ASSESSMENT OF THE RISK OF ZOONOTIC DISEASE TRANSMISSION TO MARINE MAMMAL WORKERS AND THE PUBLIC:

SURVEY OF OCCUPATIONAL RISKS

Final Report
Research Agreement Number K005486-01

Prepared for:

United States Marine Mammal Commission

Wildlife Health Center
School of Veterinary Medicine
University of California, Davis

ASSESSMENT OF THE RISK OF ZOONOTIC DISEASE TRANSMISSION TO MARINE MAMMAL WORKERS AND THE PUBLIC: SURVEY OF OCCUPATIONAL RISKS

By Jonna A.K. Mazet, Tania D. Hunt and Michael H. Ziccardi

Contributions from Frances M.D. Gulland, Teri Rowles and Michelle M. Manos

---

Final Report
Research Agreement Number K005486-01

Prepared for:

United States Marine Mammal Commission

Wildlife Health Center
School of Veterinarian Medicine
One Shields Avenue
University of California
Davis, California 95616, USA

Davis, California
2004

TABLE OF CONTENTS

ABSTRACT

Marine mammals can be infected with or be healthy carriers of zoonotic pathogens, disease agents transmissible from animals to humans. While isolated cases of human disease acquired through contact with marine mammals have been reported, no evaluation of the risks associated with marine mammal work or volunteering has been attempted. Therefore, we designed a survey to estimate the risk of work-related injuries and illnesses in marine mammal workers and volunteers. Survey participants were solicited at the Biennial Conference on the Biology of Marine Mammals (November 28-December 3, 2001, Vancouver, British Columbia, Canada) and the International Association for Aquatic Animal Medicine (May 4- 8, 2002, Albufeira, Portugal) and through the Marmam listserv. A 17-question survey asked respondents to describe their contact with marine mammals, injuries sustained, and/or illnesses acquired during their period of marine mammal exposure.

Most respondents, 88% (423/483), were researchers and rehabilitators. Fifty percent (243/483) of the respondents reported suffering an injury caused by a marine mammal; 23% (110/483) reported having a skin rash or reaction. Marine mammal work-related illnesses commonly reported by survey participants included: seal finger, conjunctivitis, viral dermatitis, bacterial dermatitis, and non-specific contact dermatitis. Severe illnesses were less commonly reported but did include tuberculosis, leptospirosis, brucellosis, and serious sequelae to seal finger (e.g. surgery and septicemia). Respondents' comments indicated that, upon their initial visit to medical facilities, physicians rarely had the information necessary to make appropriate treatment recommendations given the patients' marine mammal exposure. When knowledgeable, patients educated their physicians about the pathogens that marine mammals carry. Multiple respondents consulted with wildlife and zoo veterinarians in order to provide adequate information to their physicians on follow-up visits.

Prolonged and frequent exposure to marine mammals were significant risk factors associated with injury and illness. Other significant risk factors were contact with live marine mammals (versus contact with carcasses, water, or enclosures) and contact with

biologic material, such as blood or excretions. Adherence to safety guidelines and the use of protective clothing are recommended to decrease the occurrence of adverse health experiences by marine mammal caretakers and researchers. Training of students and volunteers handling marine mammals should include education on disease risks associated with the zoonotic diseases these animals may carry. A new website (www.vetmed.ucdavis.edu/whc/mmz) and health and safety brochure have been developed to make information about possible disease transmission from marine mammals more readily available to the public and physicians.

Keywords: marine mammal, disease, zoonoses, occupational hazards, seal finger

Acknowledgments:

This study was funded by the United States Marine Mammal Commission through Research Agreement number K005486-01. The authors thank David W. Hird for his input on survey design and implementation, as well as all of the survey participants for their candid and informative responses.

SURVEY OF OCCUPATIONAL RISKS FOR MARINE MAMMAL WORKERS

Introduction

Despite the fact that marine mammals can be infected with or be healthy carriers of viral, bacterial, fungal and protozoal zoonotic pathogens (disease agents transmissible from animals to humans), the risk of acquiring disease by scientists, wildlife rehabilitators, and animal trainers handling marine mammals is not well understood (Buck and Schroder 1990; Cowan et al. 2001). Common examples of such transmissible diseases include "seal finger," a common skin infection reported in whalers and sealers caused by a mycoplasmal organism carried in the mouth and on the skin of marine mammals (Hartley and Pitcher 2002). Epidemics of food borne illnesses, such salmonellosis, trichinellosis and toxoplasmosis have also been reported in the native peoples of arctic and Australasian regions who harvest marine mammals as part of a traditional diet (Cawthorn 1997; Tryland 2000).

Zoonotic disease transmission has been infrequently documented as a result of occupational contact between marine mammals and humans. Although hundreds of seal finger cases have been reported in fishermen, only eight cases in scientists or rehabilitators have been described (Markham and Polk 1979; Sargent 1980; Eadie et al. 1990; Cawthorn 1994; Hartley and Pitcher 2002). Other reports of marine mammal workers acquiring skin diseases include: one case of *Mycobacterium marinum* from a bottlenose dolphin (*Tursiops truncatus*; Flowers 1970); four cases of *Erysipelothrix rhusiopathiae* from a beached pilot whale (*Globicephala melaena;* Chastel; one case of a calicivirus, San Miguel Sea Lion virus, from northern fur seals (*Callorhinus ursinus;* Smith et al. 1998); and two cases of seal pox from gray seals (*Halichoerus grypus;* Thompson et al. 1993). Infections with *M. marinum* and *E. rhusiopathiae* caused painful dermal abscesses at the site of contamination, while the viral infections, seal pox and San Miguel sea lion virus, resulted in edematous nodules or vesicles. One case of *Blastomyces dermatitidis* acquired from a bottlenose dolphin has been reported; a veterinarian treating the affected animal experienced a pustular dermatitis with lymphangitis and lymphadenitis (Cates et al. 1986). One case of *Mycobacterium bovis*

from a New Zealand fur seal (*Arctocephalus forsteri*) was reported in an oceanarium worker (Thompson et al. 1993); the seal trainer experienced a tuberculous pneumonia and severe airway obstruction. Three researchers acquired leptospirosis from California sea lion (*Zalophus californianus*) carcasses, and experienced acute nephritis and clinical signs consistent with acute renal failure (Baker et al. 1998). Finally, four aquarium workers suffered from severe purulent conjunctivitis caused by influenza A virus acquired from harbor seals (*Phoca vitulina*; Webster et al. 1981). These case reports document the potential for organisms in marine mammals to infect humans. However, they do not provide any information on the relative risks associated with humans acquiring such infections.

In the United States, the Marine Mammal Protection Act of 1972 stimulated increased efforts to rescue and rehabilitate sick and injured marine mammals. Animal trainers, veterinarians, and volunteers that staff wildlife rehabilitation centers treating sick and injured marine mammals, as well as those who work at aquaria and oceanaria that exhibit marine mammals to the public, may be at risk. During certain recreational activities the public may also be at risk of acquiring diseases from marine mammals. Thousands of tourists participate in “swim-with-the-dolphin” programs each year. In 1989, over 8,000 people participated in these programs in the United States alone (National Marine Fisheries Service 1990). While information on the injurious attacks made by dolphins on humans is available, little attention has been paid to the potential for transmission of infectious diseases.

The purpose of this study was to evaluate the risk of human injury and illness associated with marine mammal captive management and research activities by surveying a sample of people involved in these activities.

Methods

Survey Administration and Participants

A 17-question survey was formulated to evaluate the risk of injury and illness associated with occupational contact with marine mammal species (Appendix 1). After piloting in a small group of marine mammal workers and review by experts in the field,

the survey was made available *via* the Internet. Participants were sought primarily by e-mail notices posted on the Marmam listserv.[1] A paper-based version of the same questionnaire was also made available to participants of both the Biennial Conference on the Biology of Marine Mammals (November 28- December 3, 2001, Vancouver, British Columbia, Canada) and the International Association for Aquatic Animal Medicine (May 4- 8, 2002, Albufeira, Portugal), as well as to individuals upon request. Postcards containing the questionnaire's web address were also provided at the conferences. Respondents participated in complete anonymity.

The survey was available for response from December 2001 to September 2002. Responses originating from the web-based questionnaire were collected electronically; the paper-based responses were received by mail at the Wildlife Health Center, University of California, Davis, California, USA.

Survey Content

The 17 questions allowed for evaluation of the respondents' interactions with marine mammals and the description of injuries and illnesses suffered by respondents during the time in which they were exposed to marine mammals (Appendix 1). Questions regarding respondents' association with marine mammals revealed the nature of occupational contact (research, rehabilitation, zoo and aquaria employment, and "swim-with-the-dolphin" programs; Appendix 1 – question 4), the duration and frequency of contact (questions 1 and 2), the type of marine mammal-specific occupational training received (question 5), and the specific mode of contact (direct contact with live marine mammals while out of water, direct contact with live marine mammals while in the water with them, contact with water in which a marine mammal has swum, contact with marine mammal excretions and/or vomitus, contact with tissue or blood samples from marine mammals, cleaning or repairing enclosures or equipment used in the care of marine mammals, and contact with dead marine mammals; question 3). Participants could select only one type of occupational contact but were allowed to

[1]MARMAM is an edited e-mail discussion list which focuses on marine mammal research and conservation, run through the University of Victoria. (www.dal.ca/~whitelab/marmam.htm) Publishers: Robin Baird, Sascha Hooker, Daniel Palacios and Siri Hakala; marmamed@uvic.ca

indicate more than one type of training and specific mode of contact. Questions regarding respondents' injuries and illnesses were designed to explore the nature and duration of the injuries and associations with marine mammal contact (questions 6 - 13). Additional questions evaluated the demographics and health of the respondents (questions 14 - 16) and allowed respondents to describe any specific treatments received for their reported illnesses and injuries including the success of those treatments (question 17).

Data Analysis

The prevalence of four major health outcomes (trauma, skin rash or reaction, respiratory illness, and prolonged malaise) was calculated from the total number of respondents. The major outcomes were further examined for severity and occurrence subsequent to or as a result of marine mammal contact.

Logistic regression was used to evaluate potential risk factors associated with the four major outcomes (trauma, skin rash/reaction, respiratory illness, and prolonged malaise) using the backward stepwise likelihood ratio method (Daniel 1999). Odds ratios and 95% confidence intervals (CI) were calculated in order to assess the magnitude of associations (SPSS, release 11.0.1, Chicago, Illinois, U.S.A.). Where appropriate, interaction terms among contact types, and duration and frequency of contact were included in the logistical equation.

Results

Survey Response and Respondent Characteristics

A total of 483 unique responses were returned, 413 of which were collected via the Internet. Forty-five percent of respondents were male; 55% were female. The largest proportion of respondents (283/483) identified research as their major type of occupational marine mammal contact (Figure 1). Nearly 80% (386/483) of respondents reported receiving training in animal restraint and handling, 76% in tissue and blood sampling, 44% in infectious disease prevention protocols, and 49% in occupational

safety. Most respondents (392/483) had substantial exposure to marine mammals with more than 5 years of experience and/or greater than 50 days per year of contact (Figures 2 and 3)

Sixty-four percent of respondents (308/483) reported having had an injury or illness during the time they were in contact with marine mammals; 54% of all respondents (n = 261) believed they had contracted an illness or injury as a direct result of marine mammal contact. Types and severity of injuries and illnesses were varied (Table 1).

Trauma

A total of 251 (52%) respondents suffered a traumatic injury as a result of working with marine mammals. Injuries were located on the extremities 218/251 (89%), on the torso or abdomen 20/251 (8%), and on the face 11/251 (4%). Ninety people, 36% of those reporting trauma, suffered one or more severe injuries including: a deep wound (77), a deep wound requiring stitches (26), or a fractured bone (10). Other severe injuries described included a dislocated shoulder and an amputation. Thirty-eight people, 15% of those reporting a traumatic injury, reported having been bitten. Of the reported injuries 5 were self-inflicted traumas, such as needle sticks and necropsy knife cuts.

Statistically significant risk factors ($\alpha \leq 0.05$) associated with injuries included marine mammal contact duration of greater than 5 years; contact frequency of more than 50 days per year; having contact specifically with live animals, excretions and/or vomitus, or blood and tissue samples. The factors related to time carried the highest risk, with those exposed most frequently having 23 times (95% CI 5.3-99.3) greater odds of experiencing a traumatic injury and those exposed for the longest duration having 19 times (95% CI 3.9-87.4) greater odds of experiencing a traumatic injury than workers with less exposure (determined using multivariate logistic regression). Having both exposure to enclosures and equipment and a contact duration of greater than 5 years also increased the odds of injury 4 times (95% CI 1.3-10.5) above workers who primarily had contact with marine mammal carcasses and a shorter contact duration. Conversely, having worked with tissue or blood samples combined with greater than 5

years of marine mammal experience decreased odds for injury. Interacting with live marine mammals combined with a contact frequency of greater than 50 days per year was similarly protective for trauma (Table 2).

External Ailments

One hundred thirteen respondents (23%) reported having a skin rash or reaction during the time they worked with marine mammals. Seventy-three of these (64%) reported that their skin rash or reaction occurred subsequent to direct contact with a marine mammal, while 36 (32%) reported that the ailment appeared subsequent to a bite from a marine mammal. The odds of workers acquiring a skin rash or reaction were doubled by having marine mammal contact for greater than 5 years (95% CI 1.2-2.8) or more then 50 days per year (95% CI 1.1-2.7); by having contact with marine mammal excretions and/or vomitus (95% CI 1.1-4.3); and by cleaning or repairing enclosures or equipment (95% CI 1.1-3.1; Table 3.

Illnesses commonly reported included seal finger (caused by either *Mycoplasma spp*. or *Erysipelothrix rhusiopathiae*) diagnosed either by survey participants themselves, consulting veterinarians, or their physicians; viral dermatitis (poxvirus, herpesvirus); bacterial dermatitis (caused by *Pseudomonas spp*., *Staphylococcus aureus*, *Mycobacterium marinum*); and non-specific contact dermatitis. Fifty-five people (11% of respondents) reported having had seal finger; however, there were no statistically significant risk factors specifically associated with acquiring seal finger.

Respiratory Illness

Eighty-nine people, 18% of the total respondents, reported experiencing respiratory illness during the time they worked with marine mammals. Of those, only 20% (18/89) believed their ailment to be the result of marine mammal contact. Increased frequency of contact was associated with a higher risk of respiratory illness with workers exposed more than 50 days per year being 3 times more likely to have a respiratory illness than workers with less annual exposure (95% CI 1.9-5.4).

Generalized Symptoms and Prolonged Malaise

Thirty people, 6% of all respondents, reported having suffered prolonged malaise during the time in which they worked with marine mammals. Of those, 30% (9/30) believed their illness was due to marine mammal contact. Many of these cases were never definitively diagnosed despite the workers seeking medical treatment. There were no statistically significant risk factors associated with prolonged malaise.

Discussion

Survey results can only be generalized to the responding population. Since the majority of the respondents to this survey became aware of the questionnaire through the Marmam listserv and during scientific conferences, it makes sense that the majority of respondents indicated that they contacted marine mammals through research and rehabilitation. While the internet has become a useful tool for administering health surveys, individuals who have experienced a significant impact to their health are more likely to remember it and to recount it to others, and individuals who have not experienced adverse health are less likely to respond leading to a non-response bias (Kuusi et al. 2004). As a result, the data presented here may overestimate the actual risk of injury and illness in people who contact marine mammals. On the other hand, 58.6% of the survey respondents were members of the research community. As a result of their scientific training, these respondents may have been more likely to have required evidence of causation rather than to assume their injuries and illnesses were linked with their marine mammal exposure. Therefore, the potential overestimation of prevalence of injury and illness may be countered by responding scientists' conservative linkages of those injuries and illnesses to marine mammal causes. The written comments by respondents provided evidence (see Appendices 3 and 4) that many individuals participating were aware of the health risks associated with their occupational activities and were making informed decisions regarding their work with marine mammals. In fact one respondent commented, "Considering the hundreds of necropsies and many months of crawling through fur seal rookery muck (splashed in the face many times), I feel I have really suffered very little in spite of the risks to which I

was exposed." Nevertheless, anonymous self-reporting of health outcomes must be interpreted cautiously, especially when a level of self-diagnosis may be involved.

The most common health problems reported by marine mammal workers responding to the survey were traumatic injuries. Over half of survey participants reported having been injured by a marine mammal. The analysis of risk factors suggests that individuals who worked more than 5 years and those exposed to marine mammals more than 50 days per year were at highest risk for injury. It is logical that prolonged and frequent exposure to marine mammals increased risk for injury proportionately with frequency of contact. Most injuries described were cuts and scrapes, followed in frequency by bites.

Cleaning or repairing enclosures or equipment was not a significant individual risk factor for injury. Yet when combined with prolonged exposure (duration of greater than 5 years), this duty carried an increased risk, making workers more than 3 times more likely to be injured than cleaning or repairing enclosures or equipment alone. The interaction between these two factors supports the logical assertion that prolonged exposure to a risk factor increases workers odds of injury. In addition, experienced individuals may have become less vigilant and may have taken fewer precautions once comfortable with their duties.

While the highest risks of traumatic injury were associated with direct exposure to live marine mammals, people who had contact with tissue or blood samples and those who contacted excretions and vomitus did have elevated and nearly equivalent odds of injury. Given the nature of the exposure, it is likely that the techniques used to collect and process biological samples involved needles, knives, and scalpels, placing the workers at risk for cuts and scrapes. In contrast to the findings associated with cleaning or repairing enclosures, experience (greater than 5 years) in these workers decreased risk, suggesting that marine mammal workers in technically-demanding or highly-trained positions may be more careful or have developed techniques to safely perform their duties and avoid personal harm.

Although it is difficult to generalize among different types of occupational exposure, our findings are consistent with the reported nonfatal cases of work-related injuries and illnesses that are recorded by employers under the Occupational Safety

and Health Administration's Survey of Occupational Injuries and Illnesses which found injuries to be the most common health problem reported in United States workers and skin ailments to be the second most prevalent non-fatal illness (National Institute for Occupational Safety and Health 2000). Nearly one quarter of the marine mammal survey respondents reported experiencing a skin rash or reaction. As with injury, people with longer and more frequent exposure were at higher risk for health ailments affecting the skin. These skin reactions were often associated with exposure to excretions and vomitus and cleaning or repairing activities and may have been in part due to the handling of caustic and harsh cleaning solutions. In fact, most of the skin reactions were described as contact dermatitis or simply rashes. Rashes were a common written complaint in individuals handling dead marine mammals. Reaction to something on or growing in decomposing whale flesh was repeatedly described (see Appendix 4); for example, one survey respondent detailed that “the rash was contracted immediately following direct and prolonged contact with deteriorating whale carcasses; the areas affected were those that were in direct contact with the carcasses; other members of the team had same symptoms after the same type of contact with same animals.”

The skin disease commonly referred to as seal finger deserves particular discussion. More than 10% of participants reported having experienced seal finger, and at least half of those affected had sought diagnostics and treatment from a physician. The scientific literature has recently identified *Mycoplasma phocacerebrale* as the likely etiologic agent (Baker et al. 1998); however, seal finger was previously described as being caused by *Erysipelothrix rhusiopathiae*. Cutaneous infections resulting from both of these organisms are clinically similar. The inoculation site is usually extremely painful, swollen, and erythematous; lymphadenitis is common (Thompson et al. 1993; Robson et al. 1998; Hartley and Pitcher 2002). Unfortunately, the recommended treatments are very different. *Erysipelothrix rhusiopathiae* is responsive to penicillins, cephalosporins and erythromycin, while *Mycoplasma spp*. are usually resistant to the aforementioned antibiotics and responsive to tetracyclines. Improper treatment of infections caused by either of these organisms could result in local and hematogenous spread leading to tenosynovitis, osteomyelitis, and in the case of *E. rhusiopathiae,*

endocarditis. This severity was illustrated by one of the surveys participants who reported suffering a prolonged malaise of more than six months with “life threatening toxemia/encephalopathy” as a sequelae to a “minor skin cut” acquired while working with a harbor porpoise carcass. *Erysipelothrix rhusiopathiae* was cultured from the infection, and despite treatment with 3 different antibiotics, amputation of the affected digit “proved life-saving.”

Prolonged malaise and respiratory illnesses were infrequently reported; therefore, substantial risk factors were not identified. However, considering the seriousness of the diseases reported, including tuberculosis, brucellosis, and leptospirosis, educating workers and volunteers about these potentially zoonotic diseases is very important. These diseases may be difficult to diagnose, and can be debilitating or life threatening for the patient. One survey participant suffered for more than 6 months from a tuberculous pneumonia that her physician attributed to her work with dolphins. Unfortunately, the documentation provided in the survey response did not allow for other possible routes of transmission to be examined. Nonetheless, this rehabilitation volunteer experienced night sweats, weight loss, chronic fatigue and anemia; she was treated for 9 months with isoniazid for the tuberculosis, and “dozens of antibiotics” for secondary bacterial infections. She expressed that she “had always been an extremely healthy person” but now is in search of continued medical assistance from “a doctor who can completely help.” Another participant suffered multiple relapses of a respiratory illness, 2-4 times per year of 2-4 weeks in duration during his 3 years of grinding biological tissues. His illness was characterized by “non-specific symptoms,” and differential diagnoses included chronic fatigue syndrome, multiple sclerosis, and brucellosis (since 10% of the tissues with which he worked were positive for *Brucella maris*). A specific diagnosis was never confirmed. This researcher was treated with various antibiotics, some of which improved symptoms temporarily, but the illness recurred. These cases illustrate a common complaint among respondents that their physicians were inadequately informed about the pathogens that could be transmitted from marine mammals. The variability in risk communication from physician to patient appeared to be very high, with some physicians immediately investigating possible marine mammal zoonoses and others dismissing potential transmission altogether. For

example, one participant was told that there were “no diseases that could be transmitted from whales to humans – so don't worry about it.” When knowledgeable, patients educated their physicians about the pathogens that marine mammals carry. Multiple respondents reported consulting with wildlife and zoo veterinarians in order to provide adequate information to their physicians on follow-up visits.

The prevalence of severe health problems should not be estimated from these survey results since the occurrences were rare and involved a level of self-diagnosis that may not be reliable. Still the accounts of the above participants’ illnesses are not unlike case reports of similar illnesses found in the scientific literature. In 1988, a seal trainer from Western Australia was diagnosed with tuberculosis caused by *Mycobacterium bovis*. Diagnosis was made after the trainer developed night sweats, weight loss, exercise intolerance, and a dry productive cough. Bacterial isolates from the trainer and the seals with which he worked were identical based on gel electrophoresis (Brew et al. 1999). In 1999, a laboratory worker handling marine mammal isolates of *Brucella* suffered from “continuing headaches, lassitude and severe sinusitis.” Brucella organisms cultured from blood samples of the researcher were indistinguishable from the marine mammal *Brucella* isolate (Brew et al. 1999).

People who work with and around marine mammals are at risk for incurring injury and acquiring zoonotic diseases. Individuals working with marine mammals at least one day per week are at the greatest risk of injury. Full time workers and committed volunteers should be advised of the associated risks, and should be encouraged to take the proper safety precautions to minimize exposure to zoonotic diseases. Longer and more frequent exposure to marine mammals necessarily increases workers odds of experiencing a skin ailment, and workers that contact marine mammal carcasses, excretions, and vomitus must be especially diligent in personal hygiene. Although rare, serious sequelae can result from a seemingly minor skin wound or respiratory infection.

Based on these findings, continued adherence to safety guidelines and the use of protective clothing are recommended to decrease the occurrence of adverse health effects in marine mammal caretakers and researchers. Training of students and volunteers handling marine mammals should include education on disease risks associated with the zoonotic pathogens these animals carry. This information and

descriptions of commonly and infrequently reported ailments and their treatments should also be made available to physicians caring for patients who have contact with marine mammals.

Literature Cited

Baker, A. S., K. L. Ruoff and S. Madoff 1998. Isolation of *Mycoplasma* species from a patient with seal finger. Clinical Infectious Disease 27: 1168-70.

Brew, S. D., L. L. Perrett, J. A. Stack, A. P. MacMillan and N. J. Staunton 1999. Human exposure to *Brucella* recovered from a sea mammal. Veterinary Record 144: 483.

Buck, C.D. and J.P. Schroder 1990. Public Health significance of marine mammal diseases.735 *in* L. A. Dierauf, eds. CRC Handbook of marine mammal medicine: health, disease, and rehabilitation. CRC Press, Boca Raton, Fla.

Cates, M. B., L. Kaufman, J. H. Grabau, J. M. Pletcher and J. P. Schroeder 1986. Blastomycosis in an Atlantic bottlenose dolphin. J Am Vet Med Assoc 189: 1148-50.

Cawthorn, MW. 1994. Seal finger and mycobacterial infections of man from marine mammals: occurrence, infection and treatment. Department of Conservation, Wellington,

Cawthorn, MW. 1997. Meat Consumption from stranded whales and marine mammals in New Zealand: Public Health and other issues. Department of Conservation, No.164.

Chastel, C., O. Masure, G. Balouet, P. Laban and A. Lucas 1975. [The student, the cetacean and swine-fever. A minor epidemic after dissection of a globicephale]. Nouvelle Presse Medicale 4: 1803-5.

Cowan, D.F., C House and J.A. House 2001. Public Health.1063 *in* L. A. Dierauf and F. M. D. Gulland, eds. CRC Handbook of Marine Mammal Medicine. CRC Press, Boca Raton, FL.

Daniel, Wayne W. (1999). Biostatistics: a foundation for analysis in the health sciences. Wiley. New York.

Eadie, P. A., T. C. Lee, Z. Niazi and D. Lawlor 1990. Seal finger in a wildlife ranger. Irish Medical Journal 83: 117-8.

Flowers, D. J. 1970. Human infection due to *Mycobacterium marinum* after a dolphin bite. Journal of Clinical Pathology 23: 475-7.

Hartley, J. W. and D. Pitcher 2002. Seal finger--tetracycline is first line. Journal of Infection 45: 71-5.

Kuusi, M., J. P. Nuorti, L. Maunula, I. Miettinen, H. Pesonen and C.-H. von Bonsdorff. Internet use and epidemiologic investigation of gastroenteritis outbreak. Emerging Infectious Diseases 10: 447-50.

Markham, R. B. and B. F. Polk 1979. Seal finger. Review of Infectious Disease 1: 567-9.

National Institute for Occupational Safety and Health. 2000. Worker Health Chartbook, 2000. Centers for Disease Control and Prevention, DHHS 2002-120. 250pp.

National Marine Fisheries Service, 1990. Final environmental impact statement on the use of marine mammals in swim-with-the-dolphin programs. National Oceanic and Atmospheric Administration. 98pp.

Osterhaus, A. D., G. F. Rimmelzwaan, B. E. Martina, T. M. Bestebroer and R. A. Fouchier 2000. Influenza B virus in seals. Science 288: 1051-3.

Robson, J. M., R. McDougall, S. van der Valk, S. D. Waite and J. J. Sullivan 1998. *Erysipelothrix rhusiopathiae*: an uncommon but ever present zoonosis. Pathology 30: 391-4.

Sargent, E. 1980. Tetracycline for seal finger. Journal of the American Medical Association 244: 437.

Smith, A. W., E. S. Berry, D. E. Skilling, J. E. Barlough, S. E. Poet, T. Berke, J. Mead and D. O. Matson 1998. In vitro isolation and characterization of a calicivirus causing a vesicular disease of the hands and feet. Clinical Infectious Disease 26: 434-9.

Thompson, P. J., D. V. Cousins, B. L. Gow, D. M. Collins, B. H. Williamson and H. T. Dagnia 1993. Seals, seal trainers, and mycobacterial infection. American Review of Respiratory Disease 147: 164-7.

Tryland, M 2000. Zoonoses of arctic marine mammals. Infectious Disease Review 2: 55-64.

Webster, R. G., J. Geraci, G. Petursson and K. Skirnisson 1981. Conjunctivitis in human beings caused by influenza A virus of seals. New England Journal of Medicine 304: 911.

TABLES

Table 1. Health problems due to marine mammal contact as reported by marine mammal workers participating in a survey between December 2001 and September 2002 (N=483).

TRAUMA [Including deep wounds(77), bites (38), wounds requiring stitches (26), and fractures(10)]	**251**
SKIN REACTIONS	**72**
Erysipelothrix rhusiopathae[a]	4
Erysipeloid infections	3
Mycoplasma spp. b	2
Other bacterial infections[a] [Including *Clostridium perfringens*, *Staphylococcus aureus*, *Mycobacterium marinum*, *Corynebacter* spp., *Pseudomonas* spp., Vibrio spp., *Pseudomona* spp]	5
Seal pox	2
Inflammation post necropsy	4
Contact dermatitis	4
Non-specific rashes	10
RESPIRATORY ILLNESS	**18**
Tuberculosis pneumonia	2
Bronchitis	2
Non-specific irritation	12
GENERALIZED SYMPTOMS AND PROLONGED ILLNESS	**14**
Brucellosis [b]	2
Leptospirosis[a, b]	2
Erysipelothricosis[a]	1
Tuberculosis pneumonia [a]	1
Conjunctivitis	3
Systemic effects after traumatic injury (no specific etiology given)	5

[a] Agent was cultured from patient [b] Agent was suspected in diagnosis

Table 2. Important or significant risk factors for injury of marine mammal workers participating in a survey between December 2001 and September 2002.

Risk Factors	Number at risk (N=483)	Adjusted Odds Ratio[a] (95% CI[b])
Exposure duration of greater than 5 years	297	18.5 (3.93-87.40)
Exposure frequency of greater than 50 days per year	267	23.0 (5.32 – 99.28)
Contact with live marine mammals	385	7.1 (2.10- 23.901)
Contact with tissue or blood samples.	407	3.0 (1.33 – 6.78)
Contact with marine mammal excretions and/or vomitus	365	3.3 (1.72 – 6.53)
Cleaning or repairing enclosure or equipment	259	1.3 (0.73-2.28)
Cleaning or repairing enclosure or equipment and Exposure duration of greater than 5 years	159	3.7 (1.33 – 10.50)
Contact with tissue or blood samples and Exposure duration of greater than 5 years	266	0.1 (0.22 – 0.58)
Contact with live marine mammals and Exposure frequency of greater than 50 days per year.	236	0.1 (0.22 – 0.50)

[a] Adjusted odds ratios using multivariate logistic regression
[b] Confidence interval

Table 3. Important or significant risk factors for skin rash/reaction of marine mammal workers participating in a survey between December 2001 and September 2002.

Risk factors	Number at risk (N=483)	Adjusted Odds Ratio[a] (95% CI[b])
Exposure duration of greater than 5 years	297	1.8 (1.15-2.79)
Exposure frequency of greater than 50 days per year	267	1.7 (1.10 – 2.72)
Contact with marine mammal excretions and/or vomitus	365	2.2 (1.08 – 4.27)
Cleaning or repairing enclosures or equipment.	259	1.9 (1.12 – 3.14)

[a] Adjusted odds ratios using multivariate logistic regression.
[b] Confidence interval

FIGURES

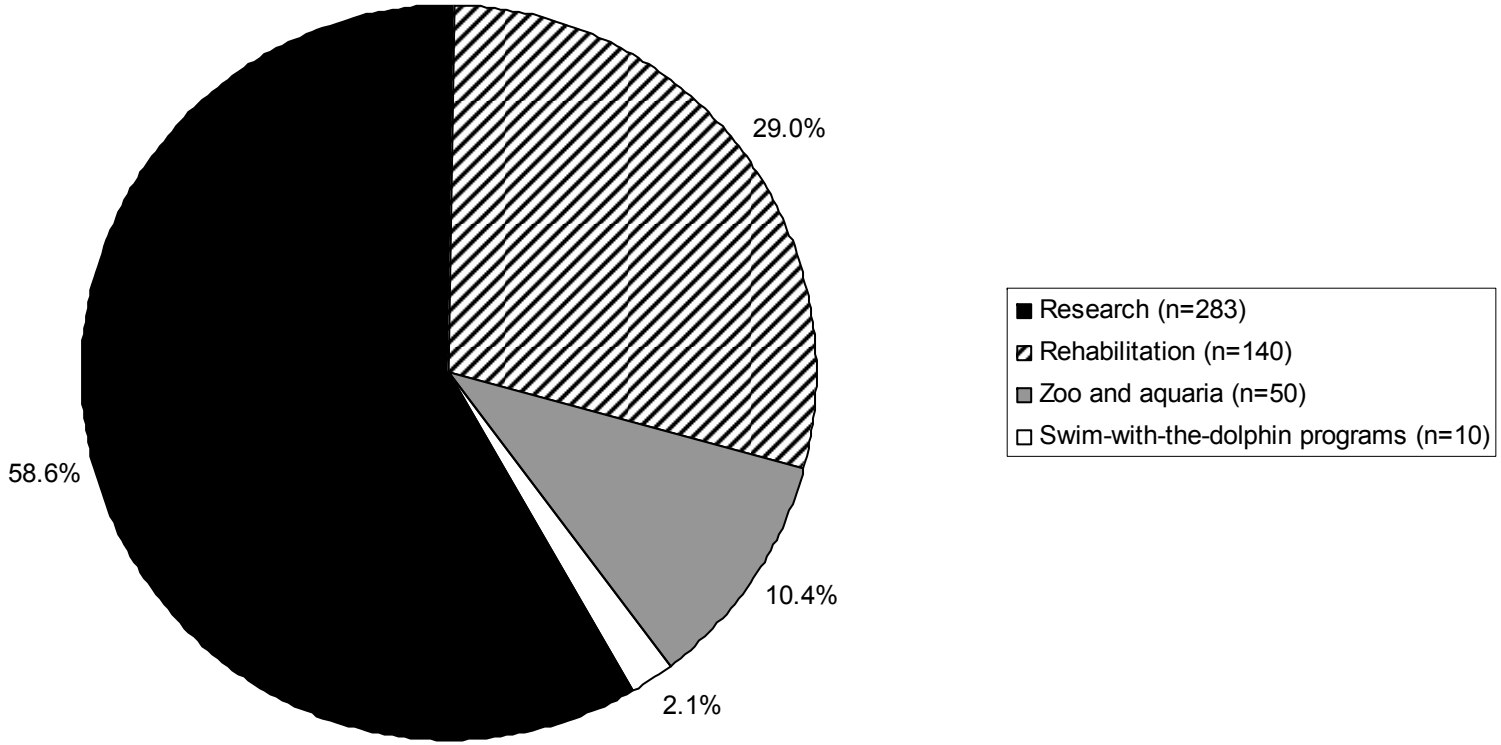


Figure 1. Type of occupational marine mammal contact reported by marine mammal workers responding to a survey between December 2001 and September 2002 (N=483).

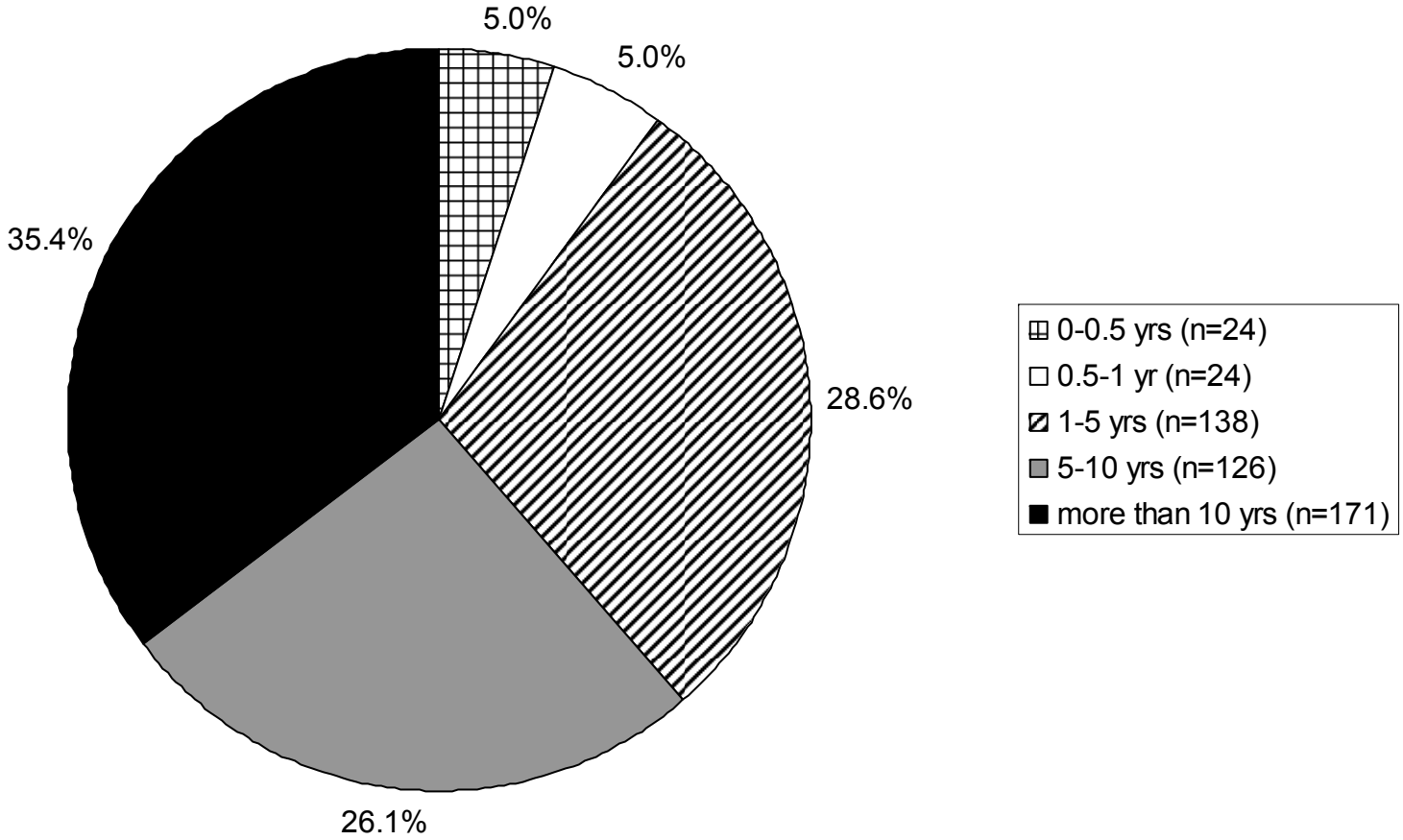


Figure 2. Duration, in years, of marine mammal contact reported by marine mammal workers responding to a survey between December 2001 and September 2002 (N=483).

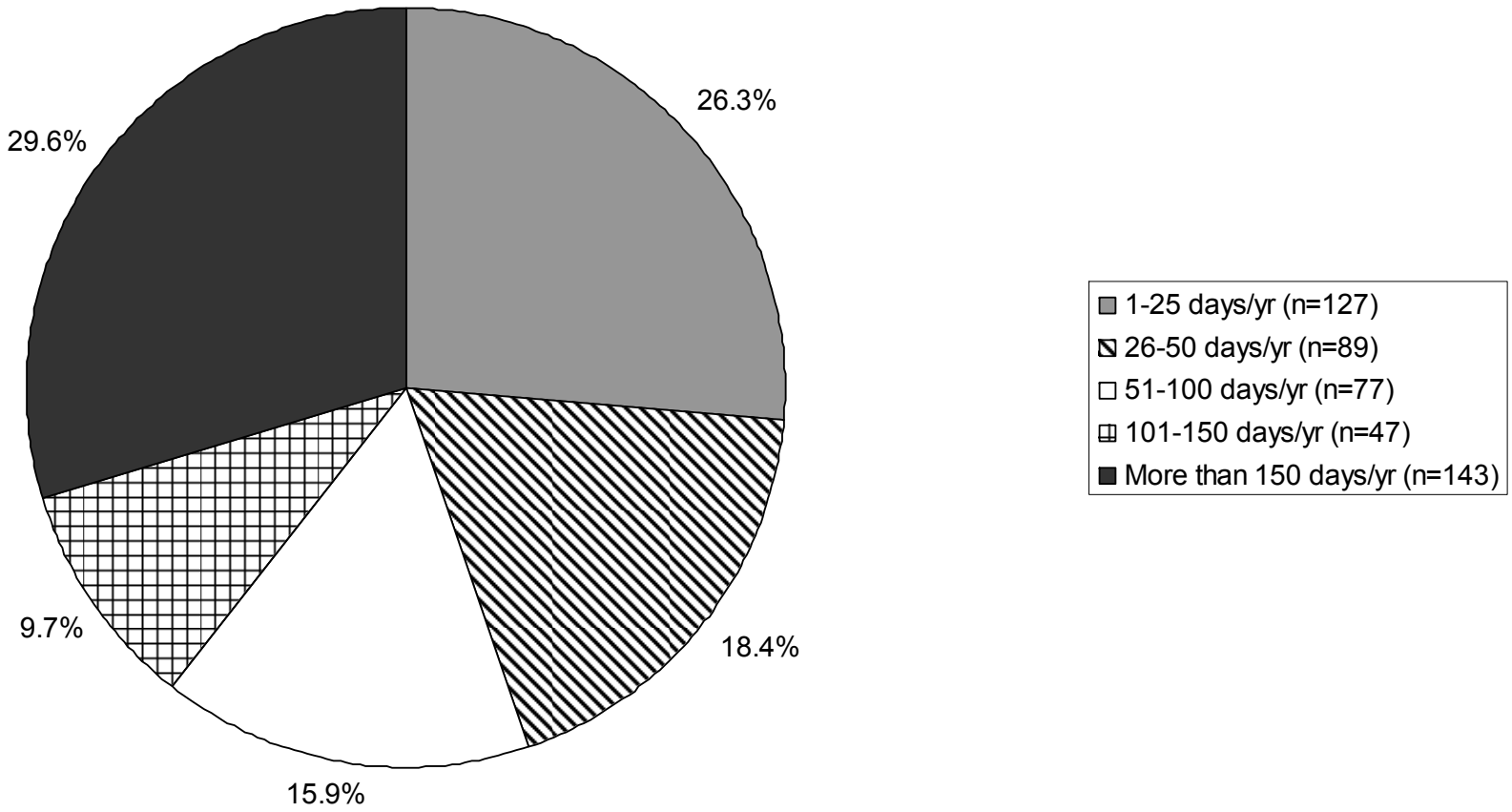


Figure 3. Frequency, in days per year, of marine mammal contact reported by marine mammal workers responding to a survey between December 2001 and September 2002 (N=483).

HEALTH AND SAFETY BROCHURE

Photo by Jonna Mazet

Safety measures to prevent injury and infections:

Obtain the recommended training, and follow all of your institution's safety procedures for safe animal handling

♦

Wear gloves and other protective gear when handling animals and specimens

♦

Avoid contact with animals if you are ill

♦

Use additional safety equipment when risks of acquiring an infection are high

♦

Use necropsy, husbandry and laboratory procedures that minimize the risk of cuts and injuries

♦

Consult your physician before working with marine mammals if you are pregnant or have other health concerns

♦

Wash hands thoroughly after animal and specimen contact

Knowledge and careful work practices are your best defense!

What you can do:

Care must be taken to **avoid all possible routes of exposure to marine mammal infections**. Although bites and contact with existing wounds are the most common routes, infections can occur through your mouth, eyes, respiratory system and skin.

Report any animal bite, scratch, or other significant exposure to marine animal blood, saliva, or other excretions to the appropriate supervisor.

If you develop an illness or other condition that could be caused by exposure, be sure to **tell your physician that you work with marine mammals**.

Resources for more information:

1. Full report available from the UC Davis Wildlife Health Center at www.wildlifehealthcenter.org

2. "Public Health" by Cowan et al. in L.A. Dierauf and F.M.D. Gulland, *CRC Handbook of marine mammal medicine 2nd ed*. 2001, Boca Raton, FL: CRC Press

3. The Centers for Disease Control and Prevention www.cdc.gov

4. National Institute of Environmental Health Science: Biological Safety http://www.niehs.nih.gov/odhsb/home.htm

Working with Marine Mammals and Your Health

Photo by Deborah Gabris

A guide for marine mammal workers and rehabilitation volunteers

Important information to keep you aware, safe, and healthy

Provided by:

U.S. Marine Mammal Commission
National Marine Fisheries Service
Wildlife Health Center, UC Davis

Important information about marine mammals

Like most animals, marine mammals can carry microbes (bacteria, viruses, fungi) that can cause illness in humans. Many marine mammals that appear healthy and normal can carry organisms that are dangerous to humans.

Marine mammals have been shown to carry many of the pathogens we associate with food poisoning, such as *E. coli*, *Salmonella*, and *Listeria*. Like other wildlife, seals and sea lions can shed the protozoan, *Giardia* in their feces. *Giardia* can cause diarrhea and other symptoms in humans. In rare cases, marine mammals may be infected with very dangerous pathogens, like the rabies virus and the organism that causes tuberculosis.

Pathogens known to be transmitted from marine mammals to people

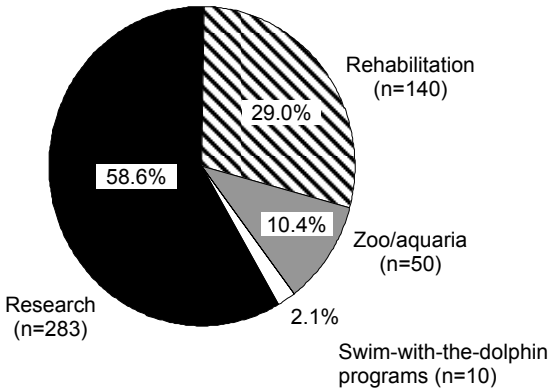
Mycoplasma found in seals can cause "seal finger" in humans. This painful and potentially serious disease can result from a seal bite or the infection of a pre-existing wound. Diligent hand washing is the best defense with infections often responding to tetracycline treatment.

Seal pox is a disease of stranded seals and can be encountered in rehabilitation centers. It can cause pox sores in humans that may persist for up to a year. There is no known effective treatment.

Leptospirosis contracted from seals and sea lions can cause serious disease in humans.

Reported injuries and illnesses in people who work with marine mammals

A total of 483 marine mammal workers responded to a recent survey about their health. The majority of respondents identified research as their primary type of marine mammal contact.



The survey showed that injuries and work-related illnesses are common.

In fact, **over half (54%) of workers reported having at least one injury or illness** that they believed directly resulted from contact with marine mammals. Most were cuts, scrapes, bites, and rashes. About 1 in 10 (11%) marine mammal workers reported developing **seal finger**.

Injury occurred in over half (52%) of workers while handling marine mammals or tissues. Of those injuries, over a third (36%) were severe (e.g. deep wound or fractured bone).

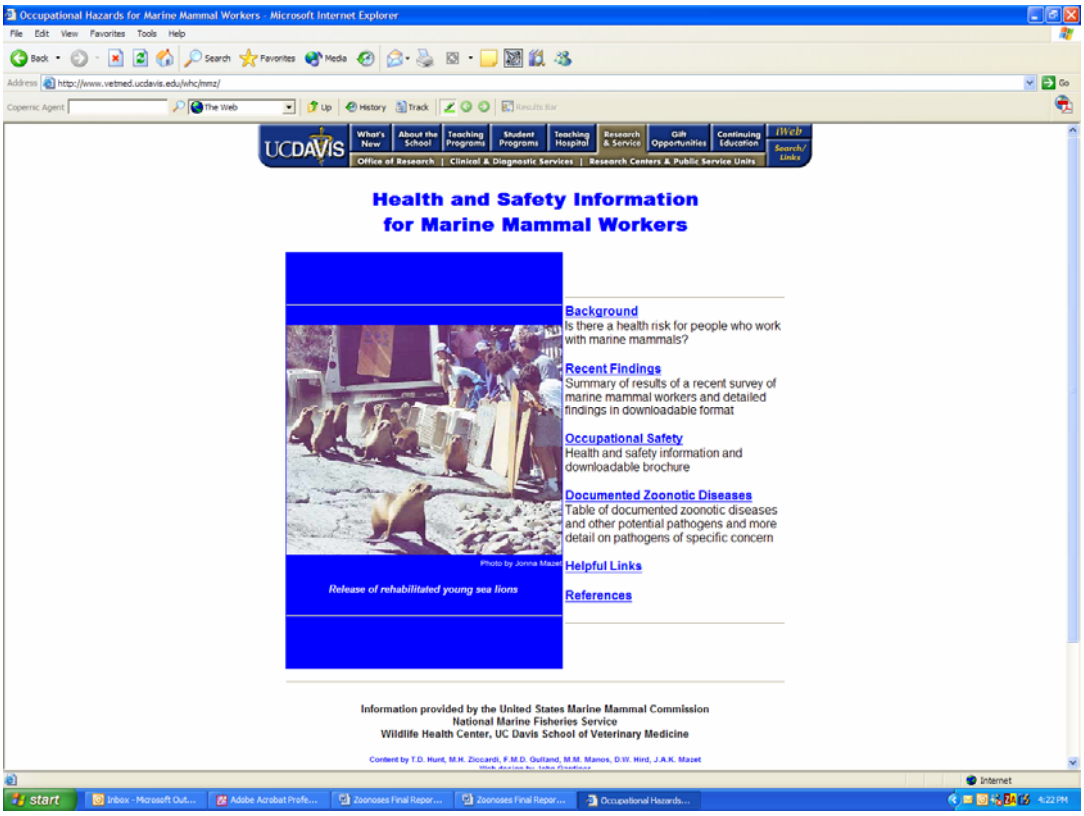
Several dangerous infections were reported by marine mammals workers, including **tuberculosis**, **leptospirosis**, and **brucellosis**.

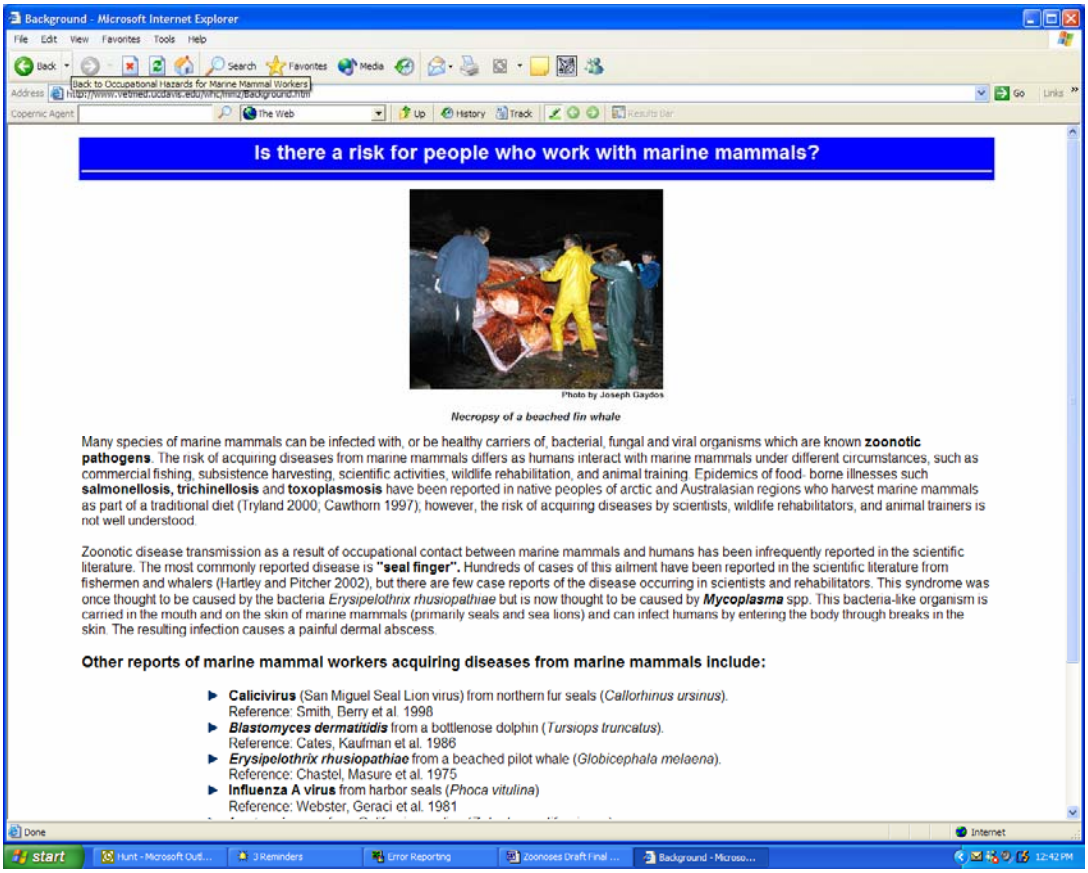
Photo by Erica Dold

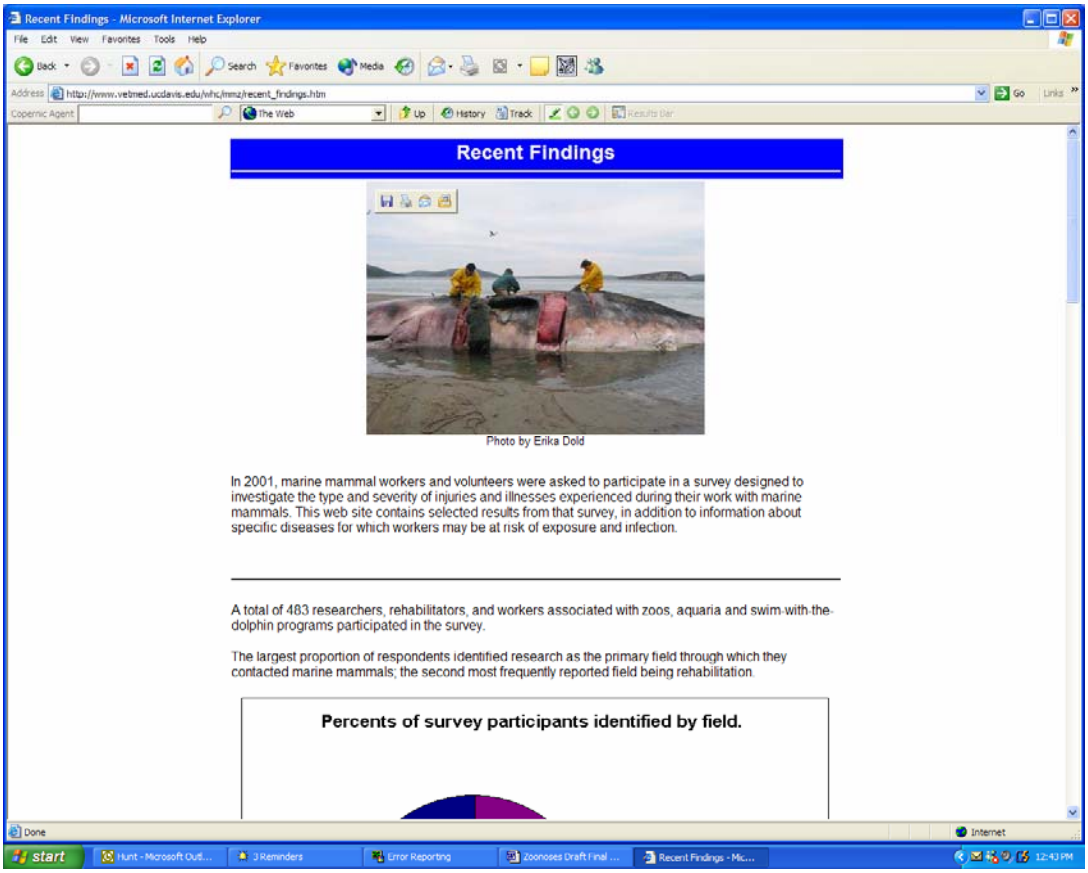
Regardless of experience and training, marine mammal workers are at risk of injury and infection.

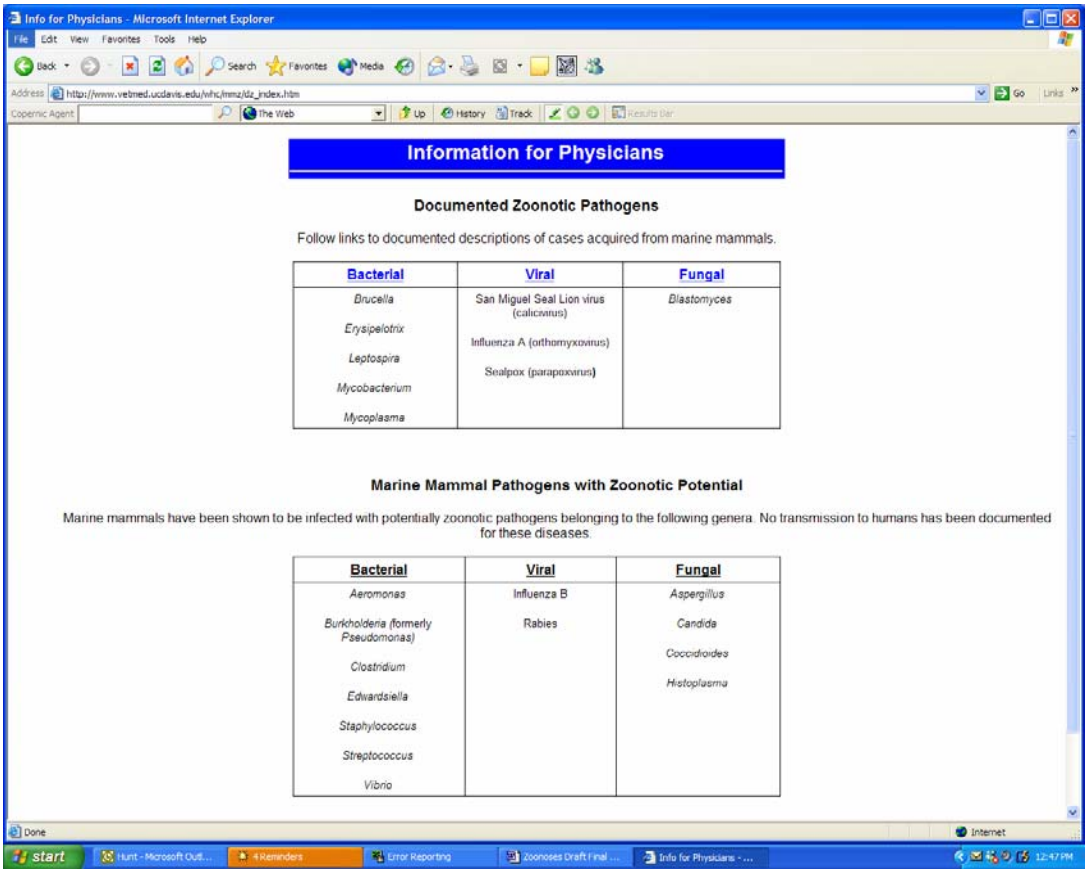
Exposure to marine mammals can mean exposure to the infections they carry.

SELECTED SCREEN CAPTURE IMAGES FROM THE HEALTH AND SAFETY WEBSITE (WWW.VETMED.UCDAVIS.EDU/WHC/MMZ)






Recent Findings - Microsoft Internet Explorer
Recent Findings
Photo by Erika Dold
In 2001, marine mammal workers and volunteers were asked to participate in a survey designed to investigate the type and severity of injuries and illnesses experienced during their work with marine mammals. This web site contains selected results from that survey, in addition to information about specific diseases for which workers may be at risk of exposure and infection.
A total of 483 researchers, rehabilitators, and workers associated with zoos, aquaria and swim-with-the-dolphin programs participated in the survey.
The largest proportion of respondents identified research as the primary field through which they contacted marine mammals; the second most frequently reported field being rehabilitation.
Percents of survey participants identified by field.


Info for Physicians - Microsoft Internet Explorer
Information for Physicians
Documented Zoonotic Pathogens
Follow links to documented descriptions of cases acquired from marine mammals.
Bacterial
Viral
Fungal
Brucella
Erysipelotrix
Leptospira
Mycobacterium
Mycoplasma
San Miguel Seal Lion virus (calicivirus)
Influenza A (orthomyxovirus)
Sealpox (parapoxvirus)
Blastomyces
Marine Mammal Pathogens with Zoonotic Potential
Marine mammals have been shown to be infected with potentially zoonotic pathogens belonging to the following genera. No transmission to humans has been documented for these diseases.
Bacterial
Viral
Fungal
Aeromonas
Burkholderia (formerly Pseudomonas)
Clostridium
Edwardsiella
Staphylococcus
Streptococcus
Vibrio
Influenza B
Rabies
Aspergillus
Candida
Coccidioides
Histoplasma

APPENDICES

Appendix 1. Cover letter and Paper-based version of questionnaire made available to marine mammal workers from Dec. 2001-Sept. 2002

Recipient

_____
_____

Re: Questionnaire for Marine Mammal Pathogens that can infect humans

Worldwide contact with marine mammals has increased as a result of more intensive rehabilitation, education, entertainment and recreation programs. Since marine mammals are known to contract and carry pathogens that can potentially infect humans, the Marine Mammal Commission, in conjunction with the National Marine Fisheries Service (NMFS), is requesting your participation in investigating such zoonotic disease occurrences. YOUR INFORMATION IS CRITICALLY IMPORTANT WHETHER OR NOT YOU BELIEVE THAT YOU HAVE EVER CONTRACTED A DIEASE FROM A MARINE MAMMAL.

The attached questionnaire is designed to survey those people who come in contact with marine mammals and are at risk of contracting zoonotic diseases. It should take APPROXIMATELY 5 – 10 MINUTES TO COMPLETE. In an effort to better understand pathogen transmission from marine mammals to humans and their associated risk, we aim to estimate the probability of disease transmission and the nature and severity of the consequences. All information provided on the questionnaire is strictly anonymous and confidential, and no attempt will be made to determine submitters' identities. Data provided may be summarized and provided to marine mammal management agencies and the public.

Thank you for your input and time.

Sincerely,

Jonna AK Mazet, DVM, PhD
Wildlife Health Center
School of Veterinary Medicine
University of California, Davis

QUESTIONNAIRE FOR MARINE MAMMAL PATHOGENS THAT CAN INFECT HUMANS

Supported by the Marine Mammal Commission in conjunction with the National Maine Fisheries Service (NMFS)

All information provided is anonymous and strictly confidential

1. How long have you worked in direct contact with marine mammals? (Check one)

❑ Never ❑ 0 to 0.5 years ❑ 0.5 – 1 year ❑ 1 – 5 years ❑ 5- 10 years ❑ More than 10 years

2. On average, how often do (did) you come in contact with marine mammals? (Check one)

❑ 0 days ❑ 1 – 25 days ❑ 26 – 50 days ❑ 51 – 100 days ❑ 101- 150 days ❑ More than 150 days

3. Please indicate situations that describe your work. (Check all that apply)

❑ Direct contact with live marine mammals while you are in the water with them
❑ Direct contact with live marine mammals while you are out of water
❑ Contact with water in which a marine mammal has swum
❑ Contact with marine mammal excretions and/or vomitus
❑ Contact with tissue or blood samples from a marine mammal
❑ Cleaning or repairing enclosures or equipment used in the care of marine mammals
❑ Contact with dead marine mammals

4. The majority of your contact with marine mammals is (was) in the area of: (Select one)

❑ Research ❑ Rehabilitation ❑ Zoo/aquarium ❑ "Swim with" program

5. Please indicate your training related to marine mammals. (Check all that apply)

❑ Animal restraint/handling ❑ Tissue/blood sampling ❑ Infectious disease prevention ❑ Occupational safety

6. During the time in which you HAVE BEEN in contact with marine mammals, did you ever suffer a traumatic injury caused by the animals? θYes θNo

If Yes, indicate the number of times you had an injury matching the following descriptions (estimates OK).

_____ Located on extremities (i.e. hands, arms)
_____ Located on face
_____ Located centrally (i.e. torso, abdomen)
_____ Superficial scratch or scrape
_____ Cut
_____ Deep wound
_____ Deep wound that required stitches
_____ Fractured bones
_____ Other (describe)
_____

7. During the time in which you were in contact with marine mammals, did you develop a skin rash or reaction? θYes θNo

If yes, indicate the number of times you had a rash or reaction matching the following descriptions (estimates OK).

_____ Reddened
_____ Painful
_____ Itchy
_____ Nodular (raised and hard)
_____ Swollen (raised and soft)
_____ Involved a joint
_____ Oozing
_____ Blister or fluid filled
_____ Located mainly on hands
_____ Located on other places on the body
Specify_____

Did the lesions ever appear subsequent to direct contact with a marine mammal? θ Yes θ No
Did these lesions ever appear after a bite from a marine mammal? θ Yes θ No
Were these lesions examined by a medical doctor? θ Yes θ No
If yes, what were the doctor's diagnoses? _____

8. During the time in which you Have been in contact with marine mammals, did you experience any respiratory illnesses? θYes θNo

If yes, approximately how often?

θ Once or twice θ Once per year θ 2-4 times per year θ 5-10 times per year θ More than once per month

How long was the longest episode?

θ Less than a week θ 1-2 weeks θ2-4 weeks θ 1-6 months θ More than six months

Do you believe any of these occurrences to be a result of your contact with marine mammals? θYes θNo
If yes, please explain. _____
Were any of these illnesses diagnosed by a medical doctor? θYes θNo
What were the doctor's diagnoses?_____

9. During the time in which you were in contact with marine mammals, did you ever experience prolonged malaise? **θYes θ No**

If yes, how often

θ Once or twice θ Once per year θ 2-4 times per year θ 5-10 times per year θMore than once per month

How long was the longest episode?

θ Less than a week θ 1-2 weeks θ 2-4 weeks θ1-6 months θ More than six months

Do you believe any of these occurrences to be a result of your contact with marine mammals? □Yes □No

If yes, please explain._____

Was this illness diagnosed by a medical doctor? θYes θNo

What was the doctor's diagnosis? _____

10. Please describe any additional symptoms from which you suffered during the time you were in contact with marine mammals? (Check all that appply)

- ❑ Fever
- ❑ Headache
- ❑ Diarrhea
- ❑ Nausea or Vomiting
- ❑ Fatigue and/or weakness
- ❑ Joint pain
- ❑ Yellow skin and eyes
- ❑ Red, runny eyes
- ❑ Ulcers on the eyes

11. Have you ever been diagnosed with complications or disease from any of the following? (Check all that appply)

- ❑ Aeromonas
- ❑ Corynebacterium
- ❑ Mycobacteria tuberculosis
- ❑ Mycoplasma
- ❑ Pseudomonas
- ❑ Streptococcus
- ❑ Poxvirus (Seal & Dolphin Pox)
- ❑ Herpes virus
- ❑ Blastomycoses
- ❑ Brucella
- ❑ Erysipelothrix
- ❑ Mycobacteria bovis
- ❑ Pasteurella
- ❑ Salmonella
- ❑ Vibrio
- ❑ Influenza
- ❑ Rabies
- ❑ Candida
- ❑ Clostridia
- ❑ Leptospira
- ❑ Mycobacteria murium
- ❑ Proteus
- ❑ Staphylococcus
- ❑ Calicivirus (San Miguel Sea Lion Virus)
- ❑ Adenovirus (Sea Lion Hepatitis)
- ❑ Rotavirus
- ❑ Aspergillosis

12. Have you ever had sealfinger? **θYes θNo**

13. Do you believe any of your described illnesses to be a result of contact with marine mammals?

θ Yes θ No

If yes, explain:_____

_____

14. Have you ever had a positive tuberculosis test during the time you were in contact with marine mammals? **θYes θNo θNot tested**

If Yes, was this by □ skin test or □ chest x–ray

15. Please indicate your gender: **θ Male θ Female**

If female, did you ever have a miscarriage during the time you were in contact with marine mammals? θ Yes θ No

16. Do you consider your immune system to be intact? **θ Yes θNo**

17. Please list medical treatments for specific problems listed above and their success or failure:

_____

_____

_____

Please return survey to the Wildlife Health Center, University of California, Davis CA 95616 USA

Appendix 2. Review of documented transmission of pathogenic organisms from marine mammals to humans.

Important marine mammal zoonoses and cases of documented transmissions

Brucella

In 1999, a researcher suffered headaches, lassitude and a severe sinusitis after exposure to marine mammal strain of *Brucella* with which the worker was in contact. The symptoms resolved in one week after treatment with doxycycline and rifampin. The researcher had a positive titer for *Brucella*, and the organism was cultured from blood samples. PCR-RFLP was used to positively identify the isolates as being comparable to marine mammal *Brucella* (Brew and Staunton 1999).

Organisms

Brucella ssp. are gram-negative intracellular bacteria and are a major source of zoonoses worldwide. *B. melitensus*, *B. abortus*, and *B. suis* are some species commonly recognized to play a role in human and animal health. Nomenclature for marine mammal strains of *Brucella* has not yet been fully developed, but *B. maris* and *B. pinnipedia* have so far been named. Transmission occurs primarily through contact with aborted fetal material, and consumption of contaminated milk.

Clinical disease in marine mammals

The bacteria have been isolated from multiple species of marine mammals, including pinnipeds, cetaceans and otters. Abortion and meningoencephalitis have been reported in dolphins from which the bacteria was isolated, but in the majority of cases, the animals did not demonstrate clinical disease (Godfroid 2002).

Clinical disease in humans

Symptoms can vary depending on the chronicity of the infection, ranging from acute "flu-like" symptoms (headaches, fever, myalgia, and malaise) to more chronic symptoms (arthritis, orchiepididymitis, and fatigue). Neurological symptoms are rare, being seen in less than 5% of cases. Serologic tests for *Brucella* are available, but culture is the most definitive test for diagnosis (Centers for Disease Control 2001).

Treatment

Doxycycline and rifampin are the recommended therapies. Other treatment has been associated with recurrence.

Erysipelothrix

In 1975, four students from the Laboratoire de l'Institut Scientifique et Technique des Pêches Maritimes (Scientific and Technical Institute of Maritime Fishing) acquired a cutaneous *Erysipelothrix rhusiopathiae* infection from a beached pilot whale (*Globicephala melaena*). The organism was isolated from both the whale and the affected students (Chastel et al. 1975).

Organism

Erysipelothrix rhusiopathiae is a gram-positive, facultative anaerobic rod, and is recognized as the causative agent of swine erysipelas.

Clinical disease in marine mammals

Cetacea appear to be more susceptible than pinnipeds and can develop septicemia, endocarditis, and chronic skin abscessation (Couch et al. 1993; Kinsel et al. 1997). The characteristic rhomboid cutaneous lesions, which are caused by thrombosis of peripheral arteries and local tissue infarction, can also be seen (Sweeney and Ridgway 1975).

Clinical disease in humans

Infection in humans is usually associated with occupational and recreational exposure. The bacteria enter through breaks in the skin and infection can present in three clinical forms:

1. Erysipeloid form: localized, self-limiting cellulitis that develops around site of inoculation.
2. Cutaneous form: a more severe and diffuse infection.
3. Septicemic form: most severe and rare form with or without cutaneous lesions. Associated with arthritis and/or endocarditis with valvular destruction (Artz, Szabo et al. 2001).

Treatment

Erysipelothrix is susceptible to penicillins and cephalosporins.

Leptospira

During the course of a 5 year study (1972-1977), three researchers became ill after exposure to California sea lions (*Zalophus californianus*) that were infected with *Leptospira.* The two workers with more severe illness became infected after necropsying a sea lion. All three developed serum agglutinating antibody titers to *Leptospira interrogans* serovar *pomona* (Smith et al. 1978).

Organism

Leptospira interrogans serovar *pomona*, is one of 200 serovars within this species of spirochete bacteria. For this and other potentially zoonotic serovars, transmission occurs directly between mammalian hosts and indirectly through exposure to contaminated water and soil.

Clinical disease in marine mammals

Renal disease has been observed in harbor seals (*Phoca vitulina*), and more commonly in California sea lions (*Zalophus californianus*) and fur seals (*Arctocephalus* spp.) (Gulland et al. 1996; Stamper et al. 1998). The disease causes tubular necrosis consistent with interstitial nephritis. Clinical signs include anorexia, dehydration and polydipsia. Cytology and serum chemistry reveals a leukocytosis and high serum phosphorus, urea nitrogen and creatinine levels.

Clinical disease in humans

In the largest outbreak of environmentally-acquired leptospirosis, the most common symptoms reported were chills, headache, myalgia, eye pain, reddened eyes and diarrhea. Clinical signs included those consistent with acute hepatitis and renal failure. Diagnostics revealed elevated liver enzymes, bilirubinemia, thrombocytopenia, proteinuria, hematuria, and elevated creatinine (Morgan et al. 2002).

Treatment

Leptospira are susceptible to penicillins.

Mycobacterium

There is one reported case of an animal handler acquiring skin lesions similar to the cutaneous mycobacterosis lesions seen on a manatee which the handler was working (Howard 1983).

In 1968, a dolphin trainer working with a bottle-nosed dolphin (*Tursiops truncatus*) was bitten and subsequently developed dermal abscesses. *Mycobacterium marinum* was cultured from aspirates taken from the lesions on the trainer's hands (Flowers 1970).

In 1988, a seal trainer from western Australia was diagnosed with *Mycobacterium bovis* tuberculosis. Diagnosis was made after the trainer developed a dry productive cough, exercise intolerance, and weight loss. Bacterial isolates from the trainer and the seals with which he worked were identical based on gel electrophoresis (Thompson et al. 1993).

Organism

Mycobacterium spp. are gram-positive acid-fast rods. *Mycobacterium marinum* is more commonly regarded as a salt- and fresh-water fish pathogen, while *M. bovis* primarily affects cattle and is an important zoonotic agent worldwide.

Mycobacterium marinum

Clinical disease in marine mammals

The organism causes dermal abscesses when infection is local, and pulmonary tuberculosis or generalized abscessation with spreading infection (Tryland 2000).

Clinical disease in humans

This disease may also be called fish handler's disease or swimming pool granuloma in humans. The organism usually enters through breaks in the skin after host contact with contaminated water. Local infection results in a nodular lymphangitis with or without lymphadenitis. Skin lesions can ulcerate, and spreading infection can cause tenosynovitis, arthritis, and osteitis (Ryncarz 1999).

Mycobacterium bovis

Clinical disease in marine mammals

Pathological findings in pinnipeds include pulmonary granulomas, lesions in the liver, draining lymph nodes, and tuberculous meningitis (Forshaw and Phelps 1991). Animals may also have subclinical infections.

Clinical disease in humans

Humans are usually infected with *M. bovis* from drinking contaminated cow's milk. Infection can cause pulmonary tuberculosis, cervical lymphandenopathy, and *Lupus vulgaris* (chronic skin tuberculosis). Urogenital infections have also been reported (Cosivi et al. 1998).

Treatment

Common treatment for mycobacteriosis is long-term streptomycin and rifampin.

Mycoplasma (Seal Finger)

While studying seal behavior at the New England Aquarium in 1979, a psychologist was bitten by a harbor seal (*Phoca vitulina*). Treatment with penicillin and oxacillin resulted in the resolution of symptoms, but the infection reappeared weeks later. The patient was then successfully treated with a 3 week course of tetracycline (Markham and Polk 1979).

In 1980, a graduate student was stabbed with a necropsy knife while working on a sea lion carcass. Clinical symptoms worsened after treatment with dicloxacillin. Radiographs showed periosteal reaction indicative of an osteitis underlying the cutaneous infection. Finally, treatment with tetracycline resolved the infection (Sargent 1980).

In 1990, a wildlife ranger was bitten while returning a seal to the ocean; he subsequently developed a skin infection. A two-week course of treatment with amoxicillin led to a persistent infection, and symptoms continued to persist after a change in antibiotics to flucloxacillin. Radiographs taken of the affected digit showed demineralization of phalanx 2 of the thumb suggestive of an osteitis. Finally a four-week course of treatment with tetracycline cured the infection (Eadie et al. 1990).

In 1998, a trainer working at the New England Aquarium was bitten by a harbor seal. Treatment was with tetracycline. Cultures taken from the trainers infected digit and the oral cavity of the seal isolated the same strain of *Mycoplasma* (Baker et al. 1998).

Organism
Mycoplasmas are gram-negative coccobacilli that lack a cell wall.

Clinical disease in marine mammals
M. phocacerebrale, M. phocidae, and *M. phocarhinis* were isolated from harbor seals (*Phoca vitulina*) during an epidemic in New England (1980) and in the Baltic Sea (1989; Baker et al. 1998). Mass mortality due to mycoplasmal pneumonia has been documented; however, pinnipeds likely carry these organisms as part of their normal flora.

Clinical disease in humans
The local infection in humans with *M. phocacerebrale* (possibly other *Mycoplasma* species as well) isolated from marine mammals is commonly referred to as "seal finger". The organism enters through breaks in the skin, and infection can occur after contact with pinniped skin and commonly after a bite from seals and sea lions.

Infection causes local erythema and nodules at the site of inoculation, with progressive swelling that can be severely painful. If left untreated (or treated with inappropriate antibiotics), the infection can progress to cellulitis, tenosynovitis, and/or arthritis (Hartley and Pitcher 2002).

Treatment
Mycoplasma are susceptible to tetracyclines and are resistant to penicillins and erythromycins. Treatment of severe cases may include arthrodesis or amputation.

San Miguel Sea Lion Virus (SMSV)

Smith, in 1998, reported the first confirmed human case of SMSV after isolating the virus from blisters on the hands and feet of a laboratory worker with systemic illness (Smith et al. 1998).

Pathogen
A calicivirus, San Miguel Sea Lion Virus is molecularly identical to vesicular exanthema of swine first identified in California in the 1920s.

Clinical signs in marine mammals
SMSV causes vesicular lesions at mucocutaneous junctions and on the ventral surface of flippers (Smith et al. 1998).

Clinical disease in humans
There have been very few suspected cases of human infections with SMSV. Lesions in humans appear to be similar to those seen in marine mammals. There is no treatment and the disease is self-limiting (Smith et al. 1998).

Influenza A

An investigator at the New England Aquarium developed a severe conjunctivitis subsequent to having a harbor seal (*Phoca vitulina*) contaminate the eye with a sneeze. Swabs taken of the inflamed eye two days post-contamination showed exposure to Influenza A (Webster et al. 1981).

Pathogen
Influenza A is an Orthomyxovirus. Influenza A has a natural reservoir in the wild bird population and can infect a wild range of hosts.
Note: Influenza B, thought to be primarily a human pathogen, was identified using reverse transcriptase polymerase chain reaction from a naturally infected harbor seal (*Phoca vitulina;* Osterhaus et al. 2000). Transmission of Influenza B from animals to humans has not been documented.

Clinical disease in marine mammals
Influenza A acts in synergy with *Mycoplasma* infections causing pneumonia in seals. The respiratory infections have been a major factor in mass mortality and stranding in harbor seal populations (Webster et al. 1981).

Clinical disease in humans
In the case mentioned above, contamination of the eye with Influenza A caused a painful purulent conjunctivitis, the onset of which was approximately 48 hrs after exposure. No treatment was attempted; the inflammation resolved in about 5 days.

Seal pox

Two researchers were infected while working with grey seals (*Halichoerus grypus*) at the University of Guelph and developed lesions on their fingers. Skin scrapings of the lesions reveal viral particles that were microscopically identical to those identified from the grey seals' lesions (Hicks and Worthy 1987).

Pathogen
Sealpox is classified as a Parapoxvirus. Other related viruses include orf in sheep and bovine papular stomatitis in cattle.

Clinical disease in marine mammals
Causes singular to coalescing nodules on the head and neck and ventral surfaces of the flippers of seals and sea lions. Histopathologically, the lesions are hyperkeratotic and parakeratotic. The nodules will often ulcerate after 2 weeks but will resolve in about 4 weeks (Hicks and Worthy 1987).

Clinical symptoms in humans
The lesions in humans have been described as "milker's nodules". They are found most commonly on digits and are raised edematous and erythematous nodules. They have a histological appearance consistent with parapox lesions (i.e. hyperkeratosis/parakeratotic). There is no treatment. Lesions should resolve without treatment.

Blastomycoses

A veterinarian treating a bottlenose dolphin (*Tursiops truncatus*) developed lymphadenitis and cellulitis and was subsequently diagnosed with *Blastomyces dermatitidis* via immunofluorescent staining of a skin biopsy. No treatment was initiated and the infection resolved on its own (Cates et al. 1986).

Organism
Blastomyces dermatitidis is a saprophytic dimorphic fungi. Humans and animals are usually infected via inhalation (Howard 1983).

Clinical disease in humans and marine mammals
Primary infection occurs in the lungs causing granulomatous lesions. Spread of the disease can occur resulting in granulomatous lesions in skin and other organs (Howard 1983).

Treatment
Treatment of blastomycosis is with antifungal such as itraconazole, fluconazole, or amphoteracin B.

Literature Cited

Artz, A. L., S. Szabo, L. T. Zabel and H. M. Hoffmeister 2001. Aortic valve endocarditis with paravalvular abscesses caused by *Erysipelothrix rhusiopathiae*. European Journal of Clinical Microbiology and Infectious Disease 20: 587-8.

Baker, A. S., K. L. Ruoff and S. Madoff 1998. Isolation of *Mycoplasma* species from a patient with seal finger. Clinical Infectious Disease 27: 1168-70.

Brew, S. D., L. L. Perrett, J. A. Stack, A. P. MacMillan and N. J. Staunton 1999. Human exposure to *Brucella* recovered from a sea mammal. Veterinary Record 144: 483.

Cates, M. B., L. Kaufman, J. H. Grabau, J. M. Pletcher and J. P. Schroeder 1986. Blastomycosis in an Atlantic bottlenose dolphin. J Am Vet Med Assoc 189: 1148-50.

Chastel, C., O. Masure, G. Balouet, P. Laban and A. Lucas 1975. [The student, the cetacean and swine-fever. A minor epidemic after dissection of a globicephale]. Nouvelle Presse Medicale 4: 1803-5.

Cosivi, O., J. M. Grange, C. J. Daborn, M. C. Raviglione, T. Fujikura, D. Cousins, R. A. Robinson, H. F. Huchzermeyer, I. de Kantor and F. X. Meslin 1998. Zoonotic tuberculosis due to *Mycobacterium bovis* in developing countries. Emerging Infectious Diseases 4: 59-70.

Eadie, P. A., T. C. Lee, Z. Niazi and D. Lawlor 1990. Seal finger in a wildlife ranger. Irish Medical Journal 83: 117-8.

Flowers, D. J. 1970. Human infection due to *Mycobacterium marinum* after a dolphin bite. Journal of Clinical Pathology 23: 475-7.

Forshaw, D. and G. R. Phelps 1991. Tuberculosis in a captive colony of pinnipeds. Journal of Wildlife Diseases 27: 288-95.

Godfroid, J. 2002. Brucellosis in wildlife. Scientific and Technical Review Office International des Epizooties 21: 277-286.

Hartley, J. W. and D. Pitcher 2002. Seal finger--tetracycline is first line. Journal of Infection 45: 71-5.

Hicks, B. D. and G. A. Worthy 1987. Sealpox in captive grey seals (Halichoerus grypus) and their handlers. Journal of Wildlife Diseases 23: 1-6.

Howard, Edwin B. (1983). Pathobiology of marine mammal diseases. Boca Raton, Fla., CRC Press.

Markham, R. B. and B. F. Polk 1979. Seal finger. Review of Infectious Disease 1: 567-9.

Morgan, J., S. L. Bornstein, A. M. Karpati, M. Bruce, C. A. Bolin, C. C. Austin, C. W. Woods, J. Lingappa, C. Langkop, B. Davis, D. R. Graham, M. Proctor, D. A. Ashford, M. Bajani, S. L. Bragg, K. Shutt, B. A. Perkins and J. W. Tappero 2002. Outbreak of leptospirosis among triathlon participants and community residents in Springfield, Illinois, 1998. Clinical Infectious Disease 34: 1593-9.

Osterhaus, A. D., G. F. Rimmelzwaan, B. E. Martina, T. M. Bestebroer and R. A. Fouchier 2000. Influenza B virus in seals. Science 288: 1051-3.

Centers for Disease Control and Prevention, 2001. Disease information, Brucellosis. Division of Bacterial and Mycotic Disease http://www.cdc.gov/ncidod/dbmd/diseaseinfo/brucellosis_g.htm

Ryncarz, R.E., Heasley, E.C., Babinchak, T.J. 1999. The Clinical Spectrum of Nodular Lymphangitis. Hospital Physician: 63-66.

Sargent, E. 1980. Tetracycline for seal finger. Journal of the American Medical Association 244: 437.

Smith, A. W., E. S. Berry, D. E. Skilling, J. E. Barlough, S. E. Poet, T. Berke, J. Mead and D. O. Matson 1998. In vitro isolation and characterization of a calicivirus causing a vesicular disease of the hands and feet. Clinical Infectious Disease 26: 434-9.

Smith, A. W., D. E. Skilling, N. Cherry, J. H. Mead and D. O. Matson 1998. Calicivirus emergence from ocean reservoirs: zoonotic and interspecies movements. Emerging Infectious Diseases 4: 13-20.

Smith, A. W., N. A. Vedros, T. G. Akers and W. G. Gilmartin 1978. Hazards of disease transfer from marine mammals to land mammals: review and recent findings. J Am Vet Med Assoc 173: 1131-3.

Sweeney, J. C. and S. H. Ridgway 1975. Common diseases of small cetaceans. J Am Vet Med Assoc 167: 533-40.

Thompson, P. J., D. V. Cousins, B. L. Gow, D. M. Collins, B. H. Williamson and H. T. Dagnia 1993. Seals, seal trainers, and mycobacterial infection. American Review of Respiratory Disease 147: 164-7.

Tryland, M 2000. Zoonoses of arctic marine mammals. Infectious Disease Review 2: 55-64.

Webster, R. G., J. Geraci, G. Petursson and K. Skirnisson 1981. Conjunctivitis in human beings caused by influenza A virus of seals. New England Journal of Medicine 304: 911.

Appendix 3. Survey respondents' comments regarding respiratory and generalized symptoms attributed to marine mammal contact. Each row represents a single respondent's comments.

Description as written by respondent	Physician's diagnosis or treatment (when sought)	Additional comments regarding disease and treatment
Symptoms associated with tuberculosis	Nine months of in-patient treatment. Physicians simply relate problem back to the dolphin exposure.	I had always been an extremely healthy person, but as soon as I began volunteering with marine mammals I came down with a very bad case of pneumonia and began losing weight. Multiple antibiotic treatments with varying success. Currently on Ferrous Sulphate for anemia (bones not absorbing) and have fatigue, night sweats, and excessive thirst. The pneumonia even destroyed all the cilia in my nasal passages. Also, I have had tons of problems with chronic fatigue and bacterial infections since then.
Tuberculosis	Presently not active or contagious.	Close capture and handling of sea lions most likely source of exposure.
Tuberculosis		Most likely source handling of sea lions
I developed respiratory problems and symptoms consistent with Brucella infection.	No official diagnosis or testing was made. Treatment with antibiotics successful.	Possibly contracted as a result of intensive seal rehabilitation under poor ventilation for a period of weeks.
Leptospirosis	Leptospirosis Oxytetracycline. Quite successful!	I "inoculated" myself by an accidental jabbing with a needle from a leptospirosic sea lion.
Sudden onset of vertigo, nausea & loss of peripheral vision	Physician put me on antibiotics, then on follow-up exam decided I had leptospirosis. Since I was on antibiotics, test came back expectedly negative. His reading on the diagnostic book was that I was a textbook case.	Symptoms began 3-5 days after a bite on the hand by northern fur seal.
Serious sequelae of minor skin cut acquired in course of post mortem dissection of a harbor porpoise	Erysipelothrix isolated. Unresponsive life-threatening toxemia/encephalopathy - required amputation of infected digit. Permanent C.N.S. problems	Amputation proved life-saving.
Nausea	H. pylori infection Treated for two weeks with antibiotics	Contracted after necropsy of dead whale when others involved developed rashes.
Respiratory problem due to unavoidable inspiration of expired air from blowhole.		Even with the best protocols in place, during very lengthy rescue operations involving cetaceans, practices tend to become sloppy when teams become over exposed to the elements and overtired e.g. hands not cleaned so often, face masks removed, surgical gloves discarded etc.
After supporting common dolphins in the water at a mass stranding in the dead of winter, I experienced chest and throat congestion.		May have been the result of the animal's blowing in my face - or from being out in the elements with them.

Description as written by respondent	Physician's diagnosis or treatment (when sought)	Additional comments regarding disease and treatment
Respiratory illness		Resulted from crawling around on a sandy beach full of mm fur, scat, dead tissue etc.
Respiratory illness		Work conducted on a sea lion rookery resulted in a considerable amount of particulate airborne material. Symptoms occurred ~24 hrs. following exposure.
Respiratory illness		Came after working with sea lions on Ano Nuevo Island which had leptospirosis.
Asthma aggravated by the inhalation of brevetoxins due to red tides from a manatee's GI tract.	Various inhalers and limit exposure.	Various breathing tests. Doctor prescribed numerous inhalers to use.
When performing necropsies on manatees exposed to Red Tide, I had throat irritation, coughing episodes, and trouble breathing.		
Soreness in my lungs when breathing		Resulted from doing a necropsy on a fin whale and breathing the fumes from the whale carcass.
After a long bout of pneumonia and bronchitis, was eventually diagnosed with, and treated for, asthma.	Positive for antibodies to mycoplasma pneumonia; doctor suspected exposure from work with marine mammals or their environment; never confirmed. Subsequently developed asthma. Currently well-controlled.	
Irritation of eyes and lips.		When transporting a stranded pilot whale off shore, I was downwind of the blow. The spray from the blow was blowing straight into my face (I did not have the option of moving position) for about 45 minutes. Lasted until I was in a position to rinse my face, and no lasting effects were noted.
Conjunctivitis caused by Staphylococcus after receiving spayed breath from a dolphin.	Diagnosed with Staphylococcus aureus. General antibiotics in eye drops successful.	
Eye infections	Eye drops	Working on dissecting Tursiops head, wore hat during procedure, during subsequent three separate instances of wearing hat outside of lab, got eye infections. Antibiotic treatment by eye drops effective in all instances. Believed to be bacterial pathogen associated with decomposition of Tursiops tissue (Tursiops degradation was advanced.)
Influenza conjunctivitis		Contracted during necropsies of seals succumbing to influenza epizootic. This case was alluded to in a publication in the New England Journal of Medicine.

Description as written by respondent	Physician's diagnosis or treatment (when sought)	Additional comments regarding disease and treatment
Sometimes I have a reaction similar to a histamine response when I deal with dead things. Sometimes I get watery eyes or a runny nose, and sometimes it seems to sting a bit. I would often get somewhat of a headache, too - more of tightness in the frontal region.		Especially pronounced if I haven't been around dead things for a while or if I'm dealing with really long-dead (not length, but VERY dead) things. I suspect I was having some sort of immune reaction to something, whether it was the dead thing or things that grow on dead things & their products. Too, I notice that reaction when I open our big walk-in freezer in which lots of dead things are kept.
Non-specific chronic fatigue	Initially diagnosis was unknown infection, and I was treated with various antibiotics that did very little. I had gone through many diagnostic tests for my illness. Later on suggestions of chronic fatigue syndrome, MS, etc. were par for the course. Years later it was discovered that as high as 10% of the animals I had processed were Brucella (*marinus*) positive. Antidepressants were also tried.	Three years of grinding biological tissues without proper respiratory protection. I tested negative for Brucella abortus.
Fatigue	Fibromyalgia/chronic fatigue syndrome	
Generalized fatigue	Mononucleosis; giardiasis	
Ran a very high fever after working with live stranding--very difficult to separate handling live stranding from marine mammal or from less than ideal human working conditions (i.e. storms, cold).	Blood test were run for lymphoma & lime disease w/ no results - no final diagnosis.	
I caught dolphin breath!		The dolphin blew into my face and I smelled the dolphin's breath. A few days later I noticed that I had the dolphin's breath. Within two weeks the slightly mucousy condition was gone. Years later I noticed that one child in a bunch of Marine Corps kids had that same distinctive breath. Because the child had been with Navy dolphins in the operations area, I was not able to get a confirmation that the child had been exposed to dolphin's breath.

Appendix 4. Survey respondents' comments regarding lesions on extremities and skin disease symptoms (seal finger, rashes, cuts, scrapes) subsequent to marine mammal contact or occupational exposure. Each row represents a single respondent's comments.

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Seal pox	Reddened, involved a joint, painful, oozing, swollen	poxvirus	Seal finger as a result of superficial bites to hands by grey seal pups. Localized swelling and stiffness in nearby joints, infection never severe and healed without medication or with oral oxytetracycline. Poxvirus as a result of a superficial scratch from a grey seal pup tooth. The pup was suffering from sealpox and the biopsy of the growth on my hand tested positive for the same. Undiagnosed infection of left hand causing severe localized swelling of back of hand and forearm (nonpitting). Enlarged local lymph node and visible tracks to shoulder. Investigative surgery to back of hand revealed little. Infection did not respond to high IV doses of Flucloxacillin, Penicillin and Metronidazole. Appeared to respond to IV Clindomycin, Gentomycin and oral Doxycycline. Cause as yet unknown!	Reddened, involved a joint, painful, oozing, swollen
Seal pox	Reddened, involved a joint, nodular	Seal pox verified by EM	Grey seals I was working with in captivity were diagnosed as having seal pox.	No treatments - just waited for them to pass.
Seal finger	Blister	Seal finger		Hospitalized for 10 days with seal finger. One surgery to clean out infection. Three (3) surgeries to try for mobility. Index finger permanently fused surgically in partially bent position.
Seal finger	Reddened, painful, oozing, itchy, nodular	Infected - treated with antibiotics (tetracycline)	Bacterial infection resulting from seal bite	Tetracycline for seal bite - 7 day course - healed up after 6 weeks

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Seal finger	Reddened, painful, oozing, itchy, swollen blister	Seal finger for joint Erysipelothrix medicated. Itchy blister due to a "herpes" virus - no medication	Seal finger but this was developed when a fish spine stabbed me + later fed and cleaned pinnipeds. Herpes virus - itchy blisters, red swollen finger.	Tetracycline for seal finger. I still occasionally get the small itchy blisters even though I work with primarily with sea birds on the rookeries. That also has breeding sea lions and elephant seals. Diagnostics per Naylan Vedros Lab.
Seal finger	Reddened, painful, oozing, blister	Dermatologist couldn't identify but veterinarian who had contracted same symptoms told me to inform MD that it was Erysipeloid infection. The symptoms were treated by local physician, in this case a dermatologist. I was prescribed two or three antibiotics, including amoxicillin and finally (on the recommendation of veterinarian) tetracycline. This last drug reduced my symptoms and the condition resolved, although I have a dysfunction of finger at the last joint.	We always thought it was indirect because the mm food, in my case herring, was believed to be the source of the bacteria - seal bite was the means of transmitting it.	We had other cases of similar erysipeloid disease among staff in this workplace. The common link was the fish and the harbor seals. I was bitten by a harbor seal while feeding. We didn't wear gloves then. However, I could have had open wounds on my hands already. Stirring around the thawing fish in a bucket would have been another possible means of acquiring the bacterial infection.
Seal finger	Painful, oozing, blister	Doxycycline for seal finger, effective 3 times	Infected cuts after necropsy. Infected bite wound.	4th time it responded to azithromycin.
Seal finger	Reddened, involved a joint, painful, itchy, nodular, swollen	Seal finger/ fish handler's disease		
Seal finger	Painful, oozing, blister	Seal finger. Tetracycline.	I contracted seal finger from a sea otter.	Symptom relief within 8 hrs.

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Mycoplasma identified from swab.	Reddened, painful, oozing, blister	Seal finger - eight days in hospital. Two operations on hand to clean out tendon and save finger (successful). Initial antibiotics given - broad spectrum gram positive including amoxicillin. Did not appear to work. Given oxytetracycline after second hand op and presentation of articles on treating seal finger and consultation with zoo vet. Immediate improvement.	Seal finger - blood poisoning Note original bite wound very small puncture wound.	Total 3 weeks off work. Full use of hand restored some but residual stiffness remains - very minor in knuckle. Rapid onset of infection tracking up tendon sheath approx. 5 days after injury.
Seal finger		Augmentin -resolved quickly.	Seal finger after scrape on finger	Treated within 18 hrs.
2 occurrences of seal finger treated with tetracycline	Reddened, oozing	I educated the medical staff as to the probability of the infection being seal finger and requested treatment by tetracycline antibiotics	I would contribute exposure to seal finger as directly caused by contact with marine mammals, although too many variables to tell.	Only medical treatment was prescription of tetracycline antibiotics for 2 episodes of seal finger with total success. The only other serious injury (deep wound) was self cleaned and bandaged in a field setting.
Seal finger	Reddened, involved a joint, painful, swollen	seal finger	Infected bite at finger joint	Doxycycline for infected wound was effective.
Seal finger	Reddened, painful, oozing, itchy, nodular, swollen			Antibiotics successfully treated early stages of seal finger on two occasions
Seal finger	Reddened, painful, blister, nodular	Doxycycline resolved my one case of "seal finger"		
Seal finger	Reddened, painful, oozing		Both were a direct consequence of infection secondary to bites	Antibiotics for bites – successful
Crushing wound/seal finger	Reddened, painful, oozing	Swollen hand – seal finger infection (tetracycline treatment started). Bitten index finger - no doctor seen, wound washed, resolved OK.	Bite wound on index finger was not infected, but crushing injury caused damage to fingernail (resolved over months. Hands swollen after dissecting seals (seal finger infection)	Hand infection diagnosed as seal finger infection – successfully treated with tetracycline over 2 weeks.

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Punctures from canines during tubing procedures.	Reddened, painful, oozing, blister	Doctor prescribed tetracycline. The doctor believed that the infection was caused by the bacteria inside a "not so clean" restraint glove.	Initial wounds were caused by handling marine mammals, but most reactions/infections have been the cause of poor cleaning of the wounds and not keeping the wound away from dirty substances (i.e. handling fish scraps, cleaning equipment, etc.). On all but one occurrence, the punctures went through protective restraint gloves. Most of the time, the infections appeared to have been caused by poor cleaning of the area and poor attempts at keeping the wound clean.	Tetracycline for seal finger worked immediately upon administration. Level of severity of infection was very low although.
I believe it was "seal finger" from handling the fish and then was aggravated by the constant moisture and handling of animals.		Try to keep the hands clean and dry, use gloves at work to avoid contact with the fish or animals; recommended laser cream at night with white gloves and to wear water repellent cream during the day.		
Seal finger	Oozing, blister	Seal finger		I pierced my thumb with a needle. This became infected after handling seals. I was on 2 antibiotics and quite ill for three weeks. My hand was swollen and my thumb stayed numb for many months.
Seal Finger	Reddened, painful, oozing, blister	Seal Finger - Treated with Ciprofloxacin		
Seal finger	Involved a joint	Several warts on hands	Seal finger on 3 occasions when puncture wounds from harbor seal bites were close to joints on hands	Minor wounds caused by seal bites were flushed and treated with Goldenseal powder - healed well + quickly. Deeper punctures near finger joints also treated with Doxycycline and healed quickly.
Seal finger – Mycoplasma	Reddened, painful, oozing	Seal finger - Mycoplasma although the MD was supplied with appropriate literature to direct the diagnosis.	Seal finger developed immediately subsequent to bite on the hand.	Successful treatment of seal finger with tetracycline.

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
I had a raised sore spot on my finger that blistered and contained clear fluid.	Reddened, painful, oozing, nodular, swollen		The skin lesion I had on my finger occurred the week after I necropsied a California sea lion which had abscessed lymph nodes. We never got a definitive diagnosis on that animal or on my finger.	
Seal finger	Reddened, involved a joint, nodular, oozing, painful, blister	Non-specific inflammation (first treatment); suspicion of mycoplasma; septic osteolysis	Mycoplasma infection one positive and one negative, but temporal coincidence and sequelae are consistent with the injury.	Surgery on hand to debride joint and remove calcification. Basically successful. Treatment was complicated due to tetracycline allergy.
Seal finger	Reddened, painful, oozing	Infection (seal finger)	Seal finger result of bite	3 days in hospital with constant fluid drip took care of it. Prescriptions included Doxycycline, Cephalexin and Keflex.
Seal finger	Reddened, oozing, blister	Erysipelothrix	During necropsy of Tursiops truncatus, got a small cut - like a paper cut. Within a week, the finger looked like burned sausage. Surprisingly, no associated pain.	Day surgery to clean out infection followed by Penicillin for approximately 30 days. No reoccurrence.
Seal finger	Reddened, painful, oozing, nodular	Seal finger - betadine and tetracycline		
Seal finger	Reddened, painful, oozing, blister		I had a seal finger-like problem that resolved with antibiotics (cephalosporin), although no organism was cultured. I received antibiotics for a number of bite wounds as prophylaxis. I had a staph infection in my leg that may have resulted from a sea lion bite.	I received antibiotics for seal finger and a few animal bites. No problems or complications ensued following treatment.
	Reddened, painful, oozing, itchy, nodular, blister	Erysipelothrix rhusiopathiae	Symptoms appeared within 12 hrs after completion of a necropsy made wearing nonlatex gloves. No other source was contacted.	Overnight intravenous intake of antibiotic that seemed to be named maxipine. This was followed by doxycycline taken by mouth.
Eczema	Reddened, itchy	Eczema. It developed after several weeks of scat collection in the wild. I wore plastic surgical gloves which sometimes became torn. The eczema has never gotten better. I had no direct contact with the animals.	Developed after several weeks of scat collection, no direct contact with animals during that time.	All treatments for eczema have failed. Hylog ointment for eczema has been the most successful, but still does not cure the problem.

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Aquarist's finger	Reddened, involved a joint, painful, itchy, nodular, swollen	Mycobacterium marinum ("aquarist's finger", "fish tank granuloma")	M. marinum suspected due to contact with water in m.m. tanks.	
Seal finger	Reddened, painful, oozing	The physician gave prescriptions after patient informed him about seal finger, including scientific literature about the problem.	The problem was the result of a superficial scratch caused by a fur seal pup bite. The problem appeared during the fourth day after the bite. Swelling in the finger, hypersensitivity and pain, skin reddened, and immobilization.	Initial treatment was Amoxicillin for five days. This was replaced by Erythromycin for six days.
Seal finger developed once	Reddened, oozing	Seal finger	Seal finger due to bite	Tetracycline - successful
Finger swelled up with ascending cellulitis on arm	Painful	Bacterial infection.	Porpoise had died of Erysipelothrix septicemia. Blood cultures were carried out on me, but no bacteria were isolated.	Hospitalization and IV broad range antibiotics for 3 days controlled infection.
Seal finger	Reddened, nodular, painful, oozing, blister	I treated the seal finger myself. For the deep bite wound on ankle diagnosis "gas gangrene" cultured Clostridium perfringens. Required 3 plastic surgeries	Many bacteria were cultured out of the bite wound from a California sea lion. Bite was improperly treated in a hospital emergency room resulting in a severe, prolonged, recovery period with several debridement surgeries for a chronic, draining tract. Cipro and cephalexin worked well for seal finger (can't take tetracycline), and I used them to prevent recurrence whenever I got a cut or scratch during a necropsy. The deep bite wound was finally cleared after a 6 week course of cipro.	Considering hundreds of necropsies and many months of crawling through fur seal rookery muck (splashed in the face many times), I feel I have really suffered very little in spite of the risks I was exposed to.
Wrist	Reddened, involved a joint, painful, blister	Seal finger cleared with a 10 day cycle of cephalexin; note that doctors did not listen to my suggestion to use cephalexin until other antibiotics had failed.	In two cases, I had what was described as seal finger, the first of which was originally diagnosed as Vibrio,) but when the antibiotic prescribed did no good, the Dr gave me the cephalexin.	
Seal finger	Reddened, painful, oozing,	Seal finger		Steroid cream for eczema - successful in controlling/removing rash
Seal finger	Reddened, painful	Occupational injury - prescribed preventive courses of antibiotics	Seal finger	Treated properly because my supervisor's husband was a doctor who new specifically how to treat it.

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Seal finger	Reddened, oozing, itchy	I was given a triple antibiotic ointment for external use, and oral antibiotics to stop the internal infection that was spreading.		Antibiotics were successful
Seal finger	Reddened	Mild wound infection.		Use of doxycycline, successful.
Seal finger	Blister	Probably Erysipelothrix		Antibiotics worked fine
Beluga finger	Reddened, painful, oozing, blister	Unknown	Although wearing latex gloves, contracted during necropsy of female beluga (cause of death undetermined -possibly due to stranding) I noticed some swell in left index finger. Initially though it was a splinter but it continued to swell and was hot.	After numerous calls to mm biologist, everyone prescribed tetracycline given for seal finger. I remembered beluga & seal finger looked alike but had to be treated differently. Beluga finger was finally treated with penicillin.
Bite	Nodular	Bite to the pinky finger from a seal. Wound left open to drain. No problems occurred other than pain and redness.		Antibiotics for seal bite with no problems. Did not develop seal finger.
Seal finger	Reddened, painful	Probable seal finger with tetracycline prescription		
Seal finger	Reddened		Seal finger was from lobster bait.	
Interdigital infections	Reddened, painful, oozing, blister	Diffuse internal infection with cellulitis and joints pain, No pathogen identified.	Pathology consistent with marine mammal pathogens. No common antibiotic treatments while in the Antarctic were successful.	Amoxicillin every 8 hour for 10 days (Failed). Erythromycin every 8 hour for 7 days (failed).Injection of penicillin (failed). Clavamox for 7 days (failed). Azithromycin and enrofloxacin for 7 days was successful.
Rash went through many stages over about a month period. It would go from itchy to painful and red and raised to blistery.	Reddened, painful, involved a joint, oozing, itchy, swollen, blister	It became known as the "whale virus". Unfortunately I was given steroids in the beginning which of course relieved the initial reaction but then it came on with a vengeance.	They were worried that I had contracted morbillivirus from the whale and were aware of the 4 people in Australia that had contracted morbillivirus from conducting horse necropsies and had all died (3 right away and 1 a year later).	Two weeks oral antibiotics. The doctors were infatuated with the infectious disease and what went on over the next 6 weeks. I am very happy to still be here!

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Rash under arm and along side where I usually restrain animals. Small bumps on forearms with some redness.	Reddened, painful, itchy, nodular, swollen, blister reddened	Prescribed Doxycycline but the rash did not go away	It was obvious that the illness was a direct result of being in contact with the whales. All the other tests came back negative to rule out other possibilities.	
Bacterial infection	Reddened, painful, nodular, swollen	The one time that I had problem examined, wound was cultured and grew Pseudomonas		
Rash	Reddened, painful, oozing, itchy, nodular, blister	Staph aureus	Confirmed Staph a. infection to right index finger from exposure to stranded Kogia breviceps, resulting surgical procedure.	Surgery successful in eliminating infection and eliminating potential removal of extremity. However, have deformed skeletal structure on right index finger.
Small rashes on hands and lower arms	Reddened, itchy		I believe the rashes and redness of the eyes resulted from fish handling and heat rash from wet suits, not from the marine mammals.	I was never treated for the problems.
Forearm	Swollen, itchy, reddened, involved a joint, painful	Uncertain, treated w/antibiotics.	Subsequent to intensive necropsy work on bottle nose dolphin.	
Legs	Swollen	Tursiops epizootic no diagnosis		
Legs	Reddened, involved a joint, nodular, blister		Result of Tursiops captures	
Rash	Reddened, itchy, swollen	Open	Skin rash/vesicles occurred ~9 mo after bare hand contact with active herpes like viral oral ulcers in sea otters. Dermatologist did not biopsy - treated with topical hydrocortisone resolved in ~2 wks.	
Contact dermatitis	Reddened		Redness in scrapes & cuts on hands/arms could have been from any number of bacterial sources in water, sand, sea water, etc.	

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Contact dermatitis	Swollen, reddened	Contact dermatitis – physicians could not diagnose.	Sometimes I get little red bumps after doing dissections.	
Right wrist	Reddened, painful, oozing, itchy	Skin dermatitis (physician had no idea what it was)	Skin reaction was from necropsy "juices"	
Contact dermatitis	Reddened, itchy	Contact dermatitis, source not sure	My excessive dry, cracking hands are believed to be due to constant immersion in salt water, contact with different fish, slight allergy to latex (questionable). If I take time off, my hands improve dramatically	
Septic infection from a superficial cut that occurred during a necropsy-not directly related to a zoonotic disease.	Reddened, painful, oozing, itchy		The infection was bacterial and I cannot say it was directly caused by the tissue I was handling at the time	
Rash on the face and neck	Oozing, itchy		Allergic to the respiratory blow of the marine mammals.	Anti-histamine drugs works.
Groin region	Reddened, involved a joint	Physician did not have a firm diagnosis. Thought it might have been some kind of allergic reaction to something in the water.		
Arms, back of thighs, face, neck	Reddened, oozing, itchy, swollen	The doctor said that there were no diseases that could be transmitted from whales to humans - so "don't worry about it"; must be some kind of dermatitis.		

Description by respondent	Description of skin reaction according to survey choices provided	Physician's diagnosis or treatment (when sought)	Comments attributing symptoms to contact with marine mammals	Additional comments
Body rash following exposure to seals in the water	Itchy	Unknown cause	The rash was contracted immediately following direct and prolonged contact with deteriorating whale carcasses; the areas affected were those areas that were in direct contact with the carcasses; other members of the team had same symptoms after the same type of contact with same animals.	No treatment at this time; steroidal ointment issued by physician but not used yet - waiting to see if rash clears on its own.
Warts	Reddened, oozing, itchy		Skin rash was only present while working directly with sea lions and dolphins. After treatment and a few months away from animals, all was well.	
Infected cuts	Reddened, Itchy		I got cut in the hand during a manatee necropsy. It got infected and I lost function of my left hand for about a week. It is back to normal now.	