2007-2009 Pacific Northwest Guadalupe Fur Seal (*Arctocephalus townsendi*) Unusual Mortality Event (UME) Summary Report

Dyanna M. Lambourn[1], Steven J. Jeffries[1], Kristin Wilkinson[2], Jessica Huggins[3], Jim Rice[4], Deborah Duffield [5] and Stephen A. Raverty[6]

[1] Washington Department of Fish and Wildlife, 7081 Phillips Lakewood WA 98498 USA

[2]NOAA/NMFS, 7600 Sand Point Way NE, Seattle WA 98115 USA

[3]Cascadia Research Collective, 218 ½ W 4th Ave, Olympia WA 98501 USA

[4] Oregon State University, Marine Mammal Institute, Hatfield Marine Science Center, Newport OR 97365 USA

[5] Portland State University, Portland OR 97207 USA

[6]British Columbia Ministry of Agriculture , Animal Health Center, 1767 Angus Campbell Road, Abbotsford, British Columbia V3G 2M3, Canada

2007-2009 Pacific Northwest Guadalupe Fur Seal (*Arctocephalus townsendi*)
Unusual Mortality Event (UME) Summary Report

Location of UME: Oregon and Washington Outer Coast
Species affected: Guadalupe Fur Seals
UME Initiation date: June 20, 2007
UME Closure date: December 11, 2009

Adult female Guadalupe fur seal (WDFW 0707-08) at Point Defiance Zoo and Aquarium.

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Background

Guadalupe fur seals (GFS) *(Arctocephalus townsendi)* were thought to be extinct by the 1800's (Townsend 1931). In 1928 a small group of animals were discovered off Baja California at Isla de Guadalupe (Wedgeforth 1928, Huey 1930, Townsend 1931). Since that time, the GFS population has been reported to be increasing at a rate 13.7% per year. In 2003 the population was estimated at 12,176 (Carretta et al. 2010, Rick et al. 2011).

The population is considered to be a single stock with two rookeries located at Isla Guadalupe and Isla Benito Del Este. GFS have stranded or have been sighted (Figure 4) as far north as Katcemak Bay, AK, (NOAA unpublished data, 2007), inside the Gulf of California, and as far south as Zihuatanejo, Mexico (Hanni et al. 1997 and Aurioles-Gamboa and Hernadez-Camacho 1999). Analysis of historical fur seal remains from the Ozette archaeological site in northwestern Washington has confirmed the rare occurrence (0 to 4% of all fur seal mandibles examined) of juvenile GFS of both sexes from between A.D. 1500 to A.D. 1700 (Etnier 2002). Since 1980, investigations by the Northwest Marine Mammal Stranding Network, working in Washington and Oregon have provided further evidence of occasional presences of GFS in Northwest waters with one stranding in 1992, one in 2005, and three in 2006 (Figure 1).

History of Guadalupe Fur Seal Unusual Mortality Event (UME)

Between June 20, 2007 and November 1, 2007, 19 stranded GFS were documented on the Washington and Oregon outer coasts which were a marked increase in GFS strandings compared to previous years. The increase in GFS strandings prompted the NOAA Working Group on Marine Mammal Unusual Mortality Events to declare an Unusual Mortality Event (UME) on October 19, 2007. There were ten additional GFS strandings after the declaration of the UME (five strandings per year in 2008 and 2009) for a total of 29 stranded GFS throughout the Northwest from 2007 to 2009. A single live adult female and 28 dead yearlings of both sexes were recovered by Network responders during this event (Table 1, Figure 2). This UME was officially declared closed on December 11, 2009.

Although GFS strandings increased in Washington and Oregon, stranding data provided by adjoining regions of British Columbia and California showed no significant change in GFS strandings in 2007- 2009. California reported a total of eleven stranded GFS, which is elevated from their average of 8.3 GFS per year, but not markedly (NOAA unpublished data). British Columbia, Canada reported no GFS or northern fur seal (NFS) (*Callorhinus ursinus*) strandings

between 2007- 2009 (Spavin, L. Pers. Comm). One live juvenile male GFS was collected in Kachemak Bay, Homer Alaska, USA in 2007. In light of the increase in GFS strandings during this time period, NFS stranding data from 2005-2010 were reviewed revealing a higher number of NFS fur seal strandings in 2006 (n=19) compared to the previous average of 6 GFS per year. For years 2005 - 2010, GFS strandings surpassed NFS strandings in Oregon and Washington in 2007, 2008, 2010 and 2011 (Figure 2).

Through continued monitoring of GFS strandings, records have been compiled from 2010 for California, British Columbia, and Alaska and through 2011 for Oregon and Washington. A total of 59 GFS have stranded during this time. An average of 8.4 GFS strandings were reported for each year between 2005 and 2011 with an increase to 19 in 2007 and 16 in 2011 (Table 1, Figures 2 and 4). Strandings occurred from mid-May through August with occasional reports between October and December (Figure 3). All GFS were dead except for one adult female that was picked up at Ocean Shores,Washington for rehabilitation and three yearlings that came ashore live but died shortly after their initial stranding.

Records of recent live sightings of GFS in Washington and Oregon waters are limited. Cascadia Research Collective (CRC), an organization that has regularly conducted surveys for marine mammals in offshore waters of Washington and Oregon, documented 62 records of fur seals during surveys between 2007 and 2009 (CRC unpublished data, 2011). All of these were recorded as NFS during the surveys. Only 8 of 62 individuals were photographed from these surveys and it was determined that three seals were originally misidentified as NFS and subsequently reclassified as GFS. Two other sightings were listed as possible GFS, based on characteristics but could not be confirmed due to distance to the animal and poor image quality. Of the three GFS that were confirmed by photographs, two sightings occurred in 2007, one on July 1st due west of Cape Alava and the second due west of Moclips (Central Washington) on August 30$^{th.}$ A third sighting occurred in 2008, also off Cape Alava. All sightings were 20-30 nautical miles offshore (Figure 4).

No known mass-mortality of other marine mammals or non-mammalian species occurred during the designated UME. It should be noted the UME for harbor porpoise in the Pacific Northwest was declared in 2006 and was open during this timeframe until closed in 2009.

Life History Details

Detailed external and internal examinations were conducted on 14 dead GFS carcasses collected during the UME. Most of the animals examined (n=12) were assessed as being “thin” with an average weight of 9 kg (range= 5-10 kg). This mass was only slightly below the average weight of 9.2 kg (n=26) for stranded GFS in Washington, Oregon, and California between 2005 and 2010. There are no published data on size and weights of weaned pups or yearling age wild GFS. Based on release weights of 18-26 kg for rehabilitated GFS at The Marine Mammal Center all the stranded Guadalupe fur seals in this UME cohort would be underweight (Frances Gulland, TMMC, pers.comm.). Lengths (tip of the nose to tip of tail) measured for 17 GFS yearlings

during the Washington and Oregon GFS UME ranged from 74 to 102 cm and averaged 88.7 cm, which was slightly longer than the average length of 86.2 cm for all stranded yearling GFS measured between 2005 and 2010 for Washington, Oregon, and California (n= 40).

Based on Level A Data for Washington and Oregon for 2005 to 2011, the majority of the GFS strandings were yearlings (n=56), two were sub-adults and there was one adult female (Table 2). There was no gender bias; the sex ratio was virtually 50:50.

Stomach contents from eleven of the stranded GFS in Washington and Oregon during 2007-2009 were examined, eight were empty and three had contents. These contents included: one unidentified otoliths (Teleostei), Cancrid crab remains (*Cancer* sp.), Pacific tomcod (*Microgadus proximus*) otolith and bones (estimated weight 39.4 g). There was no indication of ingestion of foreign debris.

Evidence of Human Interactions

During 2007-2009, 2 of 29 (6.9%) animals (PSU07-06-23-At and HMSC09-11-22-At) presented dead, entangled in fishing gear (blue-green multifilament net). The rostral limit of the snout of another seal (HMSC09-06-09-At) was truncated; consistent with NOAA fishery observer protocol for species identification during at sea fisheries (Table 4). This animal was listed as Human interaction-Could not be determine- but "suspicious". Between 2005 and 2011, 8 of 59 (13.6%) stranded GFS in Washington and Oregon had direct evidence of fishery/derelict net entanglement and an additional 3 were listed as "suspect", due to injuries around head, neck and shoulders consistent with net entanglement.

Live Animal Disposition

On July 26, 2007 WDFW0707-08 an adult female GFS was reported on the beach near Ocean Shores WA (Lat. 46.9707 N., Long. -124 .1708 W.) acting disoriented. She was subsequently picked up for a health assessment by WDFW. This animal was held for ten days at Point Defiance Zoo and Aquarium. She was thin, anemic, blind in the right eye and an old healed scar over her right shoulder. Teeth were broken on the right side of her jaw. Disease screenings was initiated for Brucella spp, leptospirosis, morbillivirus, T. gondii, S. neurona and N. caninium and were all negative. Domoic acid testing was negative as well. She was transferred on August 8th to Oregon Coast Aquarium for continued rehabilitation. It was eventually determined she was unreleasable due to failing vision and likely would go blind in her left eye as well. Concerns were raised about to her ability to forage on her own if released back to the wild. In February 2008 she was transferred to permanent captivity at Sea World in San Diego CA.

Another GFS was picked up live in Homer, AK on July 29, 2007. This animal, "Mica", was observed by boaters in nearby Katchemak Bay acting very lethargic and did not move when

approached by the vessel. This animal, originally identified as a male NFS, was captured and transported to the Alaska Sea Life Center in Seward AK for rehabilitation. After genetic analysis it was determined to actually be a GFS and not a NFS. Well out of its home range, it was transported to California on October 26, 2007, fitted with a satellite transmitter and released the following day. A tracking map (Figure 6) showed that this animal eventually returned to Mexican waters off of Baja California Peninsula near Guerrero Nergo on January 6, 2008 (Alaska Sealife Center, 2011).

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Collected/Sampled Specimens and Laboratory Submittals

Samples were collected for histopathology and ancillary diagnostic investigations at the British Columbia Animal Health Center and Oregon State University Veterinary Diagnostic Laboratory. Additional samples were collected for other marine mammal researchers including: Dr. Deb Duffield, Portland State University (genetic, skeletal, stomach content); National Marine Mammal Laboratory, Seattle, WA (genetic, skeletal and stomach contents); NMFS Northwest Fisheries Science Center, Seattle, WA (domoic acid analysis and tissues for contaminant level and archived); Dr. Michael Griggs, National Institute of Health (identification and genotyping of histotrophic protozoa); Mystic Aquarium (tissue samples archived for *Brucella* sp.screening) ; Phoenix Central Veterinary Laboratory – Everett, WA (for clinical chemistry, hematology and general disease screening of live animals); Washington Department of Agriculture, Olympia, WA (disease screening); and Washington Department of Fish and Wildlife, Hatfield Marine Science Center and Portland State University (specimen archival) (Table 3).

Histopathology and Ancillary Diagnostic Findings

Histopathology and ancillary diagnostic studies were conducted on tissues from 12 animals; 9 in 2007, 3 in both 2008 and 2009.

Common pathologic findings included : emaciation (12/12), gastroenteritis/gastritis/ enteritis/colitis (8/9), cholangiohepatitis/hepatitis (4/5), lymphoid hyperplasia (5/9), meningoencephalitis/encephalitis/encephalomyelitis (5/9), nephritis/glomerulonephritis (5/10), bronchopneumonia/pneumonia (5/9), Pulmonary edema (9/10) and edema were also noted in brain and lymph node tissues as well (Table 4).

Final determinations of causes of death are listed in Tables 5. The morphologic diagnoses are ranked as primary (1˚) secondary (2˚) and tertiary (3˚) contributors to the cause of death. The following were listed in order of most common finding to least: Malnutrition (1˚=6, 2˚= 7), Infectious- Parasitic (1˚=2, 2˚= 5, 3˚=5), Infectious- Bacterial (1˚=2), Incidental catch/ entanglement (1˚=2), Accident/Trauma (1˚=1, 2˚= 1), Unable to determine (1˚=2, 2˚= 1*), Not examined (1˚=14, 2˚= 1) (Figure 7, Table 5).

PCR analysis of pooled tissues was also conducted for *Brucella* sp. (n=6), *Leptospira* spp. (n=6), morbillivirus (n=8) and all results were negative (Animal Health Center, Abbottsford, Canada). No viruses were isolated in 6 samples inoculated into Mabin Dawby cell lines. Culture for bacteria was conducted on 8 specimens; 2 had no bacteria isolated; 6 isolates recovered included *Eschericia coli (*non-haemolytic), *Eschericia sp*., *Photobacterium damselae, Plesiomonas shigellioids, Streptococcus phocae, Streptococcus sp*. (alpha). Most are considered likely post mortem invaders. Enrichment culture of intestinal tracts for *Salmonella* sp. was negative for 8 animals. Serology on post mortem heart blood, pericardial fluid and serum from live or agonal animals *Brucella sp.*(n=4), *Leptospira spp.(*n=5*),* canine distemper virus *(*n=1*) and T. gondi, S. neurona, and N caninium* (n=2). Two GFS (WDFW0607-18, WDFW0607-22) had suspect titres for *Brucella sp.* using *B. abortus* antigen card test and only one (WDFW0607-18) had suspect tire (1:200) for *Leptospira pomona* and *grippotyphosa* (Table 6).

Domoic acid analysis was conducted on urine, fecal and/or stomach content samples from 5 animals with no detectable toxin. During the GFS UME, other stranded marine mammal samples from Washington's outer coast were also submitted for domoic acid analysis and 9 of 48 had detectable levels, but all were well below toxic thresholds. (Table 8).

Ectoparasites: Ten of 23 GFS necropsied between 2007-2009 featured goose neck barnacles (*Lepas anatifera*) attached to their fur (Table 4). Most animals had less than 10 percent of the body surface affected and infestations usually occurred in areas that were difficult for GFS to groom; behind the ear, or on their shoulders and back. One moderately decomposed GFS had 75% of its body covered with barnacles. The occurrence of barnacles was only found on animals which stranded in north of 45˚N (central Oregon) from June to August. Coincidentally, the June through August timeframe is also when other stranded pinnipeds, unrelated to the GFS UME, presented with gooseneck barnacle on their pelt from Washington State. Gooseneck barnacles have been rarely reported (2 of 220) in Sub-Antarctic fur seals and southern elephant seals (Setaas & Bester 2006). Moreover, goose neck barnacles and algae are observed on the pelage of NFS returning to California's Channel Islands following their winter migration (S. Melin, National Marine Mammal Laboratory, California Current Program, pers. Comm., 2008). Based on these observations, it is not unusual to observe barnacles attached to pinnipeds in higher latitudes. Furthermore it is unlikely to cause a health concern in normally healthy animals in good condition. However, for an animal in suboptimal body condition, barnacles may impede an animal's ability to properly groom and maintain adequate insulation in colder waters associated with higher latitudes.

Internal parasites included gastrointestinal nematodes and acanthocephalans as well as muscular, lymph nodal and neural protozoal parasites. Nematodes were noted in the stomach (4 of 8), small intestine (2 of 10), lung (2 of 10), and peripheral vasculature (1 of 7); acanthocephalans were

found in the colon (1 of 5). All infections were associated with mild to moderate inflammation and were considered within acceptable limits for wild stranded pinnipeds.

Tissues (muscle, heart, brain and lymph node) from thirteen animals were submitted to the National Institutes of Health to screen for protozoal organisms using polymerase chain reaction (PCR). All thirteen animals were positive for at least one parasite, including: *Toxoplasma gondii* (n=10); *Sarcocystis neurona* (n=7); *Neospora caninium* (n=1); and *N. caninium*- like protozoal (n=3). Four animals had single infections; six had dual infections, three were infected with three species of protozoal organisms (Figure 8). Tissues tested and results are listed in Table 8.

Immunohistochemistry (IHC) for *T. gondii, S. Neurona and N. caninium* did not identify antigen in any other sectioned tissues. PCR for *T. gondii,* using primers developed for terrestrial species, were negative on *T. gondii* on 5 samples and Apicomplexa on 3 other samples (Table 8). Had the animals not succumbed to other disease processes, it is possible that these parasites may have contributed to some degree of morbidity.

Upon review of histopathology, PCR and IHC results, toxoplasmosis was considered an immediate cause of death in 1 animal, contributory in 4 cases, and in 2 animals, detection was considered incidental. These animals were likely carriers or in the early stages of infection with no apparent untoward effects. In the remaining 6 cases, the contribution of the parasites to morbidity could not be determined because either samples, particularly brain, were not submitted for histology, or tissues were too autolyzed to assess microscopically (Table 8). Efforts to compare identified species and genotypes of these parasites with case material from GFS from Mexico, California and Washington are planned and may provide valuable insights into geographical location of parasite exposure and epizootiology of infections.

A portion of liver from each animal was harvested and vitamin A levels determined. Trace mineral analysis was undertaken for calcium, cadmium, copper, iron, lead, mercury, manganese, selenium, magnesium, and zinc. For all seals analyzed (n=9), trace minerals levels were largely within acceptable ranges as described for other pinnipeds (Puls, R. 1994). Since species specific normal reference ranges for GFS have not been established, results were interpreted based on extrapolation from sympatric species. No consistent abnormal levels were noted in any of the 9 animals examined (Tables 9).

Relevant Environmental Factors

Environmental factors were extensively examined by this group as well as by a group from the University of Washington and based on these data. No specific environmental conditions were found to have contributed to the increased number of GFS strandings or their movement further north. Etnier (2002) and Hanni et al. (1997) proposed that a more northerly GFS migration may occur during El Nino years when warm equatorial waters of the Pacific Ocean extend north, as

far as the Pacific Northwest. The strength of these events is characterized by the increase in sea surface temperature, the El Nino Southern Oscillation (ENSO) index. In researching climactic, meteorological, and oceanographic data analysis in association with the GFS strandings in Washington and Oregon from 2005-2011 has not demonstrated a clear association. Years when most strandings occurred were associated with an ENSO index in a neutral and moving toward cooling phase commonly referred to as a La Nina event (Fall 2007, Fall 2010, Winter 2011) (Appendix Table 1). The Pacific Decadal Oscillation (PDO) index was also examined; strandings occurred in both warm (2005-2007) and cool regimes (2008-2010) (Appendix: Figure 2). Sea surface temperature anomalies (Appendix Figure 2) were also examined, as well as was Copepod Species Richness variations (Appendix Figure 3) and there were no consistent factors that would explain GFS strandings or migrations further north over consecutive years.

Conclusion

GFS strandings have been documented every year since 2005, with one report prior in 1992 (Etnier 2002). Based on archeological findings, GFS have historically been present in Pacific Northwest waters and it is plausible that with their population increasing they are dispersing and returning to their "historic or ancestral pelagic migration range". Most documented strandings (recent and historic) are young animals; weaned pups and yearlings. In most pinniped species, these age classes are associated with higher mortality rates than sub-adult and adult age classes. According to Landers (1979) 60-80% of mortality in NFS occur during the first migration (from 0-2 years) and it is assumed the most of that mortality occurs within the first year. It is likely very similar for GFS. The stress of a recent weaning, coupled with their first migration to an unknown foraging area may contribute to their stranding and subsequent demise. Weaned pups and yearlings are also commonly more susceptible to infections, increased parasite loads, sub-optimal body weight, suppressed or declining immune systems (associated with waning maternal immunity), and are also more likely to become entangled and in fishing gear and derelict nets (York 1987; Lander, 1979; WDFW unpublished data).

The Northwest Marine Mammal Stranding Network has only been in place since the late 1980's. Most response activities and necropsies have been contingent on available funds and research interest. Since 2001, financial support from the John H. Prescott Marine Mammal Rescue Assistance Grant Program has enhanced marine mammal stranding response efforts, facilitated education and outreach, and funded necropsy and diagnostic investigations throughout the Northwest. These activities have improved identification of "unusual" species and significantly increased the number of stranding reports and responses. Prior to 2001, it was not apparent that GFS would be found in any significant number as far north as the Pacific Northwest, so misidentifying stranded GFS as NFS likely occurred since GFS were not an expected to occur here. These circumstances exemplify the importance of consistent funding for response, public

outreach and education, and training of first responders which has greatly increases the identification of mortality events.

Future Plans and Recommendations

We plan to continue beach and open water surveys, enhanced stranding response, standardized and thorough necropsies, and uploading level A stranding data on GFS. Moreover, we will enhance public and first responder's awareness of the GFS and notify regional stranding coordinators and programs of any changes in stranding patterns.

Conduct beach survey May – August; This timeframe represents the period when most GFS strandings have occurred. Over half of the GFS found stranded in Washington were found on beach surveys conducted by Marine Mammal Stranding Network Responders and were not reported by the public. It also happens to be the pupping season for harbor seals along Washington outer coast. This is also when an increased number of live and dead strandings are diagnosed with protozoal encephalitis. We also see an increase in stranding of the pelagic pinnipeds on the outer such as Guadalupe fur seal, Northern fur seals, and Northern Elephant seal. There are also an increased number of tourists visiting coastal beaches and subsequently reporting marine mammal strandings.

Communicate and train fishery observer programs that GFS are migrating as far north as northern Washington and should be added to the list of species potentially being taken in net fisheries.

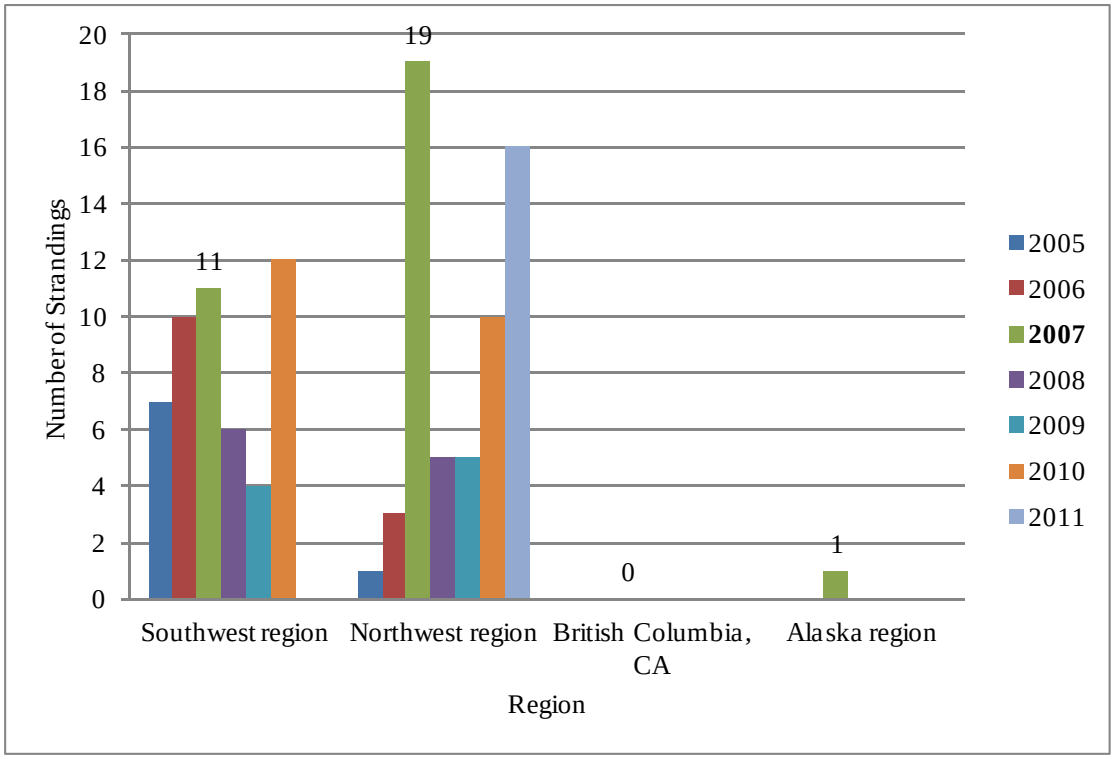
Would like to request assistance with funding for further oceangraphic modeling and statistical analysis as well as write up and publication of this stranding event.

Provide funding to track GFS strandings and potentially fund capture program tag animals for tracking GFS off the Oregon and Washington coasts to better understand their migration, foraging and life history.

Recommend updating Guadalupe Fur Seal Section of the U.S. Pacific Marine Mammal Stock Assessment. This Section has not been update in 11 years and with the new information provided updates should be considered.

Recommend listing Guadalupe fur seals on both Oregon and Washington state's Species of Concern list to bring more awareness to this species presence off the coast.

Figure 1. Total number of Guadalupe fur seal strandings on the Eastern Pacific coast by region 2005-2011



*2011 data is only from the Northwest region.

Figure 2. Guadalupe fur seal vs. Northern fur seal strandings in Oregon and Washington for 2005-2011

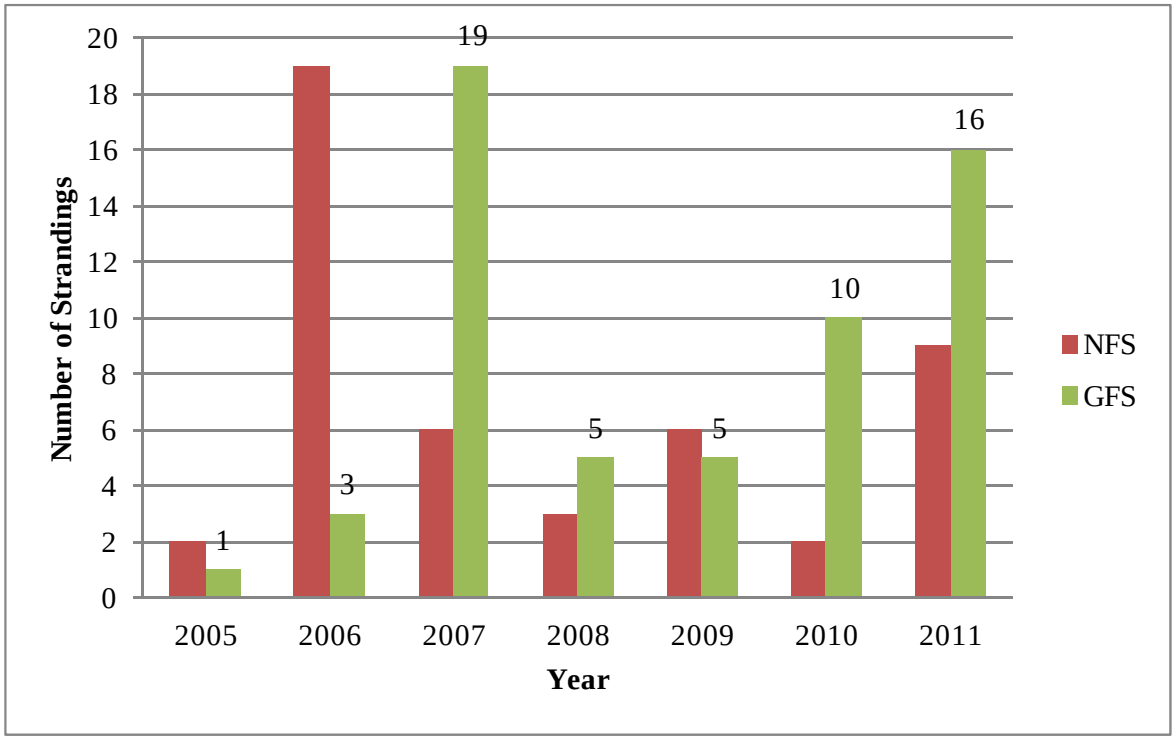


Figure 3. Cumulative Guadalupe fur seal strandings in Oregon and Washington by Julian day 2005-2011

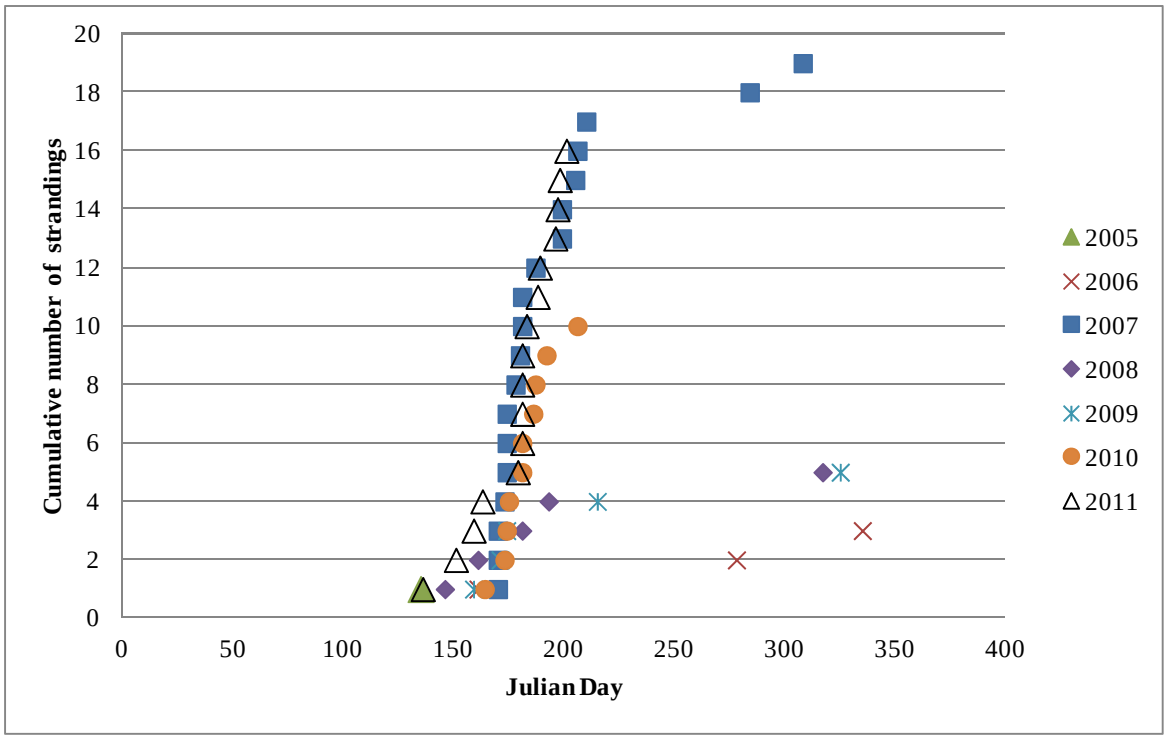


Figure 4. Map of historic and recent published distribution of Guadalupe fur seals

Figure 5. Maps of Pre- 2007, 2007, 2008 and 2009, 2010 and 2011Guadalupe fur seal strandings for Oregon and Washington.

*Blue stars are approximate location of live Guadalupe fur seal sighting

Figure 7. Causes of death for Guadalupe fur seals during UME by category and number listed as Primary, Secondary and Tertiary contributors.

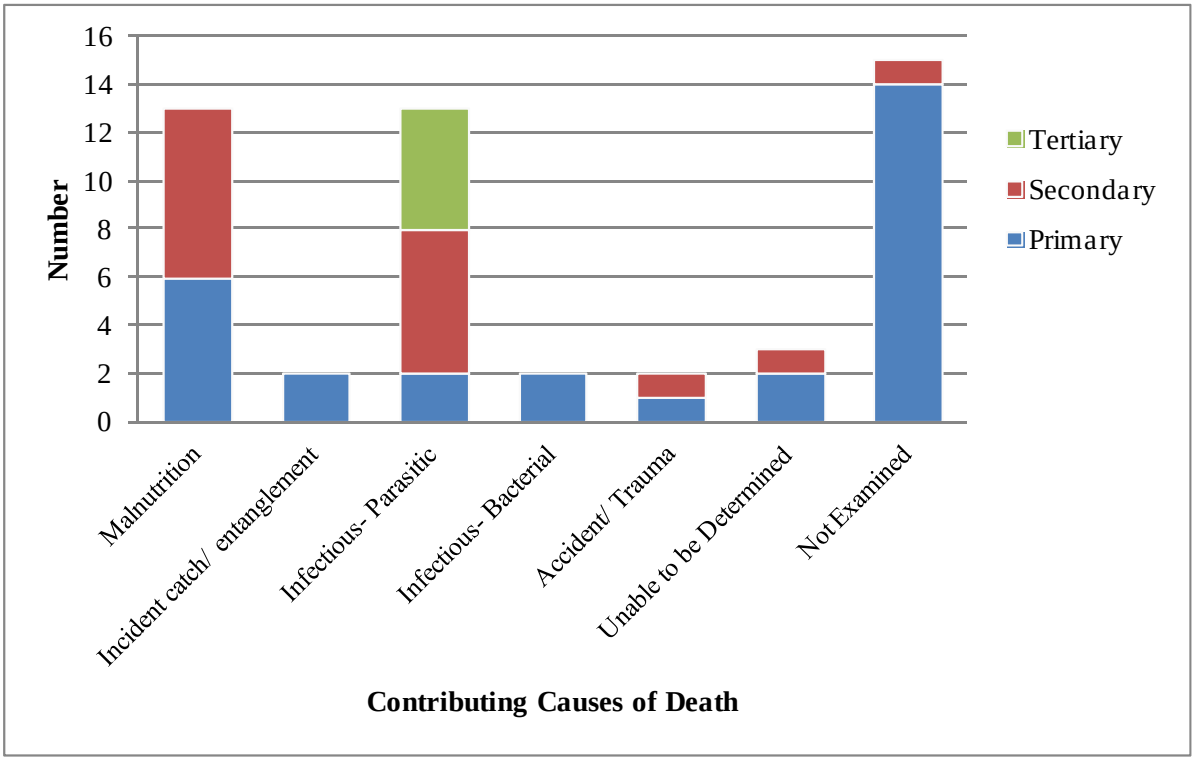


Figure 8. Total number PCR positives for protozoal organisms and the genotypes.

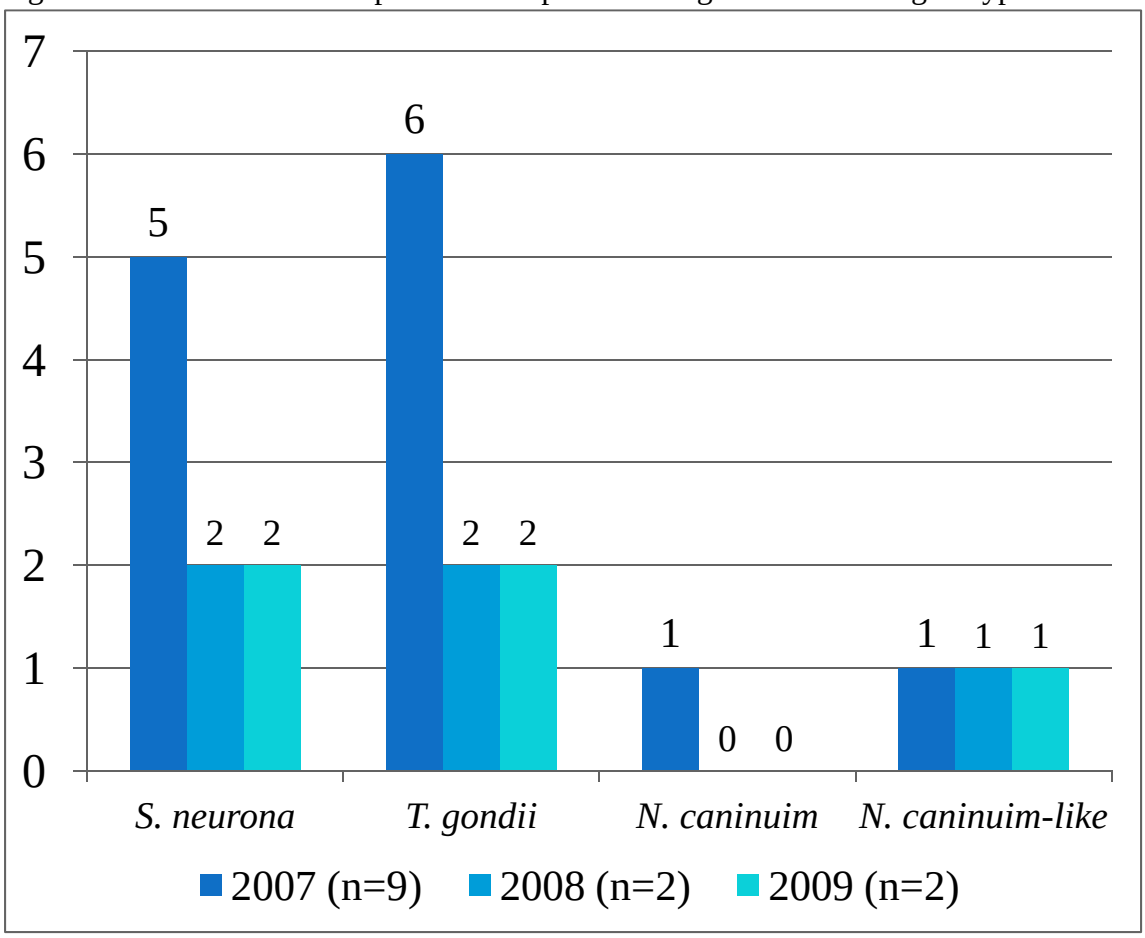


Table1. Life history information for 2007-2009 Guadalupe fur seal UME in Oregon and Washington

PSN	City	State	Initial Date	Age Class (Estimated)	Sex	Length (cm)	Girth (cm)	Weight (kg)	Blubber Depth (cm)	Carcass Condition
WDFW0607-18	Moclips	WA	20-Jun-07	Yearling	Female	95	46	10	1.5	Fresh
WDFW0607-22	Ocean Shores	WA	20-Jun-07	Yearling	Female	90	43	9	0.6	Fresh
WDFW0607-24	Ocean Shores	WA	20-Jun-07	Yearling	Female	95	47	10	1.1	Fresh/ moderate
PSU07-06-23-At	Warrenton	OR	23-Jun-07	Yearling	Female	87	n/d	6	0.4	Moderate
HMSC07-06-24-At	WinchesterBay	OR	24-Jun-07	Yearling	Male	96	45	10	n/d	Fresh
WDFW0607-27	Westport	WA	24-Jun-07	Yearling	Male	94	40	10	0.5	Fresh
WDFW0607-28	Westport	WA	24-Jun-07	Yearling	Female	89	41	8.5	0.9	Fresh
WDFW0607-30	Grayland	WA	28-Jun-07	Yearling	Male	94	39	8.8	0.5	Fresh/ moderate
07-CM-072	La Push	WA	30-Jun-07	Yearling	Unknown	86	n/d	12	n/d	Moderate
HMSC07-07-01-At	Florence	OR	01-Jul-07	Yearling	Unknown	85	44	9	n/d	Fresh
HMSC07-07-01-At-2	Bandon	OR	01-Jul-07	Yearling	Unknown	95	n/d	n/d	n/d	Fresh
HMSC07-07-03-At	Seal Rock	OR	03-Jul-07	Yearling	Male	93	n/d	n/d	n/d	Moderate
HMSC07-07-17-At	Waldport	OR	19-Jul-07	Yearling	Unknown	n/d	n/d	n/d	n/d	Moderate
HMSC07-07-19-At	Bandon	OR	19-Jul-07	Yearling	Male	81	n/d	n/d	n/d	Moderate
PSU07-07-25-At	Oysterville	WA	25-Jul-07	Yearling	Unknown	n/d	n/d	n/d	n/d	Moderate
WDFW0707-08	Ocean Shores	WA	26-Jul-07	Adult	Female	138	n/d	35	n/d	Alive
JS-2007-2	Neah Bay	WA	30-Jul-07	Yearling	Female	86	n/d	11.3	n/d	Moderate
HMSC07-10-12-At	Port Orford	OR	12-Oct-07	Yearling	Unknown	n/d	n/d	n/d	n/d	Mummified/ skeleton
HMSC07-11-05-At	Port Orford	OR	05-Nov-07	Yearling	Unknown	n/d	n/d	n/d	n/d	Mummified/ skeleton
HMSC08-05-26-At	Waldport	OR	26-May-08	Yearling	Unknown	n/d	n/d	n/d	n/d	Advanced
HMSC08-06-10-At	Florence	OR	10-Jun-08	Yearling	Unknown	90	n/d	n/d	n/d	Moderate
HMSC08-07-01-At	South Beach	OR	30-Jun-08	Yearling	Female	93	47	9.5	n/d	Fresh/ moderate
HMSC08-07-12-At	Newport	OR	12-Jul-08	Yearling	Female	90	n/d	n/d	n/d	Advanced
PSU08-11-13-At	Long Beach	WA	13-Nov-08	Yearling	Male	100	44	n/d	0.5	Moderate
HMSC09-06-09-At	Bandon	OR	09-Jun-09	Yearling	Female	89	n/d	n/d	n/d	Moderate
HMSC09-06-21-At	Lincoln City	OR	21-Jun-09	Yearling	Male	76	40	7.7	n/d	Fresh
HMSC09-06-24-At	Pacific City	OR	24-Jun-09	Yearling	Female	84	40	n/d	n/d	Advanced
PSU09-08-04-At	Seaside	OR	04-Aug-09	Yearling	Male	80	n/d	n/d	n/d	Advanced
HMSC09-11-22-At	Bandon	OR	22-Nov-09	Yearling	Female	102	n/d	n/d	n/d	Moderate

Table 2. Age and sex classes of Guadalupe fur seal strandings for Oregon and Washington, 2005-2011.

Age Class	Yearling			Adult		Subadult		Total
Sex	Male	Female	Unknown	Male	Female	Male	Female	per Year
2005	1	0	0	0	0	0	0	1
2006	0	0	2	0	0	0	1	3
2007	5	6	7	0	1	0	0	19
2008	2	2	1	0	0	0	0	5
2009	2	3	0	0	0	0	0	5
2010	3	2	4	0	0	1	0	10
2011	7	5	4	0	0	0	0	16
Total	20	18	18	0	1	1	1	59

Table 3. Samples and laboratories and collaborators specimens were submitted.

PSN	Collected for	Preservation	Lab ID	Date Sent	Date Results Received	Tissues	Sample Purpose
WDFW0607-18	Archive-WDFW	Frozen				Multiple tissues and fluid	Archive
WDFW0607-24	Archive-WDFW	Frozen				Multiple tissues and fluid	Archive
WDFW0607-22	Archive-WDFW	Frozen				Multiple tissues and fluid	Archive
WDFW0607-24	Archive-WDFW	Frozen				Abdominal fluid	Archive
WDFW0607-27	Archive-WDFW	Frozen				Multiple tissues and fluid	Archive
WDFW0607-28	Archive-WDFW	Frozen				Multiple tissues and fluid	Archive
WDFW0607-22	Deb Duffield	Frozen		10-Oct-07		Blood, Muscle	Genetics
WDFW0607-24	Deb Duffield	Frozen		10-Oct-07		Blood, Muscle	Genetics
WDFW0607-18	Deb Duffield	Frozen		10-Oct-07		Blood, Muscle	Genetics
WDFW0607-28	Deb Duffield	Frozen		10-Oct-07		Blood, Muscle	Genetics
WDFW0607-27	Deb Duffield	Frozen		10-Oct-07		Blood, Muscle	Genetics
WDFW0607-30	Deb Duffield	Frozen		10-Oct-07		Blood, Muscle	Genetics
PSU07-06-23-At	Deb Duffield	Frozen				Skull and M. tissues	Archive, Genetics, Sk. Collection
HMSC08-07-01-At	Deb Duffield	Frozen				Blood, Muscle, Stomach	Archive, Genetics, Sk. Collection
PSU08-11-13-At	Deb Duffield	Frozen				Skull and M. tissue	Archive, Genetics, Sk. Collection
HMSC09-06-21-At	Deb Duffield	Frozen		22-Jun-09		Blood, Muscle, Stomach	Archive, Genetics, Sk. Collection
HMSC09-06-24-At	Deb Duffield	Frozen		05-Aug-09		Skull, blood and muscle	Archive, Genetics, Sk. Collection
WDFW0607-22	Grigg	Frozen	GFS10	20-May-08	02-Feb-11	Heart, brain	Protozoal PCR
WDFW0607-24	Grigg	Frozen	GFS11	20-May-08	02-Feb-11	Heart, brain, blocks, ab.fluid	Protozoal PCR
WDFW0607-18	Grigg	Frozen	GFS9	20-May-08	02-Feb-11	Heart, brain	Protozoal PCR
WDFW0607-27	Grigg	Frozen	GFS12	20-May-08	02-Feb-11	Block	Protozoal PCR
WDFW0607-28	Grigg	Frozen	GFS13	20-May-08	02-Feb-11	Heart, brain , Med. L.N, Block	Protozoal PCR
WDFW0607-30	Grigg	Frozen	GFS14	20-May-08	02-Feb-11	Heart, brain	Protozoal PCR
PSU07-06-23-At	Grigg	Frozen	GFS5	10-Apr-10	02-Feb-11	Muscle	Protozoal PCR
HMSC07-06-24-At	Grigg	Frozen	GFS1	10-Feb-10	02-Feb-11	Brain, heart, muscle, Lymph node	Protozoal PCR
HMSC07-07-01-At	Grigg	Frozen	GFS2	10-Feb-11	02-Feb-11	Brain, heart, muscle, Lymph node	Protozoal PCR
HMSC08-07-01-At	Grigg	Frozen	GFS3	10-Feb-10	02-Feb-11	Brain, heart, muscle, Lymph node	Protozoal PCR
PSU08-11-13-At	Grigg	Frozen	GFS6	10-Feb-10	02-Feb-11	Brain, heart, muscle, Tongue	Protozoal PCR
HMSC09-06-21-At	Grigg	Frozen	GFS4	10-Feb-10	02-Feb-11	Muscle, heart	Protozoal PCR
HMSC09-06-24-At	Grigg	Frozen	GFS7	10-Feb-10	02-Feb-11	Muscle	Protozoal PCR
HMSC07-06-24-At	HMSC	Frozen				St, Skin	Archive
HMSC07-07-01-At	HMSC	Frozen				Multiple tissues and fluid	Archive
HMSC08-07-01-At	HMSC	Frozen				Multiple tissues and fluid	Archive
WDFW0607-22	Mystic	Frozen		17-Feb-09		Multiple tissues and fluid	Brucella- Not analyzed
WDFW0607-24	Mystic	Frozen		17-Feb-09		Multiple tissues and fluid	Brucella- Not analyzed
WDFW0607-18	Mystic	Frozen		17-Feb-09		Multiple tissues and fluid	Brucella- Not analyzed
WDFW0607-28	Mystic	Frozen		17-Feb-09		Multiple tissues and fluid	Brucella- Not analyzed
WDFW0607-27	Mystic	Frozen		17-Feb-09		Multiple tissues and fluid	Brucella- Not analyzed
WDFW0607-30	Mystic	Frozen		17-Feb-09		Multiple tissues and fluid	Brucella- Not analyzed
WDFW0607-22	NMFS- Cont.	Frozen				Blubber, Muscle, Liver	WDFW- Archived
WDFW0607-18	NMFS- Cont.	Frozen				Blubber, Muscle, Liver	WDFW- Archived
WDFW0607-24	NMFS- Cont.	Frozen				Blubber, Muscle, Liver	WDFW- Archived
WDFW0607-27	NMFS- Cont.	Frozen				Blubber, Muscle, Liver	WDFW- Archived
WDFW0607-28	NMFS- Cont.	Frozen				Blubber, Muscle, Liver	WDFW- Archived
WDFW0607-30	NMFS- Cont.	Frozen				Blubber, Muscle, Liver	WDFW- Archived
WDFW0607-18	NMFS-DA	Frozen		31-Jul-07	07-Aug-07	St. content	Domoic Acid testing
WDFW0707-08	NMFS-DA	Frozen		31-Jul-07	07-Aug-07	Urine x2, feces	Domoic Acid testing
WDFW0607-24	NMFS-DA	Frozen		31-Jul-07	07-Aug-07	Feces,	Domoic Acid testing
WDFW0607-28	NMFS-DA	Other		31-Jul-07	07-Aug-07	St. content	Domoic Acid testing
WDFW0607-27	NMFS-DA	Other		31-Jul-07	07-Aug-07	St. content	Domoic Acid testing
WDFW0607-18	NMML-Bob Delong	Frozen		22-Jun-07		Skeleton, Pelt	NMML Sk. Collection
WDFW0607-28	NMML-Bob DeLong	Frozen		24-Jul-07		Skeleton, Pelt	NMML Sk. Collection
WDFW0607-27	NMML-Bob DeLong	Frozen		31-Jul-07		Skeleton	NMML Sk. Collection
WDFW0607-30	NMML-Bob DeLong	Frozen		24-Jul-07		Skeleton	NMML Sk. Collection
WDFW0607-22	NMML-Bob DeLong	Frozen		22-Jun-07		Skeleton, Pelt	NMML Sk. Collection
WDFW0607-22	NMML-Food habits	Ethanol		22-Jun-07	20-Jan-10		Stomach content analysis
WDFW0607-18	NMML-Food habits	Alcohol		22-Jun-07	20-Jan-10		Stomach content analysis
WDFW0607-22	NMML-Genetics	Frozen		22-Jun-07		Skin- DMSO	Genetics
WDFW0607-24	NMML-Genetics	Other		12-Sep-07		Skin- DMSO	Genetics
WDFW0607-28	NMML-Genetics	Other		30-Jun-09		Skin- DMSO	Genetics
WDFW0607-27	NMML-Genetics	Other		30-Jun-09		Skin- DMSO	Genetics
WDFW0607-30	NMML-Genetics	Other		30-Jun-09		Skin- DMSO	Genetics
WDFW0607-18	NMML-Genetics	Other		22-Jun-07		Skin- DMSO	Genetics
WDFW0707-08	NMML-Genetics	Other		30-Jun-09		Skin- DMSO	Genetics
HMSC08-07-01-At	OSU	Formalin	HMSC08-07-01-At	20-Jul-08		Multiple tissues and fluid	Histopath
HMSC09-06-21-At	OSU	Formalin	HMSC09-06-21-At	22-Jun-09	31-Jul-11	Multiple tissues and fluid	Histopath
WDFW0707-08	PCVL	Other	707291008	29-Jul-07	29-Jul-07	Wh.blood, Serum, Urine, Feces	General Diagnostics/ Disease screening
WDFW0707-08	PCVL	Other	708061246	06-Aug-07	07-Aug-07	Wh. Blood, Serum	General Diagnostics
WDFW0607-18	Raverty	Frozen, Formalin, Alcohol	07/02988	24-Jul-07	08-Aug-07	Multiple tissues and fluid	Histopath and ancillary diagnostics
WDFW0607-24	Raverty	Frozen, Formalin	07/02989	24-Jul-07	08-Aug-07	Multiple tissues and fluid	Histopath and ancillary diagnostics
WDFW0607-22	Raverty	Frozen, Formalin	07/02990	24-Jul-07	06-Aug-07	Multiple tissues and fluid	Histopath and ancillary diagnostics
WDFW0607-28	Raverty	Frozen, Formalin	07/02992	24-Jul-07	06-Aug-07	Multiple tissues and fluid	Histopath and ancillary diagnostics
WDFW0607-27	Raverty	Frozen, Formalin	07/02991	24-Jul-07	06-Aug-07	Multiple tissues and fluid	Histopath and ancillary diagnostics
WDFW0607-30	Raverty	Frozen, Formalin	07/02993	24-Jul-07	06-Aug-07	Multiple tissues and fluid	Histopath and ancillary diagnostics
PSU07-06-23-At	Raverty	Frozen	10/05432	29-Dec-10	17-Feb-11	Multiple tissues and fluid	Histopath and ancillary diagnostics
HMSC07-06-24-At	Raverty	Frozen	10/01785	24-Jun-10	26-Jul-10	Multiple tissues and fluid	Histopath and ancillary diagnostics
HMSC07-07-01-At	Raverty	Frozen	10/01786	24-Jun-10	26-Jul-10	Multiple tissues and fluid	Histopath and ancillary diagnostics
HMSC08-07-01-At	Raverty	Other	10/01590	01-May-10	18-May-10	Multiple tissues and fluid	Histopath and ancillary diagnostics
PSU08-11-13-At	Raverty	Frozen	10/05431	29-Dec-10	17-Feb-11	Multiple tissues and fluid	Histopath and ancillary diagnostics
HMSC09-06-21-At	Raverty	Other	10/01591	10-Feb-10	10-May-10	Blocks for IHC	IHC
WDFW0607-28	UCD, PC	Frozen		03-Nov-07	09-Jan-08	Serum	Protozoal Serology
WDFW0707-08	UCD, PC	Frozen		03-Nov-07	09-Jan-08	Serum	Protozoal Serology
WDFW0607-18	WDA	Frozen	004750	25-Apr-08	20-May-08	Serum	Brucella and Lepto Serology
WDFW0607-22	WDA	Frozen	004749	25-Apr-08	20-May-08	Serum	Brucella and Lepto Serology
WDFW0607-28	WDA	Frozen	004756	25-Apr-08	20-May-08	Serum	Brucella and Lepto Serology
WDFW0607-27	WDA	Frozen	004755	25-Apr-08	20-May-08	Serum	Brucella and Lepto Serology
WDFW0607-18	WDFW/MMI	Frozen		30-Jun-07	30-Jun-07	Serum	In House- Brucella card test
WDFW0607-28	WDFW/MMI	Frozen		30-Jun-07	30-Jun-07	Serum	In House- Brucella card test
WDFW0607-27	WDFW/MMI	Frozen		30-Jun-07	30-Jun-07	Serum	In House- Brucella card test

Table 4. List of disease processes noted on gross and microscopic evaluations for Guadalupe fur seal strandings, 2007-2009.

Tissue/ organ	Disease process	Count	Tissue/ organ	Disease process	Count
Abdominal Cavity (n=2)			Lung (n=10)		
	Ascites	1		Atelectasis	3
	Peritonitis	1		Bronchopneumonia	2
Adrenal Gland (n=6)				Congestion	3
	Adrenalitis	2		Edema	9
	Hyperplasia	2		Pneumonia	2
Brain (n=9)				Pneumonia, Aspiration	1
	Congestion	2		Parasitism	2
	Edema	1		Thrombosis	1
	Encephalitis	1	Lymph nodes (n=9)		
	Encephalomyelitis	1		Congestion	1
	Meningoencephalitis	3		Edema	1
	Hemorrhage, meningeal	1		Hemorrhage	2
	Parasitism	9		Hyperplasia	5
Carcass (n=12)				Lymphadenitis	2
	Emaciation	12	Muscle, Skeletal (n=7)		
Gastrointestinal (n=9)				Atrophy	2
	Enteritis	1		Degeneration	1
	Fibrosis	1	Muscle, Diaphragm (n=7)		
	Gastritis	2		Myositis	1
	Gastroenteritis and colitis	5		Serosis	1
	Hemorrhagic	2	Pancreas (n=7)		
	Melena	1		Hemorrhage	1
	Parasitism	5	Skin and Adipose (n=7)		
Eye (n=4)				Fasciitis	1
	Coroiditis, Lymphoplasmitic	1		Hemorrhage/ Hematoma	2
	Congestion	1	Spleen (n=9)		
	Discharge	1		Hemorrhage	1
	Hyphema	1		Hemosiderosis	1
Gall bladder (n=3)				Necrosis	1
	Thrombosis	1	Thymus (n=8)		
Heart (n=10)		9		Edema	1
	Degeneration	2		Lymphoid depletion	1
	Endocarditis	1	Urogenital (n=8)		
Peripheral, vasculature (n=6)				Cystitis	1
	Parasitism	1		Inflammatory polyps	1
	Leukocytosis	1	Reproductive (n=5)		
Kidney (n=10)				Quiescent	3
	Congestion	1		Non-secretory	2
	Nephritis	2	External Parasites (23)		
	Pyelonephritis	1		Goose-neck Barnacles	10
Liver (n=10)					
	Cholangiohepatitis	2			
	Hemosderosis, heptocellular	1			
	Hepatitis	3			
	Necrosis	2			

* Total n= Samples with no overt lesions and /or sample decomposition/ freezing artifact hinder microscopic evaluation.

Table 5. Final case summary and primary, secondary, tertiary contributors cause of death for Guadalupe fur seals during UME.

PSN	Primary COD	Secondary COD	Tertiary COD	Final Case Summary
WDFW0607-18	Infectious (bacterial)	Malnutrition	Infectious (parasitic)	Malnutrition, stress associated with migration, secondary to bacterial infection. Gastritis, enteritis, nephritis, PCR positive to T. gondi, PCR positive to *T. gondii*
WDFW0607-22	Malnutrition	Infectious (parasitic)		Malnutrition. The multisystemic inflammatory infiltrate cumulatively would have contributed only mildly to moderately to impaired homeostasis. PCR postive for *T. gondii*
WDFW0607-24	Infectious (parasitic)	Malnutrition		Multisystemic inflammatory infiltrate and necrosis due to most likely a protozoal infection are profound. Positive on PCR- *T. gondii* 3 genotypes
PSU07-06-23-At	Incidental catch/ entanglement	Malnutrition	Infectious (parasitic)	Net entanglement, malnutrion. Positive on PCR *T. gondii* and *S.neurona* . Post mortem change and freeze artifact hampered microscopic assessment of the sectioned tissues. The history of having recovered this animal, wrapped in netting with subcutaneous hematomas in the shoulder and neck.
HMSC07-06-24-At	Malnutrition	Infectious (parasitic)		Malnutrition and parasitic- protozoal PCR positive for *T. gondii, S. neurona and N. caninium* like. Pronounced post mortem change and freeze artefact significantly impeded microscopic review and precluded determination of specific disease processes.
WDFW0607-27	Malnutrition	Infectious (parasitic)		Generalized emaciation, Protozoal infection- *T. gondii* coupled with the necrotizing hepatitis, multisystemic intravascular thrombosis, enteric parasitism and to a much lesser extent, interstitial pneumonia is sufficiently severe to account for the loss of this animal.
WDFW0607-28	Infectious (parasitic)	Malnutrition		Generalized emaciation, interstitial nephritis, encephalitis, vascular parasitism and portal hepatitis would likely have been sufficiently severe to have contributed at least moderately to antemortem morbidity and presumably the loss of this animal. Positive on PCR- *T. gondii* 3 distint genotypes and *S. neurona*
WDFW0607-30	Malnutrition	Infectious (parasitic)		Malnutrition, PCR positive for *S. neurona* and *N. canimuim*. Unable to determined due to decomposition
07-CM-072	Not Examined			Carcass found during COAAST dead bird survey; Picture taken to confirm species and basic measurement on beach. Advanced decomposition 75% body with gooseneck barnacles.
HMSC07-07-01-At	Malnutrition	Infectious (parasitic)		Malnutrion , parasitic- protozoal/ external. PCR positive for *T.gondi, S.neurona, N. caninium*- like. Pronounced post mortem change and freeze artifact significantly impeded microscopic review and precluded determination of specific disease processes.
HMSC07-07-01-At-2	Unable to Determine			Collect off beach and frozen used a teaching cavadar at OMB on further information on COD
HMSC07-07-03-At	Not Examined			Pictures and length taken. Carcass not collected; Moderate decomposition
HMSC07-07-17-At	Not Examined			Pictures taken. Carcass not collected; Moderate decomposition
HMSC07-07-19-At	Not Examined			Pictures and length taken. Carcass not collected; Moderate decomposition
PSU07-07-25-At	Not Examined			Pictures taken. Carcass not collected; Moderate decomposition
WDFW0707-08	Live-N/A			Live animal. Anemic and emaciated. Blind in one eye; Determined unreleasable transferred to Seaworld
JS-2007-2	Not Examined			Pictures and length and wieght taken. Carcass frozen and transferred to NMML. No necropsy conducted.
HMSC07-10-12-At	Not Examined			Pictures taken. Carcass not collected; Mummified/ skelatal decomposition
HMSC07-11-05-At	Not Examined			Pictures taken. Carcass not collected; Mummified/ skelatal decomposition
HMSC08-05-26-At	Not Examined			Pictures taken. Carcass not collected; Advanded decomposition and extensive scavenging
HMSC08-06-10-At	Not Examined			Pictures taken. Carcass not collected; Moderate decomposition
HMSC08-07-01-At	Accident/Trauma	Malnutrition	Infectious (parasitic)	Meninges: Acute to subacute hemorrhage, Lung: Subacute edema Adrenal: Mild multifocal lymphocytic adrenalitis.Urogenital: Focal inflammatory polyp, presumptive. PCR positive for *T. gondii, S. nuerona* and *N.caninium* like
HMSC08-07-12-At	Not Examined			Pictures taken. Carcass frozen. Not examined; Advanded decomposition and extensive scavenging
PSU08-11-13-At	Malnutrition	Infectious (parasitic)		Generalized emaciation, Protozoal PCR positive *S. neurona* and *T.gondii* .The tissues were autolyzed and there were no apparent lesions which may have contributed to the or loss of this animal.
HMSC09-06-09-At	Not Examined			Pictures taken. Carcass not collected; Moderate decomposition. Snout missing possibly removed. Not able to determine if human caused or the result of scavenging/ decomposition
HMSC09-06-21-At	Infectious (bacterial)	Malnutrition	Infectious (parasitic)	Emaciation. Enteritis and peritonitis, encephalomyelitis and emaciation resulted in a weakened state leading to an aspiration pneumonia. PCR positive *T. gondii, S.neurona*
HMSC09-06-24-At	Unable to Determine	Malnutrition	Infectious (parasitic)	No histpath conducted. Gross necropsy finding- Emaciated and PCR positive for *T. gondii* and *S. neurona*.
PSU09-08-04-At	Unable to Determine	Accident/ Trauma		Carcass collected frozen and gross examination by PSU. Skull crushed and hemmorhage thoughout animal, blood in abdominal cavity

Table 6. Bacteriology and virology PCR and culture results for Guadelupe fur seals during UME.

PSN	Pathogen	Test	Result	Level	Comments
WDFW0607-18	Brucella spp	PCR	Negative		Pooled sample of lung,lymph node, spleen, and brain.
WDFW0607-28	Brucella spp	PCR	Negative		Pooled sample of lung,lymph node, spleen, and brain.
WDFW0607-22	Brucella spp	PCR	Negative		Pooled sample of lung,lymph node, spleen, and brain.
WDFW0607-24	Brucella spp.	PCR	Negative		Pooled sample of lung,lymph node, spleen, and brain.
WDFW0607-27	Brucella spp.	PCR	Negative		Pooled sample of lung,lymph node, spleen, and brain.
WDFW0607-30	Brucella spp.	PCR	Negative		Pooled sample of lung,lymph node, spleen, and brain.
HMSC07-06-24-At	Canine Distemper Virus	PCR	Negative		Pooled tissue lung, lymph node, spleen, Thymus, skin
HMSC07-07-01-At	Canine Distemper Virus	PCR	Negative		Pooled tissue, thymus
WDFW0607-18	Canine Distemper Virus	PCR	Negative		pooled sample of lung,lymph node, spleen, and brain.
WDFW0607-22	Canine Distemper Virus	PCR	Negative		Pooled sample of lung, lymp node, brain, and spleen.
WDFW0607-24	Canine Distemper Virus	PCR	Negative		Pooled sample of, lung, lymph node, brain, and spleen.
WDFW0607-27	Canine Distemper Virus	PCR	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-28	Canine Distemper Virus	PCR	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-30	Canine Distemper Virus	PCR	Negative		pooled sample of lung, lymph node, brain, and spleen
HMSC07-06-24-At	Leptospira spp.	PCR	Negative		Pooled sample- Lung, spleen,Thymus, skin
PSU07-06-23-At	Leptospira spp.	PCR	Negative		Pooled Sample- Liver, kidney
PSU08-11-13-At	Leptospira spp.	PCR	Negative		Pooled Sample- Liver, kidney, Spleen
WDFW0607-18	Leptospira spp.	Special Stain	Negative		kidney- negative for spirochetes
WDFW0607-24	Leptospira spp.	Special Stain	Negative		kidney- negative for spirochetes
PSU07-06-23-At	Leptospira spp. (OSU)	PCR	Negative		Kidney
HMSC09-06-21-At	Leptospira spp. (OSU)	PCR	Negative		Kidney
HMSC08-07-01-At	Leptospira spp. (OSU)	PCR	Negative		Kidney
WDFW0607-22	Eschericia coli (non-haemolytic)	Culture	Positive	4+	Intestines
WDFW0607-30	Eschericia Sp.	Culture	Positive	1+	Lung
WDFW0607-24	Photobacterium damselae	Culture	Positive	1+	Intestines
WDFW0607-18	Plesiomonas shigellioids	Culture	Positive	1+	Lung, Lymph node, Spleen
WDFW0607-18	Pseudomonas putida	Culture	Positive	1+	Lung
HMSC07-06-24-At	Salmonella	Culture	Negative		Small intestine
HMSC07-07-01-At	Salmonella	Culture	Negative		Small intestine
WDFW0607-18	Salmonella	Culture	Negative		Small intestine
WDFW0607-22	Salmonella	Culture	Negative		Small intestine
WDFW0607-24	Salmonella	Culture	Negative		Small intestine
WDFW0607-27	Salmonella	Culture	Negative		Small intestine
WDFW0607-30	Salmonella	Culture	Negative		Small intestine
WDFW0607-28	Salmonella	Culture	Negative		Small intestine
WDFW0607-28	Streptococcus phocae	Culture	Positive	4+	Lung
WDFW0607-28	Streptococcus phocae	Culture	Positive	1+	Lymph node
WDFW0607-30	Streptococcus s. (alpha)	Culture	Positive	1+	Lung, Small intestine
WDFW0607-18	No Virus Isolated	Culture	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-22	No Virus Isolated	Culture	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-24	No Virus Isolated	Culture	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-27	No Virus Isolated	Culture	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-28	No Virus Isolated	Culture	Negative		pooled sample of lung, lymph node, brain, and spleen
WDFW0607-30	No Virus Isolated	Culture	Negative		pooled sample of lung, lymph node, brain, and spleen

Table 7. Protozoal PCR and IHC results and COD determination for Guadalupe fur seals during UME

Primary Stranding #	Tissue	Sarcocystis	Toxoplasma gondii	Neospora	IHC	Immediate Cause of Death	Contributing Factor	Incidental	CBD
HMSC07-06-24At	Summary	neurona	II/UX	caninium-like	Negative on brain for T.g, N.c., S.n.				Yes
HMSC07-06-24At	Lymph Node	neurona	UX	caninium-like					
HMSC07-06-24At	Brain	neurona	II	Neg					
HMSC07-06-24At	Muscle	neurona	Neg	Neg					
HMSC07-06-24At	Heart	neurona	Neg	Neg					
HMSC07-07-01At	Summary	neurona	X/I	caninium-like	Negative on brain for T.g, N.c., S.n.				Yes
HMSC07-07-01At	Brain	neurona	Neg	Neg					
HMSC07-07-01At	Lymph Node	neurona	X	caninium-like					
HMSC07-07-01At	Muscle	Neg	Neg	Neg					
HMSC07-07-01At	Heart	neurona	I	Neg					
HMSC08-07-01At	Summary	neurona	II	caninium-like	Negative on brain for T.g, N.c., S.n.		yes		
HMSC08-07-01At	Lymph Node	Neg	Neg	Neg					
HMSC08-07-01At	Brain	neurona	Neg	Neg					
HMSC08-07-01At	Muscle	neurona	II	caninium-like					
HMSC08-07-01At	Heart	neurona	Neg	Neg					
HMSC09-06-21At	Summary	neurona	I/II	Neg	Negative on brain for T.g, N.c., S.n.	yes			
HMSC09-06-21At	Muscle	neurona	I/II	Neg					
HMSC09-06-21At	Heart	neurona	UII	Neg					
PSU07-06-23At	Summary	neurona	X	Neg	No brain submitted				Yes
PSU07-06-23At	Muscle	neurona	X	Neg					
PSU08-11-13At	Summary	neurona	UII/UX	Neg	No brain submitted				Yes
PSU08-11-13At	Brain	neurona	UII/UX	Neg					
PSU08-11-13At	Tongue	neurona	UII/UX	Neg					
PSU08-11-13At	Muscle	neurona	UX	Neg					
PSU08-11-13At	Heart	neurona	UX	Neg					
PSU09-06-24At	Summary	neurona	UX	Neg	Not done				Yes
PSU09-06-24At	Muscle	neurona	UX	Neg					
WDFW0607-18	Summary	Neg	I/UI	Neg	Negative on brain for T.g, N.c., S.n.			yes	
WDFW0607-18	Heart	Neg	Neg	Neg					
WDFW0607-18	Brain	Neg	I/UI	Neg					
WDFW0607-22	Summary	Neg	UII/II	Neg	Negative on brain for T.g, N.c., S.n.		yes		
WDFW0607-22	Heart	Neg	II	Neg					
WDFW0607-22	Brain	Neg	UII	Neg					
WDFW0607-24	Summary	Neg	I, /UI/ UII	Neg	Positive staining on 2 L.N. for T.g., Negative on brain for T.g, N.c., S.n.		yes		
WDFW0607-24	FF Block 13 #2	Neg	T.g. no Genotype	Neg					
WDFW0607-24	Heart	Neg	UII	Neg					
WDFW0607-24	Brain	Neg	I/UI	Neg					
WDFW0607-24	FF- block- 15#2	Neg	T.g. no Genotype	Neg					
WDFW0607-27	Summary	Neg	T.g. no Genotype	Neg	Positive staining in Medullary L.N. Negative on brain for T.g, N.c., S.n.		yes		
WDFW0607-27	FF- block-1 #2	Neg	T.g. no Genotype	Neg					
WDFW0607-28	Summary	neurona	I,/UI/ UII	Neg	Negative on brain for T.g, N.c., S.n.			yes	
WDFW0607-28	Heart	neurona	I,/UI/UII	Neg					
WDFW0607-28	Brain	neurona	I	Neg					
WDFW0607-28	Mediastinal LN	neurona	Neg	Neg					
WDFW0607-28	FF- block- 15#2	Neg	T.g. no Genotype	Neg					
WDFW0607-30	Summary	neurona	Neg	Neg	Negative on brain for T.g, N.c., S.n.				yes
WDFW0607-30	Brain	neurona	Neg	Neg					
WDFW0607-30	Heart	neurona	Neg	caninium					

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Table 8. Domoic Acid levels in Guadalupe fur seals and other pinnipeds stranding during 2007-2009 UME.

PSN	Date	Species	Sample	Domoic Acid (ug DA/g tissue)	Location	Comments
WDFW0607-24	20-Jun-07	Guadalupe fur seal	feces	*bdl*	Ocean Shores, WA	Tested on HPLC-UV
WDFW0607-18	21-Jun-07	Guadalupe fur seal	stomach content	*bdl*	Moclips, WA	Tested on HPLC-UV
WDFW0607-28	26-Jun-07	Guadalupe fur seal	stomach content	*bdl*	Twin Harbor, WA	Tested on HPLC-UV
WDFW0607-27	26-Jun-07	Guadalupe fur seal	stomach content	*bdl*	Twin Harbor, WA	Tested on HPLC-UV
WDFW0707-08	28-Jul-07	Guadalupe fur seal	urine (1st urinatition)	*bdl*	Ocean Shores, WA	Interferring compound that gave a positive by HPLC, but negative by LC/MS
WDFW0707-08	28-Jul-07	Guadalupe fur seal	urine (later urination)	*bdl*	Ocean Shores, WA	Interferring compound that gave a positive by HPLC, but negative by LC/MS
WDFW0707-08	29-Jul-07	Guadalupe fur seal	feces	*bdl*	Ocean Shores, WA	Tested on HPLC-UV
MKH ZC 0408	8-May-08	California sea lion	urine	*bdl*	Neah Bay, WA	Analyzed by Biosense ELISA
WDFW 2008-117	25-Oct-08	California sea lion	feces	*bdl*	Moclips, WA	
WDFW2009-085	29-Aug-09	California sea lion	feces	*bdl*	Ocean Shores, WA	Analyzed by Biosense ELISA
WDFW2009-085	29-Aug-09	California sea lion	stom cont	*bdl*	Ocean Shores, WA	Analyzed by Biosense ELISA
WDFW2009-086	29-Aug-09	California sea lion	feces	**8.5**	Ocean Shores, WA	Analyzed by Biosense ELISA
WDFW2009-086	29-Aug-09	California sea lion	urine	**1.5**	Ocean Shores, WA	Analyzed by Biosense ELISA
WDFW0407-03	11-Apr-07	Harbor Seal	feces	*bdl*	Ocean Shores, WA	Tested on HPLC-UV
WDFW0507-02	9-May-07	Harbor Seal	urine	*bdl*	Ocean Shores, WA	Tested on HPLC-UV
WDFW0507-11	1-Jun-07	Harbor Seal	feces	*bdl*	Westport, WA	Tested on HPLC-UV
WDFW0607-14	21-Jun-07	Harbor Seal	urine	*bdl*	La Push, WA	Tested on HPLC-UV
WDFW0607-29	26-Jun-07	Harbor Seal	feces	*bdl*	Long Beach,WA	Tested on HPLC-UV
WDFW0807-03	13-Aug-07	Harbor Seal	feces	*bdl*	Grayland, WA	Tested on HPLC-UV
WDFW0807-03	13-Aug-07	Harbor Seal	urine	*bdl*	Grayland, WA	Tested on HPLC-UV
WDFW2008-038	2-May-08	Harbor Seal	feces	*bdl*	Long Beach, WA	Tested on HPLC-UV
WDFW2008-038	2-May-08	Harbor Seal	stom cont	*bdl*	Long Beach, WA	Tested on HPLC-UV
WDFW2008-053	28-May-08	Harbor Seal	feces	**4.9**	Westport, WA	Tested on HPLC-UV
WDFW2008-053	28-May-08	Harbor Seal	stom cont	*bdl*	Westport, WA	Tested on HPLC-UV
WDFW2008-053fetus	30-May-08	Harbor Seal	urine	**0.7**	Westport, WA	Tested on HPLC-UV
WDFW2008-078	2-Jul-08	Harbor Seal	urine	**0.5**	Long Beach	Tested on HPLC-UV
WDFW2008-088	29-Jul-08	Harbor Seal	urine	0.4	Grayland, WA	Tested on HPLC-UV
WDFW2009-016	21-Mar-09	Harbor Seal	feces	*bdl*	Oysterville, WA	Tested on HPLC-UV
WDFW2009-032	3-Jun-09	Harbor Seal	feces	*bdl*	Ocean City, WA	Tested on HPLC-UV
WDFW2009-041	11-Jun-09	Harbor Seal	feces	*bdl*	Westport, WA	Tested on HPLC-UV
WDFW2009-053	01-Jul-09	Harbor Seal	feces	*bdl*	Seaview, WA	Tested on HPLC-UV
WDFW2009-053	01-Jul-09	Harbor Seal	urine	*bdl*	Seaview, WA	Tested on HPLC-UV
WDFW2009-061	01-Aug-09	Harbor Seal	feces	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW2009-061	01-Aug-09	Harbor Seal	stom cont	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW2009-061	01-Aug-09	Harbor Seal	urine	**0.5**	Westport, WA	Analyzed by Biosense ELISA
WDFW2009-067	09-Aug-09	Harbor Seal	serum	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW2009-067	09-Aug-09	Harbor Seal	feces	**9.2**	Westport, WA	Analyzed by Biosense ELISA
WDFW2009-067	09-Aug-09	Harbor Seal	urine	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW2009-071	09-Aug-09	Harbor Seal	feces	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW 0607-17	16-Jun-07	Northern elephant seal	feces	*bdl*	Ocean City, WA	Tested on HPLC-UV
WDFW 2009-036	11-Jun-09	Northern elephant seal	feces	*bdl*	Moclips, WA	Tested on HPLC-UV
WDFW 0307-03	13-Mar-07	Steller sea lion	feces	**18.8**	Westport, WA	Tested on HPLC-UV
WDFW 0507-04	16-May-07	Steller sea lion	feces	*bdl*	Grayland, WA	Tested on HPLC-UV
WDFW 0507-04	16-May-07	Steller sea lion	intestinal cont.	*bdl*	Grayland, WA	Tested on HPLC-UV
WDFW 0507-07	18-May-07	Steller sea lion	stomach cont.	*bdl*	North Cove, WA	Tested on HPLC-UV
WDFW 0907-16	24-Sep-07	Steller sea lion	feces	*bdl*	Westport, WA	Tested on HPLC-UV
WDFW 1007-04	4-Oct-07	Steller sea lion	feces	*bdl*	Ocean Shores, WA	Tested on HPLC-UV
WDFW 2008-021	10-Mar-08	Steller sea lion	urine	**0.6**	Nahcotta, WA	Tested on HPLC-UV
WDFW 2008-021	10-Mar-08	Steller sea lion	feces	*bdl*	Nahcotta, WA	Tested on HPLC-UV
WDFW 2008-058	9-Jun-08	Steller sea lion	feces	*bdl*	Westport, WA	Tested on HPLC-UV
WDFW 2008-058Fetus	10-Jun-08	Steller sea lion	feces	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW 2009-038	9-Jun-09	Steller sea lion	thoracic fluid	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW 2009-038	9-Jun-09	Steller sea lion	pericardial fluid	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW 2009-038	9-Jun-09	Steller sea lion	stomach cont.	*bdl*	Westport, WA	Analyzed by Biosense ELISA
WDFW 2009-038	9-Jun-09	Steller sea lion	feces	*bdl*	Westport, WA	Analyzed by Biosense ELISA

bdl = below reliable detection limit

detection limits for **DA** by sample type:

feces	4.0 ng/g
stomach cont	2.0 ng/g
urine	0.4 ng/g
serum	0.4 ng/g
milk	2.0 ng/g
thoracic fl	1.0 ng/g
pericardial fl	1.0 ng/g

To put these DA values in perspective, the regulatory limit for DA in shellfish tissue is 20 ug/g (=20,000 ng/g, to use the same units reported here)

Table 9. Serological disease screening results for Guadelupe fur seal UME

Primary Stranding Number	Lab	Test	Tissue	Titre	Result
WDFW0607-18	WDFW/MMI	Brucella Card	Serum	Pos	Suspect
WDFW0607-22	WDFW/MMI	Brucella Card	Serum	Pos	Suspect
WDFW0607-27	WDFW/MMI	Brucella card	Serum	Neg	Negative
WDFW0607-18	WDA	Brucella RAP	Serum	Neg	Negative
WDFW0607-22	WDA	Brucella RAP	Serum	Neg	Negative
WDFW0607-27	WDA	Brucella RAP	Serum	Neg	Negative
WDFW0607-28	WDA	Brucella RAP	Serum	Neg	Negative
WDFW0707-08	AHDC, NY	Brucellosis	Serum	Neg	Negative
WDFW0707-08	OADDL	L. bratislva	Serum	Neg	Negative
WDFW0607-18	WDA	L. cancinola	Serum	Neg	Negative
WDFW0707-08	OADDL	L. canicola	Serum	Neg	Negative
WDFW0607-27	WDA	L. canicola	Serum	Neg	Negative
WDFW0607-28	WDA	L. canicola	Serum	Neg	Negative
WDFW0707-08	OADDL	L. grippo	Serum	Neg	Negative
WDFW0607-18	WDA	L. grippo	Serum	1:200	Suspect
WDFW0607-27	WDA	L. grippo	Serum	Neg	Negative
WDFW0607-28	WDA	L. grippo	Serum	Neg	Negative
WDFW0707-08	OADDL	L. hardjo	Serum	Neg	Negative
WDFW0607-18	WDA	L. hardjo	Serum	Neg	Negative
WDFW0607-27	WDA	L. hardjo	Serum	Neg	Negative
WDFW0607-28	WDA	L. hardjo	Serum	Neg	Negative
WDFW0707-08	OADDL	L. ictero	Serum	Neg	Negative
WDFW0607-18	WDA	L. ictero	Serum	Neg	Negative
WDFW0607-27	WDA	L. ictero	Serum	Neg	Negative
WDFW0607-28	WDA	L. ictero	Serum	Neg	Negative
WDFW0707-08	OADDL	L. pomona	Serum	Neg	Negative
WDFW0607-18	WDA	L. pomona	Serum	1:200	Suspect
WDFW0607-27	WDA	L. pomona	Serum	Neg	Negative
WDFW0607-28	WDA	L. pomona	Serum	Neg	Negative
WDFW0607-22	WDA	Leptospira	Serum	Autoclumping	N/V
WDFW0707-08	OADDL	CDV SN	Serum	<4	Negative
WDFW0707-08	OADDL	PDV SN	Serum	<4	Negative
WDFW0707-08	OADDL	PHV-Type 1	Serum	<4	Negative
WDFW0707-08	OADDL	PHV-Type 2	Serum	<4	Negative
WDFW0607-28	UCD, PC	N. caninium	Serum	<1:40	Negative
WDFW0707-08	UCD, PC	N. caninium		<1:40	Negative
WDFW0607-28	UCD, PC	S. neurona	Serum	<1:40	Negative
WDFW0707-08	UCD, PC	S. neurona		<1:40	Negative
WDFW0607-28	UCD, PC	T. gondii	Serum	<1:40	Negative
WDFW0707-08	UCD, PC	T. gondii		<1:40	Negative

Table 10. Trace mineral levels in liver of Guadelupe fur seals during UME.

Trace minerals	**n=**	Min	Max	Average
Ca-t	9	37	64	53.44
Cd-t	9	<.2	2.2	0.50
Cu-t	9	15	47	33.73
Fe-t	4	169	331	222.00
Hg-t	9	0.8	5.6	1.71
Mg-t	9	154	262	197.11
Mn-t	9	3.1	6	4.86
Pb-t	4	<2		<2
Se-t	9	2.66	5.14	3.80
VitA-l	9	139	2558	814.56
Zn-t	9	49	160	107.22

Appendixes

Figure 1. Tracking map for “Mica” rehabitlited at Alaska Sea Life Center and released off the coast of California. (http://www.alaskasealife.org/New/rehabilitation/rehab-tracking-detail.php?id=2 . Access December, 2011)

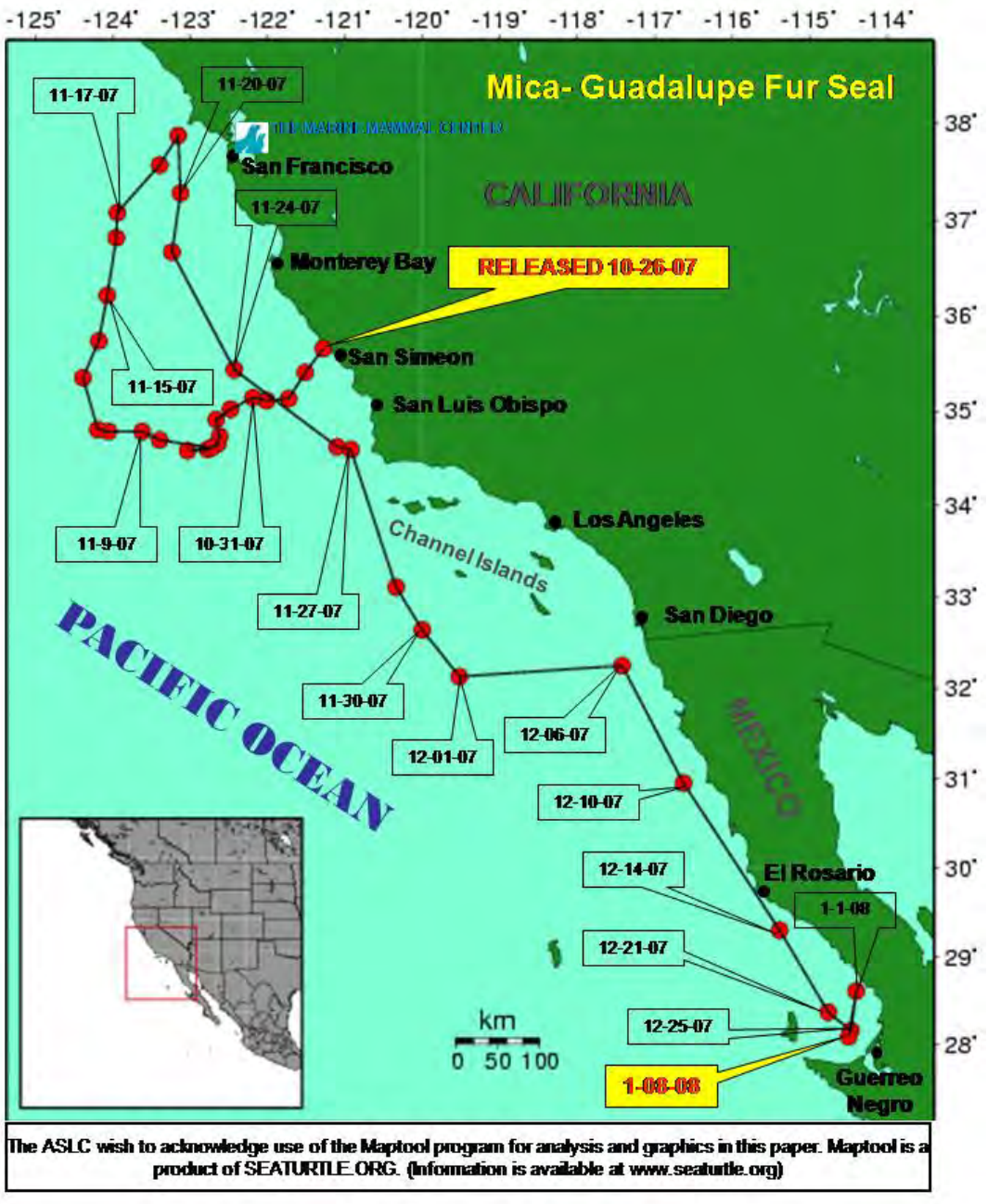

Figure 2. The PDO and the MEI indices and monthly sea surface temperature anomalies at NOAA Bouy 46050, 22 miles west of Newport, OR. (Peterson et al. 2011)

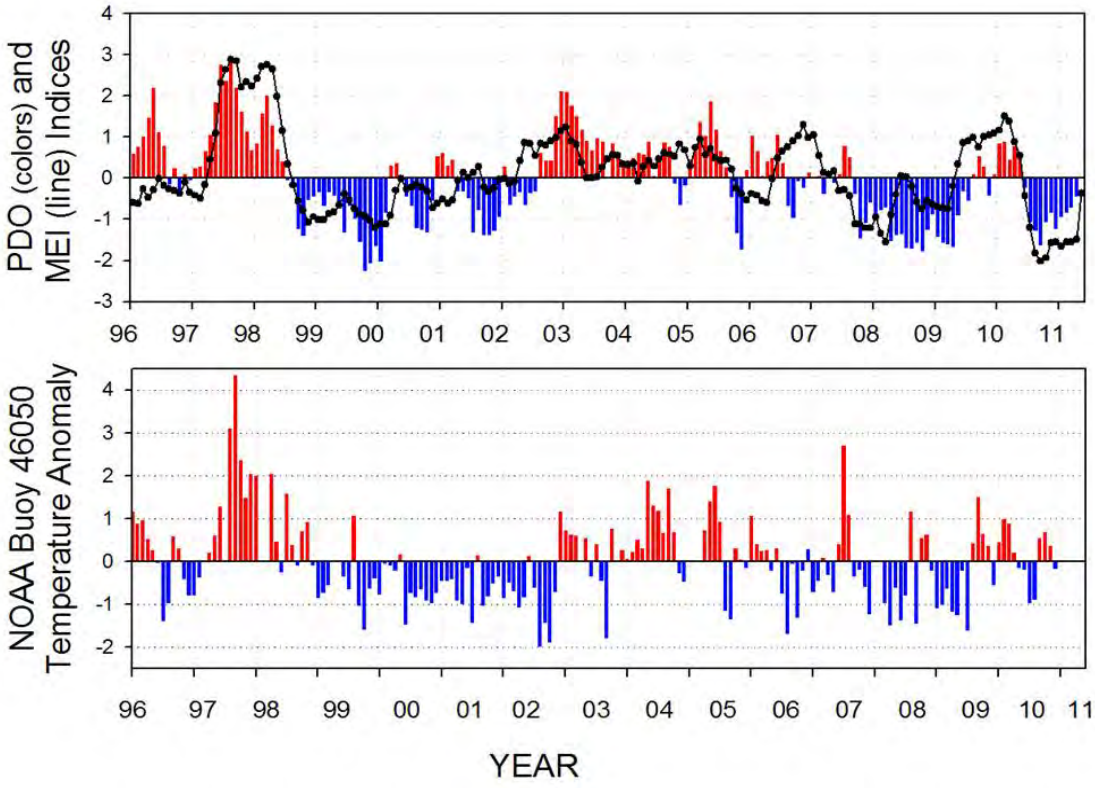

Figure 3. Anomalies in the the coastal Upwelling index during May to September each year, 1946-2010. (Peterson et al. 2011)

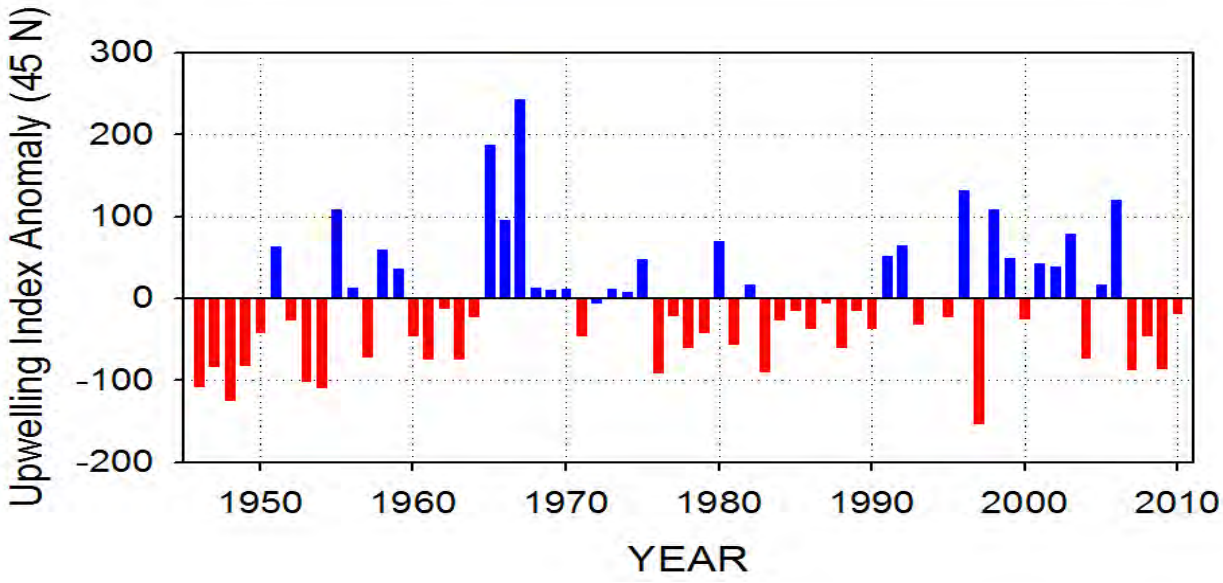

Figure 3. Anomalies in Copepod species richness compared to PDO and MEI 1996-2010. (Peterson et al. 2011)

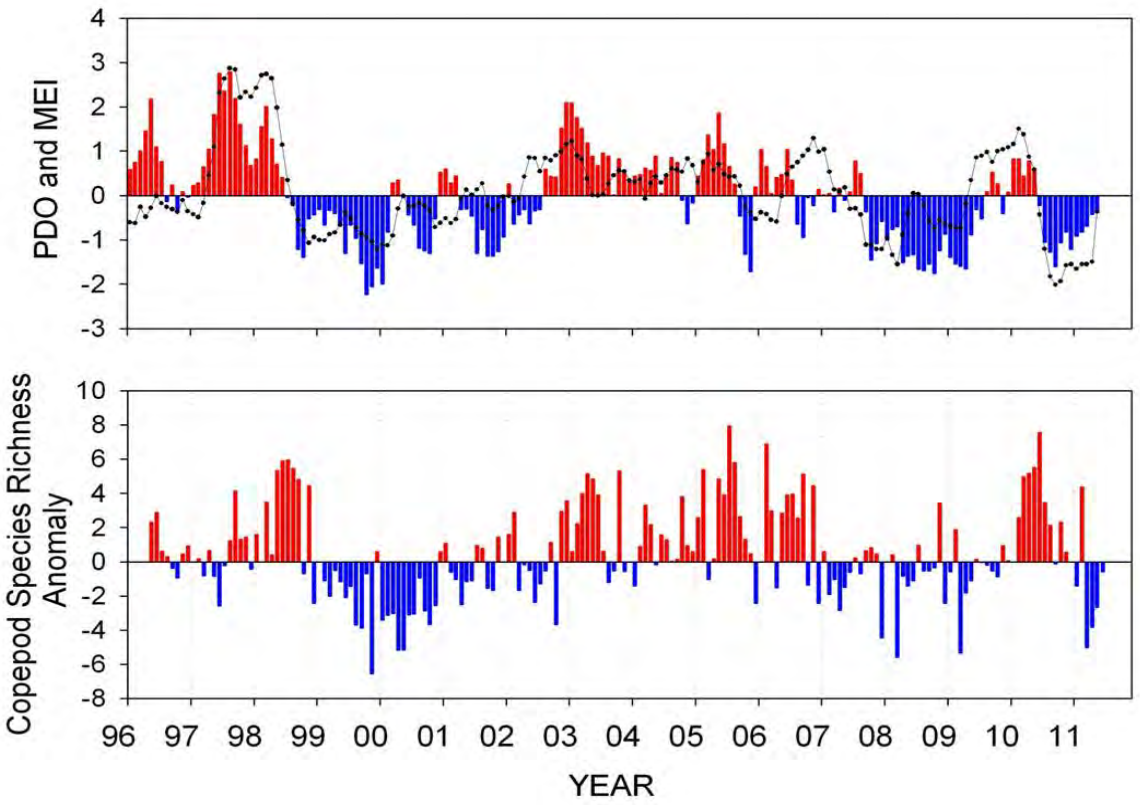

Table 1. Mulivaraiate ENSO Index (MEI) table for 1992-2011. Highlighted is when Guadalupe fur seal strandings occurred in Oregon and Washington. NOAA Climate Prediction Center. ENSO Impacts on the U.S. – Previous Events. Accessed 14 May 2012

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1992	1.8	1.6	1.5	1.4	1.2	0.8	0.5	0.2	0	-0.1	0	0.2
1993	0.3	0.4	0.6	0.7	0.8	0.7	0.4	0.4	0.4	0.4	0.3	0.2
1994	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.9	1.2	1.3
1995	1.2	0.9	0.7	0.4	0.3	0.2	0	-0.2	-0.5	-0.6	-0.7	-0.7
1996	-0.7	-0.7	-0.5	-0.3	-0.1	-0.1	0	-0.1	-0.1	-0.2	-0.3	-0.4
1997	-0.4	-0.3	0	0.4	0.8	1.3	1.7	2	2.2	2.4	2.5	2.5
1998	2.3	1.9	1.5	1	0.5	0	-0.5	-0.8	-1	-1.1	-1.3	-1.4
1999	-1.4	-1.2	-0.9	-0.8	-0.8	-0.8	-0.9	-0.9	-1	-1.1	-1.3	-1.6
2000	-1.6	-1.4	-1	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1	1.1	1.3	1.5	1.4
2003	1.2	0.9	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.9	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.1	1.1
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1	-1.1	-1.3
2008	-1.4	-1.4	-1.1	-0.8	-0.6	-0.4	-0.1	0	0	0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6	0.7	0.8	0.9	1.2	1.5	1.8
2010	1.7	1.5	1.2	0.8	0.3	-0.2	-0.6	-1	-1.3	-1.4	-1.4	-1.4
2011	-1.4	-1.3	-1	-0.7	-0.4	-0.2	-0.2	-0.3	-0.6	-0.8	-1	-1
2012	-0.9	-0.7	-0.5	-0.3								

Blue= La Nina events; Red= El Nino events: Orange Highlights = Time when Guadalupe fur seal stranding occurred in Oregon and Washington

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