Seismic Shift in Whale Studies [1]

Submitted by Rory Lattimer Tue, 2012-02-21 00:00

Fin whales are the world’s 2nd largest whale species (blue whales are the largest). These majestic creatures inhabit temperate to sub-arctic waters in both the northern and southern hemispheres. Within the Pacific Ocean basin, there are at least 3 geographically distinct populations.

In the North Pacific Ocean, fin whales have been observed as far north as the Chukchi Sea during the summer months while in winter, they spend their time off the coasts of Korea and Japan in the West Pacific, and off northern Baja California in the East Pacific.
The movements and distributions of fin whales in the North Pacific and other oceans remain poorly understood. Several methods have been used to determine the movements of fin whales, including visual and aerial surveys, genetic studies, and the compilation of historic whaling records. Passive acoustic monitoring, via instruments like hydrophones for example, has also been an effective way to study fin whales, whose loud, highly consistent calls are relatively easy to identify.
Other long-term, fixed ocean sensors are becoming increasingly important resources for scientists studying marine animals in their environments. These new approaches include a novel use of seismometer data by researchers at the University of Washington in Seattle. Michelle Weirathmueller and Dax Soule are students in William Wilcock’s research group at the University of Washington’s School of Oceanography, who have been studying the low-frequency calls of fin and blue whales in seismic data. They’ve been delving into seismic data from the Keck Seismic Network and NEPTUNE Canada’s regional network, both situated in the Northeast Pacific Ocean off the coast of Vancouver Island.

Recording of fin whale calls extracted from seismic data and sped up 15x.

Between 2003 and 2006, eight ocean bottom seismometers were deployed in the Keck Network near the Endeavour segment of the Juan de Fuca Ridge. The goal of the experiment was to investigate the relationship between seismic activity and hydrothermal venting. When the collected data were analyzed, it became apparent that earthquakes were not the only signals to have been recorded by the instruments: fin and blue whale calls were also recorded throughout much of the dataset. By studying these data, Michelle and Dax were able to count, locate and track vocalizing fin whales as they swam near the network.

More than 300,000 calls were detected over the three-year Keck Network deployment at
Endeavour, with most of the calls occurring during the fall and winter. This pattern of winter detection is shown in the following three histograms. The 2004-2005 data reveals a much lower call count, possibly indicating a response to variations in surface temperature and other environmental conditions, but it is difficult to confirm patterns and hypothesize causes from only three years of data.

Since the Keck Network consisted of eight instruments placed nearby each other, it was
possible to locate and track calling fin whales as they swam past the various seismometers. From the first year of data, more than 150 whale tracks were resolved, revealing distinct groupings of call patterns and swimming direction throughout the year. The following graph shows that during the late summer and fall months, the recorded whales tended to swim in a northward direction; there was more of a balance between northward and southward movements in the winter months.

In the analyses of Keck Network seismic data, detections of whale calls were limited to fin and blue whales, whose call frequencies are similar to the seismic waves produced by earthquakes and recorded by the seismometers in place on the seafloor. A subsea cabled observatory also provides significant increased data capacity allowing for the collection of hydrophone data that broaden the range of frequencies scientists can record and study. Some preliminary results from the NEPTUNE Canada hydrophone data are shown below.
As the Keck Network dataset continues to be analyzed, interesting patterns are emerging.
longer time series, however, would allow scientists to more accurately match whale call
patterns with seasonal and year-to-year changes in the environment. Ocean-bottom
seismometers are being reinstalled at Endeavour as part of the NEPTUNE Canada regional
network, which will allow for continuation of this study. Increased data from more NEPTUNE
Canada locations and other long-term observation sites will also allow researchers to
compare distributions over a larger area. These studies will help scientists like Michelle and
Dax to better understand the still-elusive movements and distributions of fin whales and other
marine mammals.

Thanks to Michelle Weirathmueller and Dax Soule for their many contributions to this story.

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