The Marine Mammal Center

Emerging Hotspots of Domoic Acid Associated Strandings in Central California

Tufts University | Cummings School of Veterinary Medicine

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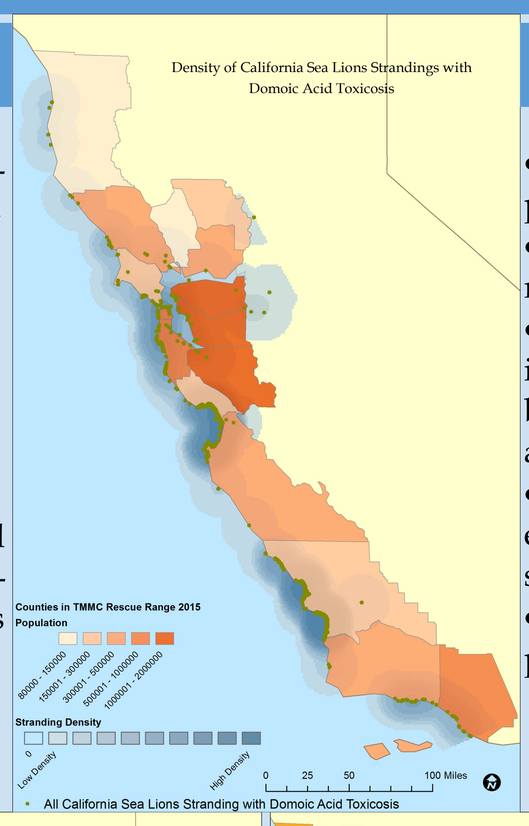
Data Sources: The Marine Mammal Center, Monterey Bay Aquarium Research Institute, US Census Bureau, Oregon State University.

Introduction

When marine mammals are sick or injured, they often end up in unusual places on land, or stranded. One of the most common causes of strandings of California sea lions is domoic acid toxicosis, a disease caused by ingestion of a naturally occurring biotoxin. This biotoxin, domoic acid, is produced by marine micro-organisms and accumulates in shellfish and fish. It is known to affect multiple species of marine mammals including the California sea lions, in addition to southern sea otters, northern fur seals and harbor seals. Domoic acid toxicosis was first described in California sea lions in 1998.There are three main categories of domoic acid toxicosis; acute, chronic and developmental. Each stage is characterized by different symptomology and pathology, and varies based on the type of exposure. Acute cases are exposed to relatively high doses of the toxin over short periods of time, chronic cases are exposed over a longer period of time, and developmental cases are exposed to high enough doses while in utero, or prior to weaning, to produce neurological affects. It is difficult to diagnosis which stage the animal suffers from ante-mortem without advanced imaging techniques. It can be equally complicated to predict where and when influxes of cases will occur.

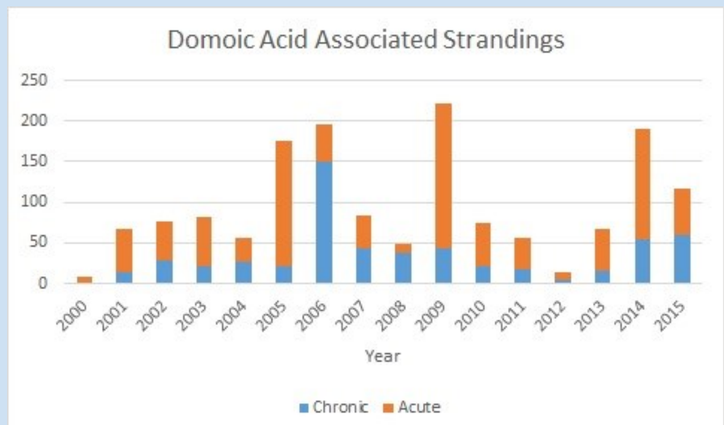
This study attempts to identify spatial and temporal hotspots of strandings associated with domoic acid toxicity along the central California coast between 2000 and 2015. All California sea lions used in the study presented to The Marine Mammal Center (TMMC) during this time period were diagnosed with a stage of domoic acid toxicosis. This study will spatially and temporally analyze, using an emerging hotspot analysis, the relationships between strandings associated with chronic domoic acid toxicosis, acute domoic acid toxicosis and volume of domoic acid present in water samples taken along the central coast of California.



Results and Conclusions

- Spatial hot spots in the San Francisco Bay Area can be easily explained by population density.
- Domoic Acid volume in the water column occurs oscillating over multiple years in the San Luis Obispo region.
- The San Luis Obispo region, where the disease was first observed in sea lions, sporadically sees a statistically significant spikes in both chronic and acute domoic acid toxicosis associated strandings in a year.
- The Monterey Bay Area appears to be an statistically significant emerging hotspot for chronic domoic acid toxicosis associated strandings in recent years.
- The Monterey bay is seeing an increase in yearly average of primary productivity.

Sea lions already suffering from chroic domoic acid toxicosis require a smaller dose of domoic acid to enter the acute phase, therefore this study suggests that as the Monterey Bay Area sees an increase in the yearly primary productivity, there will also be an increased number of domoic acid associated strandings in that region.



Methods

This study focused on acute and chronic domoic acid toxicosis as a primary cause of stranding. Each stranding location was mapped. The density of these locations was analyzed and compared to populations of the counties in which they occurred. An emerging hotspot analysis was run on the chronic strandings and acute strandings respectively. These data were compared to an emerging hotspot analysis of domoic acid volume present in the water column in the same regions. Finally, these data were also compared to a map of the increase of primary productivity in the region in 2015 compared to the average of the previous ten years.

Emerging Hotspot Key

No Trend Detected: Does not fall into any of the hot or cold spot patterns; New Hotspot: A location that is a statistically significant hot spot for the final time step and has never been a statistically significant hot spot before; Sporadic Hotspot: A location that is an on-again then off-again hot spot. Less than ninety percent of the time-step intervals have been statistically significant hot spots and none of the time-step intervals have been statistically significant cold spots; Oscillating Hot Spot: A statistically significant hot spot for the final time-step interval that has a history of also being a statistically significant cold spot during a prior time step. Less than ninety percent of the time-step intervals have been statistically significant hot spots.