Summary of Southern Sea Otter Mortality Investigations in 2012

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Summary

A total of 323 Southern sea otter carcasses were examined by California Department of Fish and Wildlife scientists during 2012. Included in this total were 33 fresh-dead animals collected (from throughout the sea otter range in California) as "random-source" cases for full postmortem examinations, providing a comparatively unbiased index of current causes of sea otter mortality. Of these random-source cases, 52% (n = 17) were confirmed or suspected shark bite cases. The primary cause of the death for the remaining 16 random-source sea otters encompassed 8 additional mortality categories, including presumed boat-strike trauma for two animals (the only direct anthropogenic cause of sea otter death observed for random-source otters examined during 2012). Microscopic examination and supplemental testing is required to diagnose some health conditions affecting sea otters. Because testing is still being completed, and because our understanding of factors contributing to sea otter mortality evolves through time as greater knowledge is gained, categories may be revised for future mortality summaries.

Introduction/Background

The California Department of Fish and Wildlife (CDFW, formerly the California Department of Fish and Game) has been investigating causes of mortality in Southern sea otters (*Enhydra lutris nereis*) since 1968, initiated in response to State Senate Concurrent Resolution 74. These investigations are conducted by the Department's Office of Spill Prevention and Response, at the Marine Wildlife Veterinary Care & Research Center (MWVCRC) in Santa Cruz, in collaboration with partners at the US Geological Survey (USGS) and the Monterey Bay Aquarium (MBA). These groups collectively respond to every report of stranded sea otters, which may be recovered dead or alive. Most stranding recoveries in California involve collection and examination of dead otters (Pattison et al. 1997, Kreuder et al. 2003). Of the few that strand alive, many die soon after stranding or are humanely euthanized due to the nature and severity of their health problems. Sea otters that strand alive with treatable health conditions undergo rehabilitation at the MBA and may be released or maintained in captivity. The extent of examination and sampling of cases has varied over the years, but since 2010, every 3rd fresh-dead otter older than 1 year has been examined by pathologists at the MWVCRC, and more abbreviated necropsies have been performed on all other cases.

Investigating causes of sea otter mortality is important in order to: 1) identify factors limiting population recovery, 2) inform best achievable care of captive sea otters, including animals recovered during oil spills, 3) track mortality trends and better characterize disease processes and emerging threats, and 4) assess, and when possible, mitigate anthropogenic sources of mortality. Although it is not a focus of the California Department of Fish and Wildlife, investigations of sea otter mortality can also help identify emerging health risks for humans living along the land-sea interface of California.

Stranding Response

During 2012, biologists from the CDFW, USGS, and MBA responded to 368 strandings of live and dead sea otters throughout California. Sea otters were recovered primarily from San Mateo County southward through Santa Barbara County (the currently established Southern sea otter range), but rare extralimital strandings from as far north as Humboldt County, and as far south as San Diego County were also included.

Of 368 wild sea otter stranding recoveries that were completed during 2012, 359 animals were found dead, died, or were euthanized. The remaining 9 stranded animals were successfully rehabilitated at the

MBA. MWVCRC staff performed postmortem examinations on 319 stranded otters. Four long-term captive sea otters that had died during 2012 were also examined at the MWVCRC, for a total of 323 cases examined by MWVCRC staff. The remaining cases received field examinations by USGS biologists. Additional information on all 2012 strandings (i.e., age, sex, and location) can be found in the California Sea Otter Stranding Network annual report, provided by USGS at: http://www.werc.usgs.gov/project.aspx?projectID=232.

Detailed Postmortem Examinations

More detailed necropsies (involving microscopic examination of some or all tissues) were performed on 66 of the cases examined by MWCRC staff in 2012. These included 24 special-request cases (such as long-term captive otters or tagged wild animals that had been observed extensively during field investigations), 33 wild, random-source animals (every 3rd fresh carcass), and 9 animals that were sampled due to special circumstances, such as an unusual/atypical presentation. Special request cases included: USGS-tagged study animals (7), MBA-tagged study animals (6), long-term captive otters (4), extralimital animals (4), and otters that died at MBA during rehabilitation efforts (3).

Detailed necropsies performed at the MWVCRC generally included a thorough gross necropsy, a standard suite of photographs, collection of all major tissues for microscopic examination (histology), collection of swabs for bacterial and/or fungal culture, and collection of samples for additional diagnostic tests (e.g., for biotoxins) pending future funding. Postmortem radiographs were performed for some cases, as directed by the case history and presentation. Preliminary results presented in this report may be further refined with the completion of additional tests. In some cases, the cause of mortality is listed as "possible" (suspected, but further testing required to confirm, where possible), or "presumptive" (based on sufficient indirect evidence).

A standard suite of tissues were collected for histology on fresh cases, including multiple lymph nodes, spleen, liver, pancreas, kidney, adrenal gland, bladder, reproductive tract, ovary or testis, epididymis (if male), lung, heart, aorta, peripheral nerves and ganglia, multiple skeletal muscles, diaphragm, tongue, tonsil, soft palate, esophagus, stomach, intestine, thyroid and parathyroid glands, thymus, omentum, pituitary gland, trigeminal nerve and ganglion, cerebrum, cerebellum and brainstem.

We limit further discussion of causes of mortality to the random-source animals examined during 2012 that received full detailed necropsies. Necropsy results for special request animals will be provided to the requestors, and in the case of tagged study animals, will be presented in future reports on those studies.

Random-Source Necropsies

Because a systematic sampling scheme is used to select for random-source sea otters for detailed necropsy (every 3rd fresh animal), these necropsies provide a relatively unbiased index of current causes of sea otter mortality. However, due to a relatively small sample size, the full suite of factors that are affecting the Southern sea otter population during a given year may not be fully represented. During 2012, fresh, random-source animals were fairly evenly distributed by month and County of stranding (Table 1). Although some tests to clarify the primary cause of death are still pending, a preliminary summary of causes of mortality is provided in Table 2.

Table 1. Number of random-source source sea otter necropsies by month and County of stranding.

Month	San Luis Obispo Co.	Monterey Co.	Santa Cruz Co.	TOTAL
January	1	1	1	3
February	0	2	3	5
March	1	0	0	1
April	1	1	0	2
May	1	1	1	3
June	2	0	1	3
July	2*	0	1	3
August	1	0	4	5
September	1	0	1	2
October	3	1	0	4
November	0	1	0	1
December	0	1	0	1
TOTAL	13	8	12	33

* One of these animals from just south of San Luis Obispo, at Guadalupe Dunes (Santa Barbara County)

Table 2. Primary cause of death for 33 fresh-dead, random-source wild Southern sea otters examined at the CDFW MWVCRC during 2012.

Cause of Mortality (Category)	Cause of Mortality (Type)	Number	Percent
Trauma	Shark Bite (confirmed or presumptive)	17	52%
Infection	Bacterial Septicemia	3	9%
Trauma	Boat Strike (presumptive)	2	6%
Trauma	Mating Trauma (nose wound)	2	6%
Poisoning/Toxins	Domoic Acid Intoxication (presumptive or possible)	2	6%
Other	Cardiovascular Failure	2	6%
Infection	Acanthocephalan Peritonitis	2	6%
Infection	Protozoal Encephalitis	1	3%
Infection	Fungal Infection (Coccidiomycosis)	1	3%
Other	Neoplasia (Cancer)	1	3%

More than half (52%) of the random-source otters that received full examinations died with suspected (12) or confirmed (5) shark bite. Shark-bitten sea otters were recovered from Santa Cruz (8) Monterey (5) and San Luis Obispo Counties (4). Shark bites cases occurred throughout the year, during every month except March, November, and December. All of these shark bite cases were presumed to be the result of attacks by white sharks (*Carcharodon carcharias*), based on observed trauma (Appendix A).

Of the two presumed boat strike cases, one animal was recovered in Morro Bay in August, and the other stranded in northern Monterey Bay in July. Of the two domoic acid intoxication suspects, one was recovered in Estero Bay in July, and the other stranded in Monterey Bay in August.

Because sea otters have a polygynous mating system, deaths of female sea otters is of greater importance for limiting population recovery than males. Only 10 of the 33 random-source cases were females, providing a smaller than desired sample size to assess impacts faced by female sea otters across their range. The ratio of shark bite cases by sex was similar between males and females (4 out of 10), and as expected, both sea otters that died with severe mating trauma (nose wounds) were females.

Discussion

Since 2009, shark-associated sea otter mortality has increased, and shark bite continued to be the leading cause of death for wild Southern sea otters during 2012. Studies to determine why there has been an increase in shark bite mortality in recent years are in progress.

It is important to note that acute lesions, including shark-bite or boat strike, may mask significant, underlying disease. Many of the otters that died from shark bite during 2012 had other significant, pre-existing health problems that could have eventually led to their death, had the animals had not been killed by sharks. The CDFW and USGS are investigating factors that could be associated with an enhanced risk of shark bite mortality, including domoic acid intoxication and protozoal encephalitis. These health concerns could potentially increase the risk of shark bite by influencing animal behavior.

Consistent with past mortality surveys, infectious disease continues to be an important cause of death for Southern sea otters: 21% of fresh, random-source otters with full necropsies succumbed to bacteria, parasites or fungi as a primary cause of death. Additional animals had infectious agents as a contributing cause of death.

The only sea otter deaths identified through random-source necropsies during 2012 that were directly anthropogenic were the two suspected boat-strike cases. However, other causes of sea otter death, such as bacterial infection, protozoal encephalitis and domoic acid exposure may be indirectly anthropogenic:

- Sea otters are commonly infected with bacteria similar to those shed in the feces of terrestrial animals and humans. A higher risk of isolation of these fecal enteric bacteria is noted for sea otters living along more urbanized coastlines and near the ocean outflows of rivers and streams (Miller et al. 2010).
- The two main protozoan parasites that have been linked with the development of fatal brain disease (protozoal encephalitis) in sea otters originate from the feces of domestic and wild cats (*Toxoplasma gondii*) and non-native opossums (*Sarcocystis neurona*). Past studies have demonstrated that the most likely source of sea otter infection by these parasites is land-sea flow from infected animal feces that were deposited in terrestrial habitat, followed by concentration in filter-feeding invertebrate prey that are consumed by sea otters (Miller et al. 2002, Conrad et al. 2005, Shapiro et al. 2012). Microscopic examination of brain tissue will be needed to confirm protozoal infection as the cause of death, and to identify the parasite, or parasites involved. Concurrent *Toxoplasma* and *Sarcocystis* infections are relatively common in sea otters, and could be associated with an enhanced risk of sea otter death.
- An association has been demonstrated between runoff of land-based nutrients, such as nitrogen and phosphorus in fertilizer, and increased severity and persistence of coastal marine toxic algal blooms, such as those producing domoic acid (Anderson et al. 2008, Kudela et al. 2008). In the laboratory, enhanced biotoxin production has also been linked with nutrient loading, especially when organic forms of nitrogen are added (Armstrong Howard et al. 2007). Much of the sea otter range is located adjacent to urban and agricultural areas with extended growing periods. Studies are in progress to investigate the association between domoic acid exposure in sea otters and proximity to urban or agricultural areas, rivers, embayments and harbor mouths.

Additional detail on causes of mortality, including contributing/secondary causes of death, will be provided in future summary publications that address trends in Southern sea otter mortality in greater detail.

Disclaimer

Information in this report is preliminary and should not be cited without permission from the CDFW. Microscopic examination and supplemental testing is required to diagnose some health conditions affecting sea otters. Because testing is still being completed, and because our understanding of factors contributing to sea otter mortality evolves through time as greater knowledge is gained, categories may be revised for future mortality summaries

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Appendix A. Images from selected necropsies.

Image 1. External bite marks typical of a white shark attack.

Image 2. Striations on bone indicative of abrasion by serrated white shark teeth.

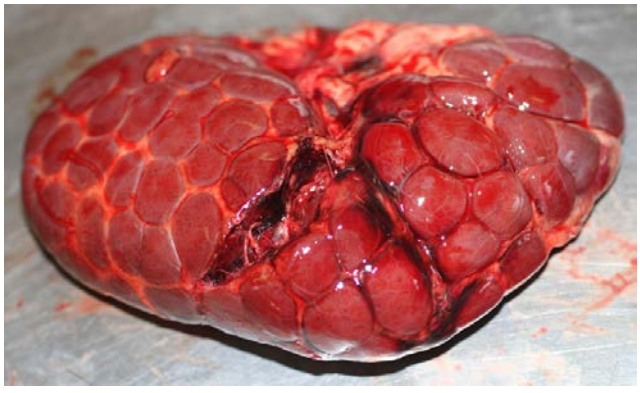

Image 3. Lacerated kidney caused by a presumed boat strike.