Marine Mammal Unusual Mortality Event Initiation Protocol

The formal determination of a marine mammal Unusual Mortality Event (UME) is made by the Marine Mammal Health and Stranding Response Program, following consultation with the Working Group on Marine Mammal Unusual Mortality Events (WG). The WG considers a suite of information provided by the person reporting the unusual mortalities, relative to a set of Criteria (see Appendix 1, below), and makes recommendations to the National Marine Fisheries Service (NMFS) and to the U.S. Fish and Wildlife Service (FWS). Expeditious determinations require receipt of organized, comprehensive sets of appropriate current and historical data. Submission of minimal or disorganized datasets can delay a formal determination because of the time involved as the WG requests and awaits additional information. The following summary is provided to facilitate the development of an initial data package for consideration. If you have any questions, please contact your NMFS Regional Stranding Coordinator, FWS Species Coordinator, or the WG's Executive Secretary, Trevor Spradlin, at (301) 713-2322 ext 103 (Trevor.Spradlin@noaa.gov).

Information on Current Situation

1. Name and contact information of person reporting unusual mortalities
    a. Name: Verena A. Gill
    b. Institution: Marine Mammals Management Office, U.S. Fish and Wildlife Service
    c. Address: 1011 East Tudor Road, MS 341, Anchorage, Alaska 99503
    d. Telephone numbers (office, cell): 907-786-3584/250-3721
    e. Fax number: 907-786-3816
    f. E-mail address(es): verena_gill@fws.gov
    g. Collaborating organizations: Alaska SeaLife Center, Alaska Veterinary Pathology Services.

Location: (describe full geographic range, give latitude and longitude of limits):

Although sea otters strand for a variety of reasons (including disease, boat strikes, starvation, inter- and intra-specific trauma), this mortality event addresses an unusually high number of cases that have been diagnosed as having died from *Streptococcus bovis* endocarditis/septicemia (SBE/S). Sea otter carcasses with this condition have been found between 53.28°N, 168.35°W and 59.85°N, 150.90°W. This area ranges from Umnak Island in the eastern Aleutian Archipelago to Kachemak Bay on the Kenai Peninsula (Figure 1). Although most of this area is within the range of the southwest Alaska population stock of northern sea otters, the majority of cases have occurred in Kachemak Bay (59.10°N, 152.00°W by 59.85°N, 150.90°W) within the southcentral population stock. The southwest Alaska population was listed as threatened under the Endangered Species Act (ESA) in August 2005. Although not listed under either the ESA or MMPA, the southcentral Alaska population is immediately adjacent to the southwest Alaska population in Kamishak Bay, separated by a distance of approximately 120km across Cook Inlet.

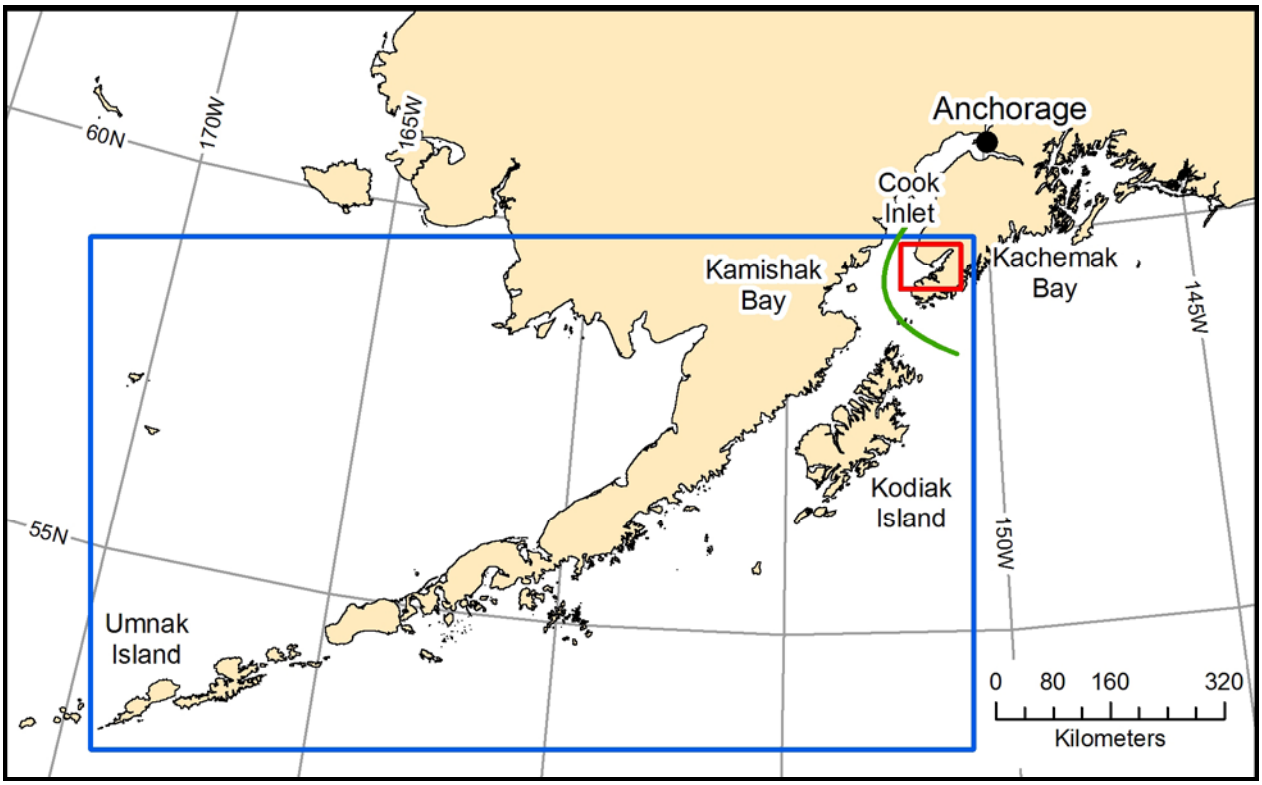


Figure 1. Location of sea otter strandings identified as SBE/S cases. Blue box indicates overall range of identified cases. Red box indicates location of Kachemak Bay where the majority of cases have occurred. Green line indicates boundary between the southwest and southcentral Alaska population stocks.

Date of first stranding(s), location(s):

The date of the first northern sea otter stranding noted with SBE/S in this series was 7 November 2002, in Kodiak, Alaska. Kodiak is within the ESA listed southwest Alaska DPS of the northern sea otter.

2. Species, age classes, condition codes involved – are these different from historical records?

All cases are northern sea otters (*Enhydra lutris kenyoni).* Of the 63 (out of 147 records in our database) animals with SBE/S 72% were male and 44% were prime-age adults (4-10 years). The age and sex composition of the affected animals is different than that of historical records for sea otters for populations at equilibrium density. In sea otter populations that are food resource limited, the dying population is primarily ages 0-1 and older (>9) years of age (Kenyon 1969, Monson et al. 2000). However, in our stranding records these age groups only account for 13% of mortality. In this analysis only specimens that were in good post-mortem condition were included.

3. Total number of dead individuals to date, number of live-stranded animals– are these different from historical records?

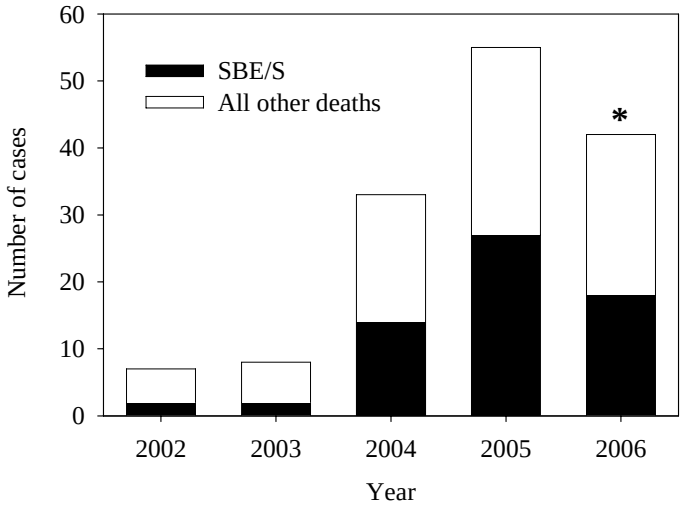
Since November 2002, 63 out of 147 animals (43%) that were in good enough condition to necropsy were determined to have died from SBE/S. Of the 20 animals that have been brought in alive to rehabilitation, 7 were affected with this condition and died or had to be euthanized almost immediately (Dr. Carrie Goertz pers. comm.). It is unusual to have this many animals die from a disease that is normally a sporadic disease in other species (Dr. Thomas Lipscomb pers. comm.). Having a large proportion of animals die of a single infectious disease condition suggests some change in the system equilibrium, such as the introduction of a "new" disease into a previously naïve population (Dr. Kathy Burek pers. comm.).

Historical information - The numbers of dead otters presently being reported and provided to us are far higher than anything recorded in the previous 20 years for Kachemak Bay. Although the FWS stranding program has only been fully operational for the past 3 years, for the past 20 years volunteers from the Kachemak Bay based Center for Coastal Studies have organized systematic beach walks that have covered every beach in the area. All findings were catalogued annually. Sea otter strandings were not observed, although live on-water sightings were recorded along many beaches. In addition, the group Cook Inlet Keeper has a series of salt water test sites in Kachemak Bay that are sampled each month. Observers also report that no otter carcasses were found prior to this recent event. Other anecdotal information comes from residents and avid beachcombers in the area over the last 5 years, who have begun to report dead sea otters on the beaches in the past year.

The pilot boat *Katmai* and operates in Kachemak Bay almost every day throughout the year. The crew, many of whom have worked on the vessel for more than 10 years, have reported that they have only recently begun to see stranded sea otters from 2004-2006. The vessel operators have begun providing detailed accounts of their observations to the local stranding network in Kachemak Bay.

Two other boat captains in Kachemak Bay (Cy St. Amand and L.A. Holmes) have also been documenting sea otter observations since 1995. From 1995 to 1999 they observed no stranded otters. In 2000, they began to see occasional stranded sea otters and after 2001 they noticed that the number of strandings was increasing. By 2005 they were observing dead otters regularly every month. In 2006 they report that they can find at least one dead otter every day on the beaches of Kachemak Bay.

Finally, the Alaska Maritime National Wildlife Refuge, which is based out of Homer, Alaska, have also noted that in the past several years they have been getting more reports, picking up more dead otters, and seeing more sick animals than before.



The number of sea otter carcasses that were in good enough condition to necropsy from 2002-2006.

* 2006 data only includes cases up until the beginning of July.

4. Have there been any changes in effort that might affect reporting of strandings?

Over the last 3 years FWS, NMFS, and the Alaska SeaLife Center (ASLC) have been working to develop a marine mammal stranding network in Alaska. There have been workshops in several communities, including Homer, to raise the awareness on the importance and value of live and dead stranded marine mammals. We do not believe that the recent increase in reporting of sea otters is due to additional search effort, as the level of cetacean and pinniped reporting has remained consistent over this same time period. In addition, other indices of stranding rates described above support the conclusion that there has been a real increase in sea otter strandings since 2002.

5. Describe the current level of response, proportion of animals rescued, proportion of carcasses being examined through necropsy?

We are currently responding to all live and dead stranded sea otters reported. Every carcass obtained is being examined by veterinarians familiar with marine mammal necropsy techniques or a board-certified veterinary pathologist. Samples from these cases undergo further analysis (i.e. histopathology, microbiology, and serology). However, the continuing sharp increase in numbers of carcass presentations has exceeded our ability to support this level of examination. All animals found alive but sick are being transported to the ASLC for care and treatment, although none have survived to date.

The current level of stranding response represents a multi-agency collaboration that includes representatives from the U.S. Fish and Wildlife Service Marine Mammals Management Division, the Alaska Maritime National Wildlife Refuge, the Alaska SeaLife Center, Alaska Veterinary Pathology Services, and the University of California – Davis. In addition, a network of

volunteers assist by responding to reports of stranded otters, transporting carcasses, and assisting with necropsies.

6. Samples being collected:

Samples checklist

	Histo	Chill		Frozen tissue archives					
Tissue	Histo	Micro UCD	Protoz (UCD)	AMMTAP	UAF museum	USFWS	Disease	TOX	Other
Container *	9	2,7,12	7 , 2	5	11	See below	2,3,4,7,12	5, 8	
Storage	RT	Refrig + ship ASAP	Refrig + ship ASAP	-20 or -80	-20 or -80	-20 or -80	-80	-20 or -80	
Size	0.5 – 1.0 cm	$3cm^3$	2- $3cm^3$	150 gm, 2 samples	Pea sized	Variable	3 – 5 cm^3	100 gm opt 10-15 gm (min)	
Adipose				A = g B = g			❑	❑ ❑	
Adrenal	❑					❑	❑		
Amniotic fluid							❑ ❑		
Baculum						❑			
Bile							❑	❑	Amber vial
Blood							❑		ml
Bone marrow	❑								
Brain	❑		❑					❑	
Colon	❑	❑ loop				❑ 4 “			
CSF			❑				❑		ml
Duodenum	❑								
Esophagus	❑								
Eye	❑								
Feces								❑ ❑	
Gall bladder	❑								
Gonad	❑								
Hair			❑						
Heart Aorta	❑								
Heart IVS	❑								
Heart Lpap	❑				❑		❑		
Heart RV	❑								
Ileum	❑								
Jejunum	❑	❑							
Kidney	❑			A = g B = g	❑	❑ R	❑	❑ ❑	
Lesion 1	❑ ❑						❑ ❑		Photo: Site:

	Histo	Chill		Frozen tissue archives					
Tissue	Histo	Micro UCD	Protoz (UCD)	AMMTAP	UAF museum	USFWS	Disease	TOX	Other
Lesion 2	❑ ❑						❑ ❑		Photo: Site:
Liver	❑	❑		A = g B = g	❑	❑	❑	❑ ❑	
LN Retro	❑								
LN inguinal	❑								
LN ax	❑								
LN prescap	❑								
LN hilar	❑								
LN mes	❑	❑							
LN other	Any abn	❑					❑		
Lung	❑						❑ ❑		
Muscle	Diaphr, PFL, PHL, intercost					20 gm in zip and genetics vial	❑		
Nasopharn	❑	❑							
Oral lesions	❑						❑		
Pancreas	❑								
Parasite:A									ETOH
Parasite:B									ETOH
Pelt						❑			
Pericardial fluid							❑		Ml
Pleural fluid							❑		ml
Placenta	❑						❑		
Pre-molar						❑			
Right Femur						❑			
Repro tract						❑			
Serum			❑				❑	❑	ml
Skin	❑						❑		
Spinal cord	❑								
Spleen	❑				❑		❑		
Stomach	❑								
Stomach contents						❑	❑		
Thymus	❑						❑		
Thyroid	❑								
Tongue	❑								
tonsil	❑								
Trachea	❑								
Urinary bladder	❑								

	Histo	Chill		Frozen tissue archives					
Tissue	Histo	Micro UCD	Protoz (UCD)	AMMTAP	UAF museum	USFWS	Disease	TOX	Other
Urine							❑	❑ ❑	ml
Uterus	❑								
Whisker						❑			

* Container codes:1 – Ziplock; 2 – whirlpak; 3 – 1 or 2 ml cryovial; 4 – 5 ml cryovial; 5 – Acetone cleaned Teflon or foil then into ziplock or whirlpak / or an I-chem jar; 6 – Ethanol; 7 – into culture media / buffer; 8 – amber colored cleaned vial or cleaned glass vial covered with foil; 9 – 10% neutral buffered formalin; 10 -- purple top, 11 color coded cryovials for UAF, 12 culture swab

7. Describe consistent gross lesions or unusual behaviors.

We have seen two distinct types of disease associated with *Strep. bovis* group bacteria. The first and most common are cases of valvular endocarditis (VE) in which the aortic and/or left atrio-ventricular valves have large, vegetative nodules firmly attached to and distorting the valve(s) (see photo at right). This condition is associated with severe pulmonary edema, pleural effusion and most often extensive thromboembolic disease characterized by infarctions; most frequently in the kidney, liver, spleen and less often in the brain, adrenal glands, and skeletal muscle. We have been able to consistently culture a member of the *Strep bovis/equinus* complex identified as *Streptococcus infantarius spp. coli* from the valvular lesions and multiple tissues and often the GI tract. The second syndrome is septicemia due to the same organism, which is most likely the earliest stage of this process leading to the infectious VE. Generally there is no obvious primary lesion typically associated with VE such as a tooth root abscess, discospondylitis, osteomyelitis or other chronic bacterial infection.

Many sea otters that have been observed alive prior to their death appear to be paralyzed in their hindquarters. These animals were all SBE/S cases and their paralysis was subsequently explained on necropsy by a saddle thrombus or emboli in the cerebellum and/or cerebrum. Many more have been observed (but not recovered and examined) hauled out in Kachemak Bay with limited or no use of their hindquarters, suggesting this disease (SBE/S) may be more prevalent in the population than the carcass recovery rate would indicate.

Histologic examination of a portion of the cases has consistently demonstrated large numbers of gram positive cocci in the valvular lesions and within the bloodstream. Most cases demonstrate endarteritis with marked fibrinoid necrosis in some of the tissues. Fibrinoid necrosis is a non-specific lesion, but can be seen with organisms capable of damaging the vessel wall directly or

through with autoimmune type III reactions, and some toxins. There has been a suggestion of intranuclear inclusion bodies in some cases in the endothelial cells, but no virus has been detected by viral culture. Other lesions including diffuse alveolar damage, pulmonary edema and congestion, generalized congestion and acute and chronic infarcts in multiple organs are consistent with heart failure and thromboembolic disease. Examination of more cases of VE as well as the septicemia cases are needed as well as follow up tests on a per case basis (immunohistochemistry, PCR, viral or bacterial cultures).

After the 1989 *Exxon Valdez* oil spill, 282 sea otter carcasses were recovered from the wild and/or rehabilitation centers and necropsied (Lipscomb et al. 1996). Only one of these animals from Prince William Sound, Alaska, had vegetative VE (as seen in SBE/S cases), but no further diagnosis, such as microbiology, was performed on that animal so it is unknown what bacteria was present on the lesion (Dr. Thomas Lipscomb pers. comm.). Independent of the *Exxon Valdez* spill, close to 100 otter carcasses were examined in the decade preceding 2002 and vegetative lesions on the heart valves were detected during gross necropsy in only four animals; two from Prince William Sound in 1996 and 1997, and two from Kachemak Bay in 1988 and 1989 (USFWS unpubl. data). Of these four, the heart in only one (Kachemak Bay 1988) was cultured and was positive for a Group D Strep. bacteria. This is the same Strep. complex we have been documenting in this recent mortality event (Dr. Barbara Byrne pers. comm.). The only published report of this condition was from a live female collected in Prince William Sound, that died 8 days later with VE which was culture negative (Joseph, et al. 1990).

8. Describe any unusual meteorological, environmental, or anthropogenic conditions (including changes in fishing activity).

None.

9. Are any other organisms affected? If so, what and (roughly) how many have been affected?

Not to our knowledge.

10. What are your preliminary hypotheses regarding the nature/causes of the situation?

The high incidence of SBE/S may be due to increased exposure to *Strep. bovis*, increased virulence of this bacteria in northern sea otters, or there may be predisposing factors affecting individual animals that allows the bacteria to colonize the heart valves. Such predisposing factors could include: 1) immunosuppression due to a viral infection (i.e. retroviral, morbillivirus), contaminant loads, or genetic predisposition/reduced variability; 2) viral or other pathogen infection which causes damage to endothelial cells (i.e. adenovirus, *Bartonella spp*.); 3) pre-existing valvular abnormality due to congenital defect (i.e., genetic) or other factors; or 4) something in the diet that causes damage to the GI tract and release of *Strep. bovis* into the bloodstream.

Causes of mortality in southern sea otters have been extensively studied, and we have corresponded with Dr. Melissa Miller, a veterinary pathologist working on sea otters in California. Sporadic cases of *Strep. bovis* septicemias, and very rare cases of VE have been seen

in southern sea otters (2 out of "hundreds of necropsies", Dr. Melissa Miller, pers. comm.). Therefore, southern sea otters either have a less pathogenic type of *Strep. bovis*, or lack whatever predisposing factor is present in northern sea otters in Alaska.

11. Does this situation seem similar to any previous situations that you have experienced? If so, please explain.

No.

12. If contingency funds were made available, how would you conduct your investigation? What kinds and levels of effort would be applied?

The number of carcasses we are receiving currently exceeds our ability to maintain our existing level of investigation. Specifically, the effort requires collection and shipment of sea otter carcasses, additional refrigeration and freezer capacity, detailed necropsies conducted by qualified veterinarians, and sample analysis.

In addition to keeping up with additional stranded animals, we also have a backlog of existing samples that require histopathological and microbiological analysis. We propose that tissues from any animal with lesions suggestive of a pre-existing viral infection would be analyzed for viral culture, PCR, and possibly electron microscopy. Complete serological and contaminant/toxicological assays may also be needed to rule out potential predisposing factors.

As the investigation to date has been restricted to stranded animals, the prevalence of this condition in the live population is not known. We propose to conduct a live-capture study of sea otters in Kachemak and Kamishak Bays to determine occurrence of SBE/S in the wild population. Pending the results of the live capture study, additional testing of environmental elements such as contaminants or pathogens in food resources may be required.

Another pressing need is to determine the number of otters presently in the Kachemak Bay area. The last aerial survey in this area was conducted in 2002 about the time that the current mortality event began. A systematic aerial survey of Kachemak Bay and adjoining Kamishak Bay would be used to assess the impact this event may have had on the population, and to serve as a baseline for comparison should this event continue or increase.

13. What resources do you need to continue investigation of the situation?

To maintain our current level of stranding response, necropsy, and sample analysis throughout the current calendar/fiscal year would require additional funds in the amount of $34,300 based on the number of animals that have stranded so far in 2006. However, if the mortality event proceeds at the current rate we would need at least $70,000 a year. In addition to maintaining an adequate level of response to future strandings, funds in the amount of $30,000 are needed to analyze the current backlog of samples. In addition, there is a desperate need for a designated full time coordinator to manage this level of effort.

To conduct a comprehensive live-capture study of sea otters in Kachemak and Kamishak Bays as described above funds estimated in the amount of $57,000 would be needed.

The above studies would also both benefit from review of the current sample collection protocols, sample analysis, and interpretation by the WG and recommendations for future sampling.

Based on the results of the 2002 aerial survey in Cook Inlet and the Kenai Peninsula, we estimate that approximately 70 hours of aircraft charter time would be required to complete the survey. The total cost of a survey, including travel and per diem, would be approximately $27,000.

14. What criteria (see attached) do you think your situation meets?

Of the 7 criteria for determining an unusual marine mammal morbidity/mortality event (Appendix 1), 4 apply to the current sea otter situation:

1) A marked increase in the magnitude or a marked change in the nature of morbidity, mortality or strandings when compared with prior records.
4) The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
5) Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g. blubber thickness).
7) Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

Although we have not documented an unexplained decline of the southcentral Alaska population stock, criteria 7 is included because SBE/S has been documented within the ESA-listed southwest Alaska DPS, and the area where the majority of cases have occurred (Kachemak Bay) is immediately adjacent to the listed population.

Literature Cited

Kenyon, K.W. 1969. The sea otter in the eastern Pacific Ocean. North American Fauna 68:1-352.

Joseph, B. E., Spraker, T. R., Migaki, G. 1990. Valvular Endocarditis in a Northern Sea Otter (*Enhydra lutris*). Journal of Zoo and Wildlife Medicine 21(1): 88-91.

Lipscomb, T.P., R.K. Harris, A.H. Rebar, B.E. Bellachey, and R. Haebler. 1996. Pathological studies of sea otters, *Exxon Valdez* Oil Spill State/Federal Natural Resource Damage Assessment Final Report (Marine Mammal Study 6-11), U.S. Fish and Wildlife Service, Anchorage, Alaska.

Monson, D.H., D.F. Doak, B.E. Ballachey, A. Johnson, and J.L. Bodkin. 2000. Long-term impacts of the Exxon Valdez oil spill on sea otters, assessed through age-dependent mortality patterns. PNAS 97(12): 6562-6567.

Pedersen, K., J. C. Jørgensen, H. H. Dietz, T. H. Andersen. 2003. Verrucous endocarditis associated with *Streptococcus bovis* in mink (*Mustela vison*). Veterinary Record 153: 264-268.

Historical Information

See Attachment A.