred in March 2000. The U.S. Navy conducted active sonar training in conjunction with a battle group exercise in a channel near the Abacos Islands, an island group of the Bahamas. The event involved several warships employing active sonar for protracted periods. Within hours of the ships' passages, 14 beaked whales (nine *Z. cavirostris*, three *Mesoplodon densirostris*, and two in which species could not be identified) were found stranded along the shores of Abaco and Grand Bahama to the north, and three single animal strandings of other species were reported nearby. Beaked whales were notable because they were not known to have mass-stranded previously in this area. A subsequent joint investigation by the U.S. Navy and the National Oceanic and Atmospheric Administration (NOAA) concluded that the use of naval mid-frequency active sonar (MFAS) precipitated the Bahamanian beaked whale mass stranding (Evans & England, 2001). One other species stranding, a spotted dolphin (*Stenella frontalis*), was found to have been a coincidental event. Two minke whales (*Balaenoptera acutorostrata*) were reported alive, stranded in shallow water on N. Eleuthera near the time of the beaked whale mass strandings. These animals were successfully returned to deeper water and swam away; therefore, neither animal was examined and no definitive statement can be made about the cause(s) of their stranding.

Marine mammals sometimes strand in the shallow waters along shore lines in many other parts of the world. In most cases, the cause of strandings cannot be determined. Commonly identified causes include disease, parasites, harmful algal blooms, malnutrition, trauma from human or natural interactions (such as ship strike and shark attacks), fisheries and gear entanglements, and exposure to a range of pollutants (Geraci & Lounsbury, 2005).

The Marine Mammal Commission's findings from its Beaked Whale Workshop (Cox et al., 2006), as well as earlier papers (NRC, 2003; Brownell et al., 2004; International Whaling Commission [IWC], 2004; Norman et al., 2005), noted the need for a more complete retrospective analysis of suspected links between military sonar use and cetacean stranding events. The study reported here is an attempt at an objective retrospective analysis to determine whether a significant statistical correlation exists between naval sonar operations at sea and marine mammal strandings. Specifically, this study examined the correlation between mid-frequency sonar use and beaked whale mass strandings in four areas for which significant information on naval operations is available (naval operational data available to this study was skewed toward U.S. Navy activity; due to the statistical techniques employed, this does not bias results). Three are areas in which the U.S. Navy has historically conducted sonar training and in which beaked whale mass strandings have occurred. The fourth is an area in which frequent U.S. Navy operations occur, but no beaked whale mass strandings have been reported.

Materials and Methods

Past investigations of links between beaked whale mass strandings and military sonar use have often counted the number of instances in which strandings and military operations coincided (Frantzis, 1998, 2004; Evans & England, 2001; Martín Martel, 2002; Brownell et al., 2004; Freitas, 2004; Martín et al., 2004). This study examined the equally critical related questions of how many times military sonar operations took place without any observed impact on whales in the same area, and how many strandings in a given area occurred in the absence of military activity. To perform an objective analysis of this type, representative samples of naval operations and beaked whale mass strandings were compiled, and statistical analyses were performed using a resampling method (bootstrap) (Efron & Tibshirani, 1993) and a standard Poisson Distribution model.

Data from four areas were examined: the Mediterranean & Caribbean Seas and the coasts of Japan and southern California. The first three areas were chosen because they had relatively large numbers of beaked whale mass strandings, including some cases of strandings coincident with naval activity. The last site was chosen because good data were available on sonar exercises and on strandings. These are sites that have been the focus of prior scientific and public discussions about sonar-related marine mammal strandings. For the Mediterranean & Caribbean Seas and Japan, beaked whale mass stranding data sets compiled by D'Amico et al. (this issue) were used. These data sets included both operational information and beaked whale mass stranding data in the Mediterranean Sea from 1992 to 2004, in the Caribbean Sea from 1991 to 2000, and around Japan from 1978 to 1999. For southern California, stranding data were compiled from hard-copy stranding reports from NOAA's West Coast Stranding Network Office in Long Beach. This data set covered the period November 1982 to March 2007 for the entire California coast. This analysis focused on the latitudes from 34° N and lower to coincide with the U.S. Navy's southern California fleet training area. There were no beaked whale mass stranding events in this region during this time period, which was consistent with the findings of D'Amico et al.

Data employed in this paper were derived primarily from D'Amico et al. (this issue). D'Amico et al. reviewed all public, readily available sources, including U.S. Navy and NATO press releases, newspapers, and Internet news sources, as well as official publications, stranding records, and scientific reports to develop two databases for comparison: (1) naval exercises that contained one or more ships that potentially had an operating MFAS system or that involved multi-ship, multinational exercises for which specific ships were not identified but which were assumed to use MFAS for the anti-submarine warfare (ASW) component of the exercise; and (2) occurrence and location of beaked whale mass strandings worldwide to assess both incidence and prevalence as possible correlates of sonar use. That paper reported 126 beaked whale mass stranding events globally between

1950 and 2004, the period after the implementation of modern high-power MFAS. For this analysis, the listings in the D'Amico et al. data set were supplemented with additional information from records at the Navy Historical Center, Washington, DC, for the regions of interest.

Operational data for the Caribbean and southern California were primarily obtained from the U.S. Navy. Data for naval operations in the Mediterranean and off the coast of Japan included exercises led by allied navies (e.g., NATO exercises in the Mediterranean and Japanese or Korean exercises around Japan [all naval operational data were approved for release]). However, because these data were gathered from U.S. Navy records, they are skewed toward U.S. naval events and likely missed many allied exercises in which there was no U.S. involvement. Because there is no reason to assume foreign mid-frequency sonars are more or less likely to affect marine mammals than U.S. Navy sonars, the overrepresentation of U.S. operations does not introduce a bias. Only exercises in which mid-frequency sonar was likely to have been used, based on exercise descriptions and participating ships, were included. However, these exercises were not reconstructed down to the level of ship-tracks and timelines to determine exactly when and where (within the overall exercise area) sonar was used. Analyses of that type would be a useful follow-on to this study to establish definitive cause-effect relationships if the required information can be readily obtained. The goal of this paper is thus to test for significant correlations using the above data sets.

Essentially, these data comprised major (multi-ship) exercises. Correlations between beaked whale mass strandings and exercises of this type may not be applicable to all sonar use (i.e., single ship limited-use events).

Results

Mediterranean Sea

The Mediterranean Sea was divided into five regions: (1) Western, (2) Adriatic, (3) Central, (4) Aegean, and (5) Eastern (Figure 1). Figure 2 shows a timeline of periods of naval activity and times of beaked whale mass strandings in each of the five regions of the Mediterranean Sea shown in Figure 1. All of the stranding events shown in this figure involved *Z. cavirostris*, the only beaked whale that is common in the Mediterranean Sea (Notarbartolo & Demma, 1994).

Overall, five of the 14 *Z. cavirostris* mass strandings observed in the Mediterranean Sea from 1992 to 2004 coincided with the following naval operations:

- 25 February 1996 in the Gulf of Valencia, Spain
- 12 May 1996 on the west coast of Greece
- 2 and 3 October 1997 on the west coast of Greece
- 7 February 2001 on the coast of Algeria

Note that two of the mass strandings occurred within 1 d and 96.5 km of each other. These were counted as two separate events to be consistent with the definitions in D'Amico et al. (this issue). Counting this as a single event does not change the conclusions of the statistical analyses. Of the five events that coincided with naval operations, only the 7 February 2001 event is not reported in D'Amico et al. The inclusion of an additional spatial-temporal correlation between naval activities and a beaked whale mass stranding off the coast

Figure 1. Geographic boundaries of the five study regions, Mediterranean Sea

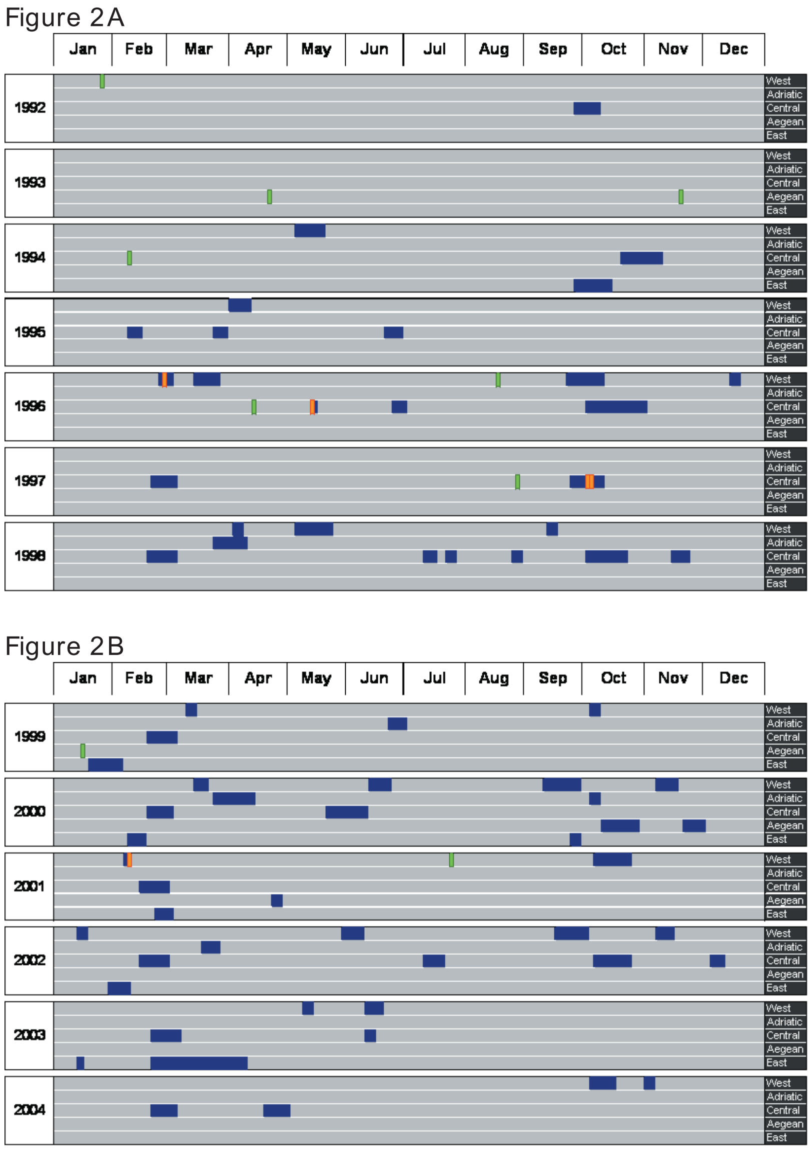

Figure 2. Timeline of naval operations and beaked whale mass strandings, Mediterranean Sea; bars indicate periods of major naval activity, and vertical tick marks indicate beaked whale mass strandings. A: 1992 to 1998; B: 1999 to 2004.

of Algeria is due to the availability of the detailed operational data used for this study.

What are the implications of five of the 14 beaked whale mass stranding events coinciding with naval operations? To address this question, a bootstrap resampling technique was used (Efron & Tibshirani,1993). The bootstrap uses the stranding data distribution to estimate the number of strandings likely to have occurred during periods of naval activity if stranding occurrences during periods of naval activity followed the same underlying distribution as the strandings during times of no naval activity. This procedure resulted in an estimate for the number of strandings expected during times of naval activity in the absence of a correlation between strandings and sonar. This process was then repeated many times to develop a distribution of such estimates. This distribution can then be compared to the number of strandings actually observed. The expected value of this distribution reflects the stranding rate during the entire time period. The bootstrap is nonparametric, assumes no analytic distribution of data, and is based only upon the empirical distribution of the strandings observed. It calculates the sampling distribution around this expected value, allowing the determination of the significance of any observation. It also allowed examination of any seasonal effects.

Figure 3 summarizes the results of 10,000 iterations of the bootstrap calculation. Only one of the results equaled the actual number of beaked whale mass strandings observed (five). Therefore, it was inferred that there was an increased incidence of beaked whale mass strandings when naval sonars were present and operating at a confidence level greater than 99.99%.

Figure 3. Bootstrap simulation results, 10,000 iterations, Mediterranean Sea

As a check on the bootstrap modeling, the difference in stranding rates between the times when naval sonars were present or not present was tested. By dividing the Mediterranean into five regions, 23,725 region-days from 1992 to 2004 were obtained (13 y × 365 d/y × 5 regions). Five strandings occurred during the 822 region-days in which active sonar use occurred. Nine strandings occurred during the 22,903 region-days in which active sonar was not occurring.

Assuming each region-day represented an independent draw from a binomial distribution, let p_n be the daily probability of stranding when navy sonar was not present and p_s be the probability when it was present. The null hypothesis (H_0) is that there is no difference between stranding rates in the presence of military active sonar compared to when no sonar is present:

H_0: $p_n = p_s$

The alternative, one-tailed hypothesis (H_A) is that the sonar-present stranding rate is higher:

H_A: $p_s > p_n$

The estimated stranding rate under the null hypothesis is p_{est} = 14/23,725 = 0.00059 strandings per region-day. If there is no difference in stranding rates, the expected number (μ) of strandings on sonar-days is 822 * p_{est} = 0.485. However, the observed number of strandings on sonar days is 5. The likelihood of this difference occurring due to chance fluctuations can be calculated using the Poisson approximation to the binomial:

$$P = 1 - \sum_{x=0}^{4} \frac{e^{-\mu} \mu^{x}}{x!}$$

With μ = 0.485, p = 0.00015, so the null hypothesis is rejected with an achieved significance level of 0.00015. (To test the robustness of our results, this statistical analysis was also performed without the division of the Mediterranean Sea into five basins. This resulted in p = 0.08.)

Japan

Figure 4 shows the study area around Japan. In this case, the area was divided into the Pacific side and the Sea of Japan side. A timeline of naval sonar activity and beaked whale mass stranding events (involving *Z. cavirostris* and *Mesoplodon* spp.) from 1978 to 1999 is shown in Figures 5A and 5B.

Because the number of coincident events is zero, there is no possibility of finding a significant correlation between naval sonar activity and beaked whale mass strandings. These results are consistent with D'Amico et al. (this issue), which reported that no events were found that were spatially-temporally coincident based on available data on naval operations. D'Amico et al. developed a ranking system to categorize the level of confidence in available data to support inferences about the role of MFAS in a given stranding event, ranging from 1 (most robust) to 5 (least robust). Twelve of these events were ranked 3 in D'Amico et al. due to their proximity to the Japan OPAREA (Operations Area) complex (U.S. Department of the Navy [U.S. DoN], 2005a), and one event was ranked 5 as the literature indicated other probable causes for the stranding.

The bootstrap simulation was performed to determine if the observation of zero coincident events is consistent with the null hypothesis for

Figure 4. Geographic boundaries of study area around Japan

this level of naval sonar activity and strandings. Figure 6 shows the result for 10,000 iterations. The observation of zero coincident events is a likely outcome under the null hypothesis.

The difference in stranding rates with and without naval sonar activity present was tested. The estimated stranding rate under the null hypothesis is $p_{est} = 18/16{,}070 = 0.0011$ strandings per region-day. Under the null hypothesis, the expected number (μ) of strandings on sonar-days is $913 * p_{est} = 1.02$. The probability (P) of observing zero given $\mu = 1.02$ is

$$P = e^{-1.02} = .36$$

so, the null hypothesis of no difference in stranding rates between periods of naval sonar activity and periods with no sonar activity cannot be rejected for this region. The sensitivity of this test to detect significant correlation was also examined; given $\mu = 1.02$, the probability of two or more coincident events is 0.27 (still insufficient to reject the null hypothesis), and the probability of three or more coincident events is 0.08. Thus, this test would reject the null hypothesis and detect significant correlation at the 0.05-level of significance given approximately three or four coincident events.

Caribbean/Bahamas

The Caribbean Sea was divided into three regions to reflect the two major areas in the Caribbean in which the U.S. Navy has conducted training: (1) Bahamas (where the U.S. Navy has an instrumented sonar range), (2) "Puerto Rico Operating Area (PROA)" (the Navy's former training area on the eastern side of Puerto Rico), and (3) "Other" as shown in Figure 7. Figure 8 shows a timeline of naval sonar activity and times of beaked whale mass strandings in each of the three regions. Strandings here include the species *Z. cavirostris*, *M. densirostris*, *M. europaeus*, and *Mesoplodon* spp.

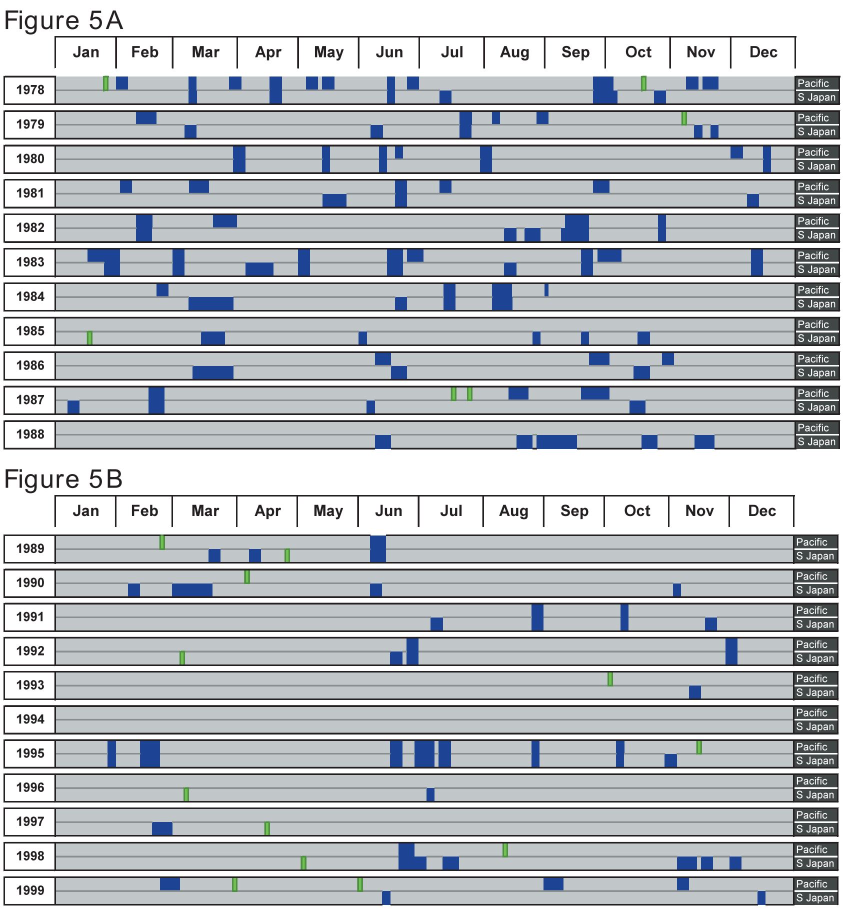

Figure 5. Timeline of naval operations and beaked whale mass strandings, Japan; bars indicate periods of major naval activity, and vertical tick marks indicate beaked whale mass strandings. A: 1978 to 1988; B: 1989 to 1999.

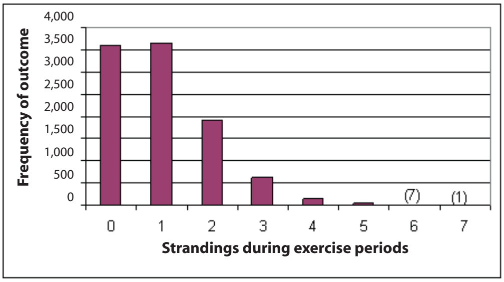

Figure 6. Bootstrap simulation results, 10,000 iterations, Japan

Overall, four of the seven beaked whale mass strandings observed in this area from 1991 to 2000 coincided with naval operations:

1. July 1998 in the PROA
2. October 1999 in the USVI (adjacent to the PROA)
3. March 2000 in the Bahamas
4. April 2000 in Jamaica

D'Amico et al. (this issue) listed the Bahamas' 2000 event as rank 1. The July 1998 and October 1999 events were ranked 3 due to their proximity to the Caribbean OPAREA complex. The fourth event, Jamaica, was listed as a rank 4 in D'Amico et al. because this site was not near a naval OPAREA. With the inclusion of the more detailed data on naval activities, these three events would be raised to rank 2.

A bootstrap simulation was performed to determine if the observation of four coincident events is consistent with the null hypothesis for this level of naval sonar activity and strandings. Figure 9 shows the results for 10,000 iterations. Four or more coincident strandings is a highly unlikely outcome under the null hypothesis ($p = 0.002$).

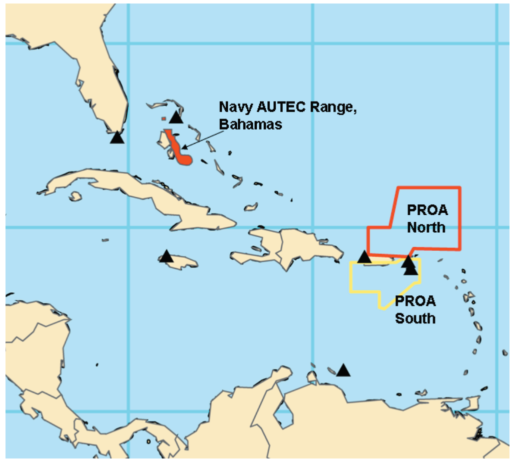

Figure 7. Caribbean study area

The difference in beaked whale mass stranding rates with and without the presence of naval sonar activity was also tested. The estimated stranding rate under the null hypothesis is $p_{est} = 7/10{,}959 = 0.0006$ strandings per region-day. Under the null hypothesis, the expected number (μ) of strandings on sonar-days is $733 * p_{est} = 0.468$. The probability (P) of observing four or more given $\mu = 0.468$ is

$$P = 1 - \sum_{x=0}^{3} \frac{e^{-\mu}\mu^{x}}{x!} = 0.001$$

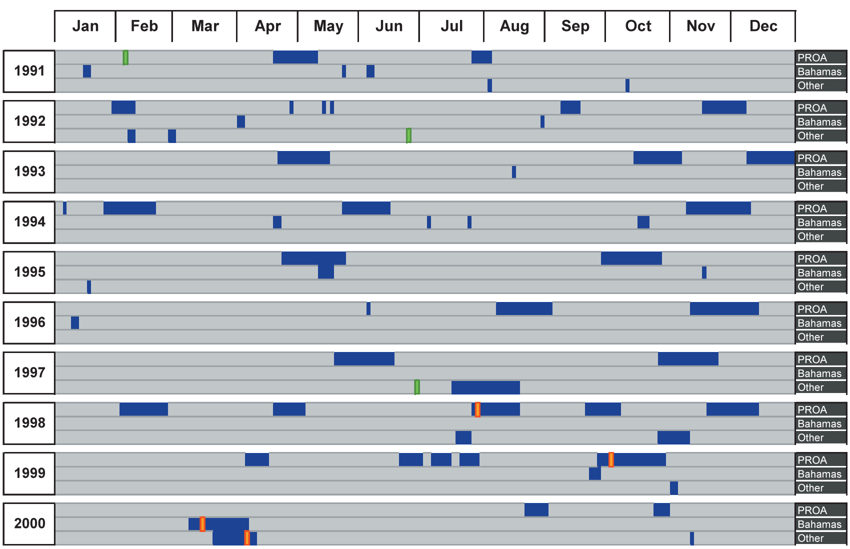

Figure 8. Timeline of naval operations and beaked whale mass strandings, Caribbean Sea; bars indicate periods of major naval activity, and vertical tick marks indicate beaked whale mass strandings.

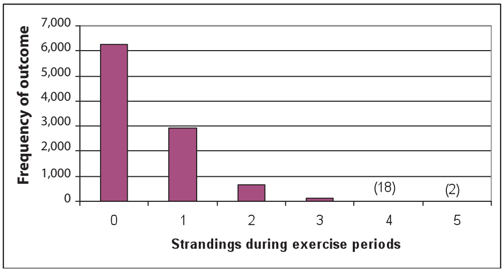

Figure 9. Bootstrap simulation results, 10,000 iterations, Caribbean Sea

so the null hypothesis was rejected and it was concluded that there is a significantly higher stranding rate during periods of naval sonar activity for this region.

Southern California

Figure 10 shows a timeline of U.S. Navy operations off the southern California coast from November 1982 to March 2007, a region of heavy U.S. Navy activity (U.S. DoN, 2005b). No beaked whale mass strandings were observed during this time period, despite U.S. Navy operations taking place roughly 18% of the time. However, beaked whales are known to be present in this area (Forney et al., 1995; Barlow & Cameron, 2003). Because the overall mass stranding rate is zero, a statistical comparison of the stranding rates with sonar present and sonar absent cannot be performed for this region. Instead, for this region, a detailed analysis of single stranding events and U.S. naval activities was performed (see Filadelfo et al., this issue).

Discussion

A crucial point regarding the data needs of a statistical analysis such as this one is that the data sets for both strandings and naval operations do not have to be complete. However, the data must be unbiased. Because our stranding and naval operation data sets were derived independently, it is unlikely that our data suffer from biases in either direction.

A historical correlation between large-scale naval activity and beaked whale mass strandings in four regions of frequent naval activity showed different results among the regions. Significant correlations were seen in two regions—(1) Mediterranean and (2) Caribbean Seas—but not in Japan and southern California. D'Amico et al. (this issue) suggested that areas of steep bathymetry close to an adjacent coastline, with military sonars used seaward, might be an important factor in the occurrence of sonar-related strandings.

Four of the five coincident events in the Mediterranean Sea—three events off the west coast of Greece and the event off the coast of Algeria—occurred in areas that showed a region of steep drop-off to deep waters close to the adjacent coastline, with probable naval operations occurring to the immediate seaward direction. In the Caribbean, these conditions existed for the events in Puerto Rico and the U.S. Virgin Islands. The conditions for the stranding event in the Bahamas have been well-documented (Evans & England, 2001), and this incident also was in an area with steep bathymetry in a somewhat confined

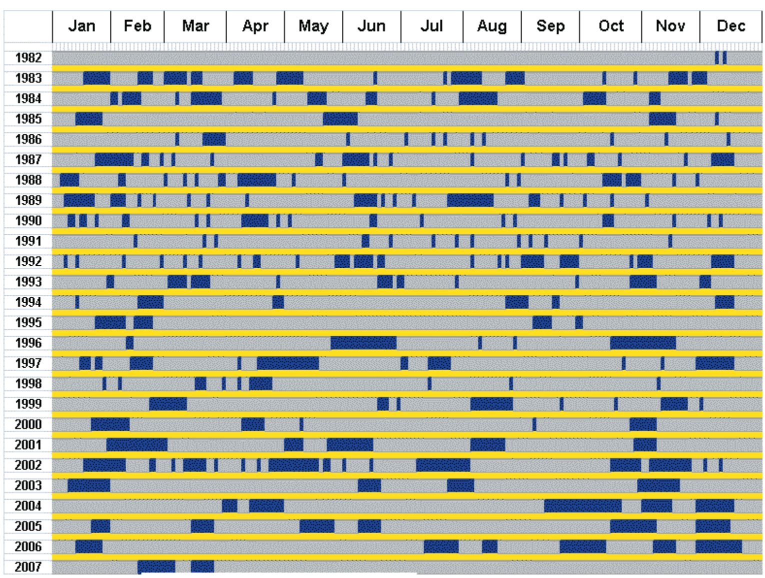

Figure 10. Timeline of naval operations, southern California

channel. Our data on locations of naval activity around Japan was extremely limited beyond general location (Pacific coast or Sea of Japan). The Pacific coast along southwestern Japan has a broader shelf with some deep trenches offshore.

Most U.S. Navy activity in southern California takes place in the waters to the west and south of San Clemente Island (approximately 33° N/118.5° W), where the U.S. Navy has an instrumented ASW training range (Global Security, 2009). A key feature of U.S. Navy sonar activity in this area is that it is not immediately adjacent to the California coast.

With the inclusion of more detailed data on naval operations, only one additional spatially-temporally coincident event (Algeria) was added to those identified in D'Amico et al. (this issue). The more detailed data on naval operations also suggest raising three events occurring in the Caribbean to rank 2.

Results presented herein suggest that naval activity is not leading to mass strandings of beaked whales in all areas but, rather, that there are locations with particular bathymetric conditions that are problematic. Results of this analysis with the very limited available historical data are consistent with thoughts that the location of naval exercises relative to local topography is an important factor which perhaps makes beaked whales more susceptible to strandings associated with military active sonars and which suggests the fullest documentation of all stranding events is warranted. Clearly, much more work remains to be done on this issue.

Acknowledgments

We thank Mr. Joe Cordero of the National Oceanic and Atmospheric Administration, Long Beach, California, for making their California stranding database available to us. We also thank Ms. Jessica Wolfanger of the Center for Naval Analyses (CNA) for processing the stranding data, Dr. David Ruskin of CNA for suggestions concerning data analysis procedures, and Dr. Robert Gisiner of the Marine Mammal Commission for many useful suggestions in the formulation of this project.

Literature Cited

Barlow, J., & Cameron, G. A. (2003). Field experiments show that acoustic pingers reduce marine mammal by catch in the California drift gill net fishery. *Marine Mammal Science*, *19*(2), 265-283.

Brownell, R., Yamada, T., Mead, J. G., & Van Helden, A. L. (2004). *Mass strandings of Cuvier's beaked whales in Japan: U.S. naval acoustic link?* (Report SC/56E37). Milano, Italy: European Cetacean Society.

Cox, T. M., Ragen, T. J., Read, A. J., Vos, E., Baird, R. W., Balcomb, K., et al. (2006). Understanding the impacts of anthropogenic sound on beaked whales. *Journal of Cetacean Resource Management, 7*(3), 177-187.

D'Amico, A., & Verboom, W. C. (Eds.). (1998, June 17-19). *SACLANTCEN human diver and marine mammal environmental policy and SACLANTCEN marine mammal and human diver risk mitigation rules* (SACLANTCEN Report M-133). Summary Record, Marine Mammal Environmental Policy and Mitigation Procedures Panel, La Spezia, Italy.

D'Amico, A., Gisiner, R. C., Ketten, D. R., Hammock, J. A., Johnson, C., Tyack, P. L., et al. (2009). Beaked whale strandings and naval exercises. *Aquatic Mammals*, *35*(4), 452-472.

Efron, B., & Tibshirani, R. (1993). *An introduction to the bootstrap.* Boca Raton, FL: CRC Press.

Evans, D. L., & England, G. (2001). *Joint interim report Bahamas marine mammal stranding event of 15-16 March 2000.* Retrieved from www.nmfs.noaa.gov/prot_res/overview/interim_bahamas_report.pdf.

Filadelfo, R., Pinelis, Y. K., Davis, S., Chase, R., Mintz, J., Wolfanger, J., et al. (2009). Correlating whale strandings with navy exercises off southern California. *Aquatic Mammals*, *35*(4), 445-451.

Forney, K. A., Barlow, J., & Carretta, J. V. (1995). The abundance of cetaceans in California waters. Part 2: Aerial surveys in winter and spring of 1991 and 1992. *Fishery Bulletin*, *93*, 15-26.

Frantzis, A. (1998, March 5). Does acoustic testing strand whales? *Nature*, *392*(29). Retrieved 20 November 2009 from www.awionline.org/ht/a/GetDocumentAction/i/10156.

Frantzis, A. (2004, February). The first mass stranding that was associated with the use of active sonar (Kyparissiakos Gulf, Greece, 1996). In P. Evans & L. Miller (Eds.), *Proceedings of the Workshop on Active Sonar and Cetaceans Held at the European Cetacean Society 17th Annual Meeting, 8 March 2003* (*European Cetacean Society Newsletter*, *42* [Special Issue], 14-20).

Freitas, L. (2004, February). The stranding of three Cuvier's beaked whales *Ziphius cavirostris* in Madeira Archipelago–May 2000. In P. Evans & L. Miller (Eds.), *Proceedings of the Workshop on Active Sonar and Cetaceans Held at the European Cetacean Society 17th Annual Meeting, 8 March 2003* (*European Cetacean Society Newsletter*, *42* [Special Issue], 28-32).

Geraci, J. R., & Lounsbury, V. J. (2005). *Marine mammals ashore: A field guide for strandings* (2nd ed.). College Station: Texas A&M University, Sea Grant College Program.

Global Security. (2009). *Southern California Offshore Range (SCORE)*. Retrieved 30 November 2009 from www.globalsecurity.org/military/facility/score.htm.

International Whaling Commission (IWC). (2004). *Scientific Committee report annex K: Report of the Standing Working Group on Environmental Concerns:*

Marine mammal hearing and evidence for hearing loss (Appendix 4, pp. 27-31). Cambridge, UK: Author.

Martín Martel, V. (2002). *Especial varamiento de cetáceos–Viceconsejería de Medio Ambiente.* Gran Canaria: Government of the Canary Islands. Retrieved 30 November 2009 from www.gobcan.es/medioambiente/varamientos.

Martín, V., Servidio, A., & García, S. (2004). Mass strandings of beaked whales in the Canary Islands. In P. Evans & L. Miller (Eds.), *Workshop on Active Sonar and Cetaceans, European Cetacean Society 17th Annual Conference.* (*European Cetacean Society Newsletter*, *42* [Special Issue]).

National Research Council [NRC], Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. (2003). *Ocean noise and marine mammals*. New York: National Academies Press. 204 pp.

Norman, S. A., Raverty, S., McLellan, B., Pabst, A., Ketten, D. R., Fleetwood, M., et al. (2005). *Multidisciplinary investigation of harbor porpoises (*Phocoena phocoena*) stranded in Washington State from 2 May-2 June 2003 coinciding with the mid-range sonar exercises of the* USS SHOUP (NOAA Technical Memorandum NMFS-NWR-34). Washington, DC: NOAA Northwest Fisheries, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Notarbartolo, G., & Demma, M. (1994). *Guida dei mammiferi marini del Mediterraneo.* Padova, Italy: Franco Muzzio Editore.

Payne, R. S., & Webb, D. (1971). Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Science*, *188*, 110-141.

Simmonds, M. P., & Lopez-Jurado, L. F. (1991). Whales and the military. *Nature, 351*, 448.

U.S. Department of the Navy (U.S. DoN). (2005a). *Marine resources assessment for the Japan and Okinawa complexes operating area.* Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. Contract #N62470-02-D-9997, CTO 0028. Prepared by Geo-Marine, Inc. Plano, TX.

U.S. DoN. (2005b). *Marine resources assessment for the southern California operating area.* Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. Contract #N62470-02-D-9997, CTO 0028. Prepared by Geo-Marine, Inc. Plano, TX.