Rehabilitation and Release of Marine Mammals in the United States: risks and benefits

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Marine Mammal Science 2007 Vol 23 (4) 731-750. 10.1111/j.1748-7692.2007.00146.x

Abstract

Rehabilitation of stranded marine mammals elicits polarized attitudes: initially done alongside display collections, but release of rehabilitated animals has become more common. Justifications include animal welfare, management of beach use conflict, research, conservation, and public education. Rehabilitation cost and risks have been identified which vary in degree supported by data rather than perception. These include conflict with fisheries for resources, ignorance of recipient population ecology, poor understanding of long term survival, support of the genetically not-so-fit, introduction of novel or antibiotic resistant pathogens, harm to human health and cost. Thus facilities must balance their welfare appeal against public education, habitat restoration, human impact reduction, and other conservation activities. Benefits to rehabilitating marine mammals are the opportunity to support the welfare of disabled animals and to publish good science and so advance our understanding of wild populations. In specific cases, the status of a population may make conservation the main reason for rehabilitation. These three reasons for rehabilitation lead to contrasting, and sometimes conflicting, management needs. We therefore outline a decision tree for rehabilitation managers using criteria for each management decision, based on welfare, logistics, conservation, research and funding to define limits on the number of animals released to the wild.

Keywords: Rehabilitation, Release, Conservation, Education, Animal Welfare

Introduction

Scope: The purpose of this review is to describe the recent history of and legal basis for the rehabilitation of marine mammals in the United States. We make no attempt to focus on other regions of the world. The reasons for and against, and uncertainties associated with undertaking rehabilitation are discussed in the context of individual animal welfare, fundamental science, conservation biology and ecosystem management agendas. A strategy for when rehabilitation with or without release should be attempted is then proposed, given these concerns. This review is less about science than it is values, ethics and risks, given what we do and do not know.

Background: Marine mammals are poorly known, charismatic species that command considerable scientific inquiry and public attention. When these animals are found on land, they generate responses varying from concern over their welfare, to interest in the potential environmental factors causing them to come ashore, in addition to attention from hunters where legal. These responses, motivated by a variety of animal welfare, conservation, research and cultural goals, have resulted in coordinated efforts at times to collect and in some cases to attempt to rehabilitate stranded animals. Gradually, conservation with concomitant needs for better understanding of threatened and endangered species has emerged as an alternate to purely animal welfare agendas as an aim of stranding response. The high public profile, monetary expense and labor efforts involved in rehabilitation programs with unclear aims have exposed them to criticism from the research and conservation communities. Thus, whilst extant programs evolved from a welfare origin they now raise conservation concerns, and there needs to be a review of the relative merits and values of these end points. Marine mammal

rehabilitation is an effort that currently lacks a coherent central set of core values, ethics or goals. As a result the effort is ill defined (except on the most local level) and, in many cases self contradictory. After more than a quarter of a century the effort remains inconsistent, poorly supported and fractious. Efforts to correct this will require either internal change by stranding organizations or changes by external regulation.

Legal and Historical Perspective

Workshops to improve coordination were held in 1977 (Geraci and St. Aubin 1979; St Aubin *et al.* 1996), 1987 (Reynolds and Odell 1991) and 1991 (St Aubin *et al.* 1996). The program was reviewed by the National Marine Fisheries Service (NMFS) in 1990 (Wilkinson 1991). In 1992, an amendment to the Marine Mammal Protection Act (MMPA) established centralized coordination of marine mammal stranding response efforts in the United States, with a national stranding coordinator to standardize regional network operations and define national stranding response policy. More recent steps are summarized in the interim release guidelines (Whaley and Borkowski 2006). These guidelines give detailed protocols for release decisions, but do not attempt to address the philosophy or ethics of such actions.

Today a series of independent organizations around the United States responds to stranding events and/or undertakes rehabilitation of cases that are not immediately translocated and released or euthanized. Stranding response groups include federal and state agencies, museums, research laboratories, academic institutions, public display facilities, as well as dedicated rehabilitation centers. Most do not undertake rehabilitation.

The rescue of marine mammals is covered in United States law by two provisions of the MMPA. Section 109 (h) allows for the "taking" of marine mammals for: "A) the protection or welfare of the mammal, B) the protection of public health or welfare or C) the non-lethal removal of nuisance animals." In 1992 the MMPA was amended to include Title IV (The Marine Mammal Health and Stranding Response Act) that requires NMFS to collect and disseminate information about the health of marine mammals and health trends of marine mammal populations through the collection of stranding data. The legal framework for stranding response then identifies three different goals of stranding efforts – welfare of individual animals, protection of human health or welfare, and the collection of scientific information that may be used for management and conservation - without clearly identifying a priority or decision tree to address conflicting goals.

In the 1970's, release of rehabilitated stranded marine mammals was not considered a serious issue. Most animals either did not survive or were placed in permanent collections in zoos or aquaria. The numbers of animals recovered, facilities available to treat them and numbers of animals that survived were all small. As knowledge of marine mammal medicine and husbandry improved, the rehabilitation concept grew, and the capacity of aquaria and other display facilities to absorb rehabilitated animals effectively shrank proportionally. Stranded animals increasingly took the place of captured animals for public display facilities. Less space however became available for permanent care. The emergence of infectious disease as a factor in strandings (Goldstein *et al.* 2004), further reduced permanent holding capacity by discouraging public displays from holding stranded animals. Release became more of a consideration and the de facto goal of an increasing number of "rehabilitation for release" programs.

"Rehabilitation" itself may be defined in two slightly different ways, either as an attempt to return an animal to full health or to return it to a reasonably functional condition. While one view is likely overly idealistic and one is overly pragmatic, the difference is more than purely semantic. The efforts and ethics involved in the former are more far reaching than those aimed at returning an animal to some degree of function or health. The vagueness of even this most basic concept simply adds to the conflicting values and options within which stranding organizations work.

The 1991 workshop (St Aubin *et al*. 1996) undertook a systematic review of marine mammal rehabilitation in general, and release issues in particular. There was general agreement that the health of wild populations should be of greater concern than the welfare of an individual animal. This would seem to tip the balance in favor of conservation when it and welfare concerns collide. Issues of highest concern were risks of introduction of disease into wild populations and the potential genetic consequences of releasing rehabilitated animals (Wilkinson and Worthy 1999). The reader should refer to the St. Aubin report and the Wilkinson review for important historical and technical background. In this review we consider current best practices. A complete literature review as well as an alternative view of rehabilitation programs has been published recently from a Canadian perspective (Measures 2004).

The first two eras in the evolution of marine mammal rehabilitation could be classified as: 1) Beach management and 2) Advancing veterinary care. The former is perhaps best represented in the publication of a field guide for responding to strandings, (Geraci and Lounsbury 1993) and the latter is reflected in a recent benchmark textbook (Dierauf and Gulland 2001) and a more comprehensive stranding guide (Geraci and Lounsbury 2005). It is reasonable to suggest that with the advent of reliable and increasingly small and affordable satellite-linked transmitters, GIS software and the ability to transmit vast amounts of data via the internet, the current era, building on the prior two, should be based on animal welfare and conservation, and focused on research and validation of rehabilitation techniques by post-release tracking. The costs of clinical testing and veterinary care were once considered prohibitive and largely an exercise in "treating a dying animal". Such tests are now considered essential tools for collecting useful scientific information on disease epidemiology and pathogenesis, and a necessary part of even minimal treatment programs. Future programs may rely as much on tools to assess the results of rehabilitation and its effect on wild populations as previous programs used clinical analysis and veterinary care to better understand the treatment of individuals. Such programs that focus on selected animals through multi-disciplinary studies can yield new knowledge useful in the welfare of individuals and the conservation of wild populations.

Table 1 summarizes the current level of effort being invested in marine mammal rehabilitation and release in the various coastal regions of the United States. Growing populations of pinnipeds are the primary target, with most activity in the Southwest, followed by the Northeast and Northwest regions. Cetacean rehabilitation and release is far less common nationally.

Marine mammal rehabilitation raises a suite of philosophical questions about ethics and human values, whose answers depend on a range of perspectives (Lavigne *et al.* 1999). The animal welfare advocate, conservationist, research scientist, hunter, or commercial fisherman see marine mammals from many perspectives: as sentient beings,

as important components of their natural ecosystems, as scientific resources, as quarry and food, or as detractors to profit margins. Such concerns may be, but are not necessarily, mutually exclusive. Attitudes toward marine mammals and wildlife in general have changed dramatically since the establishment of stranding networks and vary according to region and other demographic variables (income, age, education level, sex, race). Most support and detraction for rehabilitation programs is of a local nature, thus the agenda and expectations vary regionally with the different economic and employment climates driving different attitudes, as well as with the species of marine mammal being rehabilitated. Stranding organizations are often directly dependent on local funding and support for their work. As a result, local public attitudes toward wildlife in general, and specifically marine mammals, strongly influence the missions of stranding organizations. As rehabilitation programs evolve to include conservation and research and/or education in their missions, there needs to be a clear understanding of how to combine different perspectives to avoid misconstruction, misrepresentation or conflict amongst staff, funders and the general public, and to make the most effective use of very limited resources. Ideally organizations will maintain core values while applying locally appropriate attitudes and ethics – within the structure of legal rules and guidelines.

Reasons for rehabilitating marine mammals

Rehabilitation facilities around the United States publicly refer to one or more of the following reasons to justify their actions. Such reasons range in focus from:

1. Humane care of animals, especially intervention in cases impacted by human activities.
2. Mitigation of human/animal beach use conflict.
3. Research, both applied to rehabilitation and care of collection animals and other more fundamental disciplines.
4. Conservation of endangered species.
5. Post-release tracking to elucidate poorly understood wild population ranges, as well as to monitor post-release survival and behavior.
6. Education of the public about marine ecosystem health and marine mammal conservation.

Humane care: Welfare of the individual animal forms the base of veterinary medicine, and is the driving force for marine mammal rehabilitation. Removal of netting that is cutting in to a pinniped's neck provides immediate relief for the animal and gratification for the rehabilitator (Figure 2a). However, decisions on the beach can be far more complex. Faced with a distressed marine mammal, it may be necessary to prognosticate the relative pain and suffering of long, drawn out rehabilitation treatment and potential retention in captivity for the remainder of its life, compared to euthanasia. Furthermore, limited availability of holding facilities necessitates euthanasia on a sliding gradient of criteria as the case load varies. Such acts can induce a negative public image and result in loss of support. However, in a world where resources are limited, and decisions to not euthanize an animal can lead to significant further chronic suffering in the wild or captivity, with inevitable ultimate demise, the well informed and carefully measured application of euthanasia should not be overlooked. The Greek etymological root of 'euthanasia' is 'a good death'. It is incumbent upon rehabilitation organizations and governmental agencies to educate the public that rehabilitation is not necessarily in

the best interests of the individual, and suffering may best be alleviated through euthanasia. For example, 18% of stranded adult California sea lions (*Zalophus californianus*) examined post mortem in California had disseminated cancer (Gulland *et al.* 1996). Because this disease is painful and progressively debilitating, due to vertebral and spinal cord erosion by tumors, early diagnosis and euthanasia is considered the most humane treatment for these animals by those authors and rehabilitation resources have been directed at early diagnosis rather than treatment.

Furthermore, welfare of stranded animals must be carefully evaluated to prevent anthropomorphizing and not acting in the best interests of an individual animal's welfare. For example, euthanasia may be a more humane option for a beached large whale than prolonged attempts at rehabilitation. Similarly it is the policy on Cape Cod, Massachusetts to euthanise single stranded cetaceans, other than phocoenids, irrespective of condition, as they have shown a very poor survival rate when beach released, or in rehabilitation.

Beach conflict: Different areas of the US coast vary in their relative densities of humans and pinnipeds on beaches that at least in part drive regional management styles and constraints for stranded marine mammals. The distribution of stranding responders in the continental US west coast ranges from multiple facilities and agencies serving single counties in California, to three entities serving the entire state of Oregon. Differing attitudes are driven by the intensity of the haul out space conflict between humans and pinnipeds. Where such conflicts are most intense, such as in parts of California and New York, the humans that are displacing pinnipeds may be the engine driving local rehabilitation efforts. In contrast Oregon, with a largely undeveloped coastline, does not rehabilitate pinnipeds that come from stocks that are not endangered, threatened, or depleted[1]. In Alaska, conflicts arise due to vast differences in cultural attitudes to marine mammals amongst residents. In an extreme example, a seal harvested in late pregnancy was eaten by one group of people, while its pup, born by caesarian section, was rehabilitated by another[2].

Conservation/enhancement of endangered species: The National Marine Fisheries Service ran a translocation and rehabilitation program for Hawaiian monk seals (*Monachus schauinslandi*) in the 1980's on Kure Atoll to enhance juvenile survival of this declining endangered species. The rehabilitated seals may be some of the few surviving females from that decade alive in the 21st century. Thus rehabilitation of a few individuals of a critically endangered species can be important to the maintenance of reproductive females. The monk seal story, however also illustrates the risks and limitations of rehabilitation and enhancement programs. Similar translocations of monk seal pups to Midway Atoll in 1992-1993 resulted in the disappearance or death of most pups. In 1995 12 pups captured for transfer to Midway Atoll developed eye problems during rehabilitation, resulting in blindness in most pups. Concerns about the risk to the wild population (Aguirre *et al.* 1999) prevented release and the seals are now held in permanent care facilities. The program was suspended in 1998 when blood samples from wild caught seals appeared to indicate antibodies to morbillivirus in one island sub-

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population, although subsequent testing showed the virus not to be present. The survival rates of wild pups have not been good in recent years, and the captive care program without translocation was started again in 2006 on Midway Atoll (http://www.pifsc.noaa.gov/psd/captivecareproject.php>). The program's efforts have been reviewed by Lavigne (Lavigne et al. 1999) and in Marine Mammal Commission annual reports.

While release of rehabilitated animals is often presented as a means of enhancing depleted populations, in fact many conservation concerns are inversely density dependent. If the number of released animals becomes large relative to a smaller wild population, disease and genetic impacts from released animals could potentially be greater. Thus, both potential value and potential risk increase when releasing individuals into small wild populations. The majority of pinnipeds rehabilitated in the US today, however, are from species or stocks that are from numerically healthy populations (e.g. 180,000 California sea lions (Figure 2b), 100,000 harbor seals (*Phoca vitulina*) in the Gulf of Maine (Waring *et al.* 2004), so that the numerical conservation value to the population of rehabilitating a single animal is nonexistent.

The conservation value of rehabilitation as an outreach and education tool is discussed below.

Research: It is important to realize that many questions facing marine mammal science cannot be addressed in the rehabilitation context. However advances by the study of animals in rehabilitation include the following disciplines, with examples from each: infectious disease (Duignan *et al.* 1995; Gulland *et al.* 1997; Haulena *et al.* 2002; Haulena *et al.* 2006; King *et al.* 1998; Lipscomb *et al.* 2001; Maratea *et al.* 2003; Thornton *et al.* 1998), medicine (Fauquier *et al.* 2003; Gulland *et al.* 2000; Lander *et al.* 2003), pathology (Fauquier *et al.* 2003; Ridgway and Carder 2001), parasitology (Ferti and Landry 1999; Poynton *et al.* 2001), management (Dierauf 1984), human interaction (Goldstein *et al.* 1999; Howorth 1994), immunology (King *et al.* 2001) and zoonoses (Colagross-Schouten *et al.* 2002). Increased information on these topics enhances our understanding of marine mammal health. Although most studies are based on common species, much information also applies to the management of threatened and endangered species.

There has been a steep increase in the number of published scientific papers on marine mammals since the early 1970's (Lavigne et al. 1999). These authors also noted an increase in professional societies and laboratories dedicated to marine mammal science. They conclude that the increase in publication seems to far exceed what would be expected simply from the trends in the number of scientists, projects and particularly funding. When corrected (to 1978 dollars) U.S. funding for marine mammal research has remained nearly flat both in absolute terms and as a fraction of total research dollars. In contrast, public funding of some (but not all) non-profit rehabilitation organizations with active research and education programs has increased dramatically (see annual reports for The Marine Mammal Center (http://www.tmmc.org/about_us/financials.asp), suggesting that rehabilitation activity can be used to increase funding and in some cases rehabilitation can be used to attract public interest in marine mammal research, as long as the research activities appeal to public opinion.

Post-release tracking: Many rehabilitated animals that have been tracked have shown unexpected movements, and whether this is a result of the pathophysiological

abnormality that caused them to strand or normal for the individual within a population range cannot be determined yet. Recent studies have shown, however, that behavior of wild-caught juvenile Steller sea lions held for up to several months in captivity did not differ significantly from free ranging counterparts following release (Mellish *et al.* 2006). Tracking has also shown that Steller sea lions survive post-rehabilitation, and that their dive behaviors are similar to wild pups of the same age despite rehabilitation in shallow tanks (Lander and Gulland 2003). Two rehabilitated bottlenose dolphins (*Tursiops truncatus*) of the little-studied intermediate and offshore forms were tracked for 43 and 47 days respectively (Wells *et al.* 1999b) revealing possible new information about ranges for these forms of the species, although it can not be stated with any certainty that the dolphins' movements were representative of animals that did not strand and undergo rehabilitation. Similarly, tracking and subsequent re-sighting of rehabilitated rough-toothed dolphins (*Steno bredanensis*) over a period of five months demonstrated the success of rehabilitation efforts as well as the location of a previously un-described stock of rough-toothed dolphins (Wells *et al.* 1999a).

Two rehabilitated pilot whales (*Globicephala melas*) survived at least 4 months post release (Nawojchik *et al.* 2003). Thus there are significant successes and research advances that have been published both for cetaceans and pinnipeds. However for most species there is no way to control for survival studies of releases, given the lack of a suitable control population, thus making it hard to validate rehabilitation techniques and procedures.

Education and outreach: Marine mammals in rehabilitation may be used as centerpieces for education and outreach programs highlighting conservation needs. A live animal in rehabilitation due to a health problem arising from habitat degradation can be used for effective outreach programs about habitat conservation. Thus an entangled animal in rehabilitation may do more for conservation through its role in an outreach program than it does through a numerical contribution to the population after release. Present regulations however prohibit the display of animals undergoing rehabilitation further dampening the participation of public display institutions in rehabilitation. Educational programs must be carefully constructed and managed unless animals have been designated as non-releasable and are in permanent care.

Reasons against rehabilitation of marine mammals

Risks associated with rehabilitating marine mammals can be considered in three categories: issues presently supported by scientific data (see 3, 4 below); issues with a theoretical basis but no data to support them as yet (see 1, 5, 6 below); and "perceived" issues which current data do not support (see 2 below). These risks include:

1. Conflict with other stakeholders: Populations showing a significant growth in numbers that may be perceived a competitor with local fisheries.
2. Artificial support of the genetically not-so-fit by releasing rehabilitated animals that otherwise would have died on the beach through natural selection processes.
3. Introduction of pathogens acquired or modified during rehabilitation to a naïve wild population.

4. Transmission of zoonotic infections to humans interacting with animals being rehabilitated.
5. Expense: costs to rehabilitate individuals may not have the same benefit as other population-wide conservation measures.
6. Conflict with conservation goals for other more threatened or endangered species.

Management Conflicts: Many marine mammal populations, especially pinniped, are growing: the Northwest Atlantic harbor, harp (*Phoca groenlandica*, hooded (*Cystophora christata*) and gray (*Halichoerus grypus)* seals and California sea lions on the west coast are good examples. As a local population grows in size in proportion to the capacity of regional rehabilitation facilities, the proportion of animals that can be managed humanely out of habitat shrinks. This question also blends into issues of broader management concern as a growing pinniped population becomes a perceived or real threat to the sustainability of fisheries. At some point there will be an increasingly vocal demand from the fishing industry for resumption of culls. This is a reality today with regard to the California sea lion.

Some species cross not only local but international borders and demographics. In these cases, attitudes and values may be starkly contrasting. Such juxtaposition is evident where four flipper-tagged harp seals were rescued, treated and released in New York waters, returned to their home range in Canada only to be harvested in local hunts[3].

Genetics: There is a concern that rehabilitation of genetically "less fit" animals may interfere with natural selection and alter host-parasite population dynamics. The limited studies to date have pointed to a lower survival and increased susceptibility to disease of animals with higher degrees of inbreeding in sea lions (Acevedo-Whitehouse *et al.*), striped dolphins (Valsecchi *et al.* 2004) and gray seals (Bean *et al.* 2004). There are abundant empirical data from terrestrial species indicating that the co-evolution of host and parasite tend to modify pathogenicity of the parasite and increase the resistance of the host (Toft and Karter 1990). By artificially enhancing survival of an infected host to reproductive age by removing parasites, rehabilitation could interfere with host/parasite co-evolution. One potential outcome is to reduce the adaptive pressure keeping more virulent forms of parasites and disease in check and allowing more damaging forms of disease to develop (Ewald 1996).

Early on in the marine mammal rehabilitation era, the number of rehabilitated animals was so small that population-level genetic effects seemed to be remote. The size of the wild population in relation to the released population was sufficient to allay most fears about serious effects to wild populations and this was a de facto assumption of the day. This view does not account for potential effects from localized release of animals or the increase in the number of animals released and, as rehabilitation programs become more successful, this premise may no longer hold true.

Introduction of Pathogens: A released rehabilitated animal could introduce a novel or modified pathogen that it acquired in rehabilitation into the marine environment, and potential effects on a naïve wild population could be devastating. Pathogens could be acquired from terrestrial hosts, such as canine distemper, leptospirosis (Stamper *et al.* 1998) or influenza, or be enzootic marine mammal pathogens altered by the rehabilitation process. This can occur as an unwanted side effect of treatment. Pathogens can be

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modified by contact with new hosts, or modified by treatment (antibiotic resistance) or changes in selective pressure. An ecological perspective (Ewald 1996) proposes that pathogens adapt to changes in their environment by altering their pathogenicity. In humans it has been proposed that less virulent forms of cholera out-compete more damaging forms when spread of the disease is made more difficult (through sanitation), resulting eventually in a less severe form of the illness in hosts. By contrast, incomplete treatment with antibiotics and crowding can favor more virulent strains (that replicate, spread and cause disease more quickly with less adaptive pressure to spare their hosts). A recent study documented an increase in antibiotic resistant *E. coli* in elephant seals (*Mirounga angustirostris*) through the rehabilitation process (Stoddard *et al.* In Press). The high density housing inherent in captive husbandry also elevates the risk of disease transmission from other hosts, such as humans and domestic animals. With increasing pressure to treat more animals, more quickly, rehabilitation centers, if viewed ecologically, would be just the environment to alter pathogens in a way that could promote virulence. While this result is not a given, it should be one of the warnings that the effects of a rehabilitated animal on a wild population are not necessarily a statistical moot point. This latter concern is perhaps most starkly voiced in a recent Canadian review of the subject (Measures 2004): "..concerns about Canadian marine mammals at risk such as the killer whale, St. Lawrence beluga, blue whale, harbor porpoise etc. threatened by diseases potentially carried by straddling stocks of marine mammals rehabilitated in the U. S. should be formally conveyed to the U.S. Government…..".

Health risk to humans: Morbillivirus, influenza, caliciviruses, leptospirosis, seal finger, and other zoonotic risks have been previously reviewed (St Aubin et al. 1996) and are all diseases of concern with rehabilitation operations to humans. Brucellosis has more recently emerged as a further concern (Maratea et al. 2003). Protection of people is inadequate, as many of these infections are asymptomatic in marine mammals, yet can cause severe and occasionally fatal disease in humans. Our understanding of the carrier status of individuals is only as good as our capacity and effort expended to investigate the status of specific pathogens in a particular individual. Thus one must assume that there will be zoonotic pathogens present that remain undetected in healthy marine mammals.

Expense: Costs associated with rehabilitation of individual animals far exceed those associated with sampling dead or euthanized stranded marine mammals. In one example, a cetacean rehabilitation facility in the southeastern US treated 25 non-endangered dolphins or small whales over a recent five-year period. Of these, nine dolphins were released, 13 animals died or were euthanized, and three dolphins were considered non-releasable and placed into public display. The average cost of hospital operations leading to the release of each dolphin was more than $157,000 (not including extensive volunteer service or facility construction costs). Dividing the hospital operating costs for the five years by the number of days of treatment of the nine released dolphins yields a cost of more than $1,225 per animal-day, over an average of 130 days of care for each individual. A recent review of US west coast odontocete rehabilitation has shown 'that the success of rehabilitating and releasing stranded odontocetes in California is minimal, and the stress of stranding and rehabilitation in addition to pre-existing disease can result in morbidity and mortality (Zagzebski *et al.* 2006). In another example, a pinniped rehabilitation facility on the US west coast over a recent 5 year period treated an average of 632 individuals each year, at an average cost of $2,500 each. These latter

pinniped costs per animal are lower compared to the cetacean example due to a very large case load, small space and water allowance to yearling animals, and a short survival time of some due to the facility's euthanasia policy. An extreme expense was the rehabilitation of a young gray whale "JJ" by Sea World Inc (Andrews *et al.* 2001). There is a question as to whether funds for rehabilitation of live animals would be better spent for other purposes (funding research, education or conservation). The answer is complex, and likely to depend on local attitudes and values towards animals, science and conservation. It is likely that in some cases funds for rehabilitation would not be available for other pursuits, but in other cases the funds for rehabilitation are drawn from budgets that would otherwise support research.

It is important to recognize that the general public tends to support welfare agendas more readily than less tangible scientific or even conservation agendas, whereas the latter tend to be supported by private and governmental agencies. It should also be recognized that the opinion and agenda of funding agencies and the general public can evolve with careful education about the costs and benefits of different management strategies. Recently, the Monterey Bay Aquarium adopted a policy to euthanize stranded sea otter (*Enhydra lutris*) pups that could not be placed into a surrogate hand-rearing program. Based on the experience of twenty years rehabilitating sea otter pups, this organization determined that the rehabilitation of pre-weaned pups without a surrogate female was unlikely to be successful, and decided to use limited funds on other aspects of sea otter conservation rather than rehabilitation. This decision has been very controversial and illustrates the conflict between an agenda that encompasses the sum of economic, practical, and survival expectancies vs. one that is driven more by the overarching value of the welfare of an individual animal without looking at the broader contexts. It also highlights the public outreach dilemma for an organization encouraging coastal conservation while "killing" a charismatic keystone species from the same ecosystem.

Conflict with other conservation goals: On both coasts pinniped (sea lion on the west coast and harbor seal on the east) populations are growing at roughly 10% annually. They are routinely rehabilitated under agreements from NOAA Fisheries, an agency also charged with conserving endangered salmon stocks that are preyed upon by sea lions and seals.

Uncertainties involved with marine mammal rehabilitation

1. Lack of information about how best to release an animal.
2. Ignorance about the reproductive potential of released animals.
3. Risk of abnormal behavior in the wild resulting from human interactions during captivity.
4. Capacity to forage successfully once released.
5. Ignorance about long term survival.

Release uncertainties: Common operational dilemmas exist, such as: "Is it better to transport an animal for release a long distance (into a "more suitable range") or to release an animal near its stranding site?" This decision (and even the general guideline

to release an animal into "home range") is challenging in those cases where such background information is not available for the release candidate. This puts rehabilitators (and federal managers that authorize the release) in the position of taking an action that cannot be demonstrated to be in the animal's best interest, and the managers in the position of creating release guidelines that can not be demonstrated to be in the animal's best interest (NOAA 1997).

Reproductive success: The ability of released rehabilitated marine mammals to reproduce successfully is largely unknown.

Human interactions: The interaction of animals being rehabilitated with humans during rehabilitation can lead to interactions in the wild that result in released animals becoming 'nuisance' animals, in some cases begging from humans. This has occurred with California sea lions, sea otters and bottlenose dolphins. It is hard to predict such cases prior to release.

Inability to forage: The ability of rehabilitated animals to forage independently cannot be accurately predicted prior to release. Because of vast differences between captive and wild environments, it is difficult to simulate and assess foraging capability during treatment. Although animals can (and often are required) to be exposed to live prey items, the relevance of such tests has not been rigorously evaluated. If an animal cannot forage in the wild, a slow death due to malnutrition and its complications can be viewed as subjecting a released animal to pain and suffering, thus questioning the animal welfare tenet of undertaking rehabilitation.

Inadequate assessment of long term survival: There is a paucity of unbiased information, exacerbated by an understandable willingness to publish successes and move on from the failures and a difficulty in publishing null results in the peer reviewed literature. Data are theoretically available, but relatively rarely published from satellite tag tracks, visible tag returns, photo-identification, and re-stranding events. The last feature should be available from "Level A" data submitted to NMFS regional stranding coordinators, but has not thus far been systematically summarized in an available format, and fails to account for mortalities that occur at sea. Disseminating data should be considered a part of "good animal care". Furthermore, rehabilitation of oiled birds and marine mammals after oil spills has also had limited success (Brody *et al.* 1996; Estes 1998; Jessup 1998).

Conclusion

A decision on whether or not rehabilitation of marine mammals is justified in the United States currently depends on personal/ institutional philosophy. A conservationist might argue that the potential negative impacts (discussed above) of released rehabilitated animals on the recipient population might sway the balance to favor judicious use of euthanasia, beach release of "appropriate" (not a risk to the wild, and likely to survive) mass stranded animals, and sustenance of captive colonies with selected rehabilitated candidates as appropriate. Captive colonies and data acquired in stranding response may educate government agencies and the voting public about the need for habitat conservation. They also may encourage commercial and recreational marine practices that minimize human impacts that induce morbidity and mortality of marine mammals.

An animal welfare advocate might argue that the intrinsic worth of well being to an individual marine mammal in itself justifies whatever efforts can be afforded to apply, irrespective of species status, final result, or cause of stranding. However fiscal reality would perhaps suggest that such investment should be made by the interested private sector, rather than by taxpayers through governmental support. Taking this one step further, it would be reasonable to ask, for example, whether the $157,000 spent to rehabilitate a single dolphin that stranded as a result of natural selection might have been better applied to improving the welfare of thousands of con-specifics through increased public education, law enforcement, or research activities.

A scientist might see management of live and dead beached marine mammals as an opportunity for the curious to further our knowledge, and apply such understanding to matters of conservation.

The above arguments are not necessarily mutually exclusive, but they do result in different priorities being established in the mind of each individual involved in the practice of marine mammal rescue and rehabilitation. The challenge is to find the common ground and the greater good. Finding this common ground will also require educating members of the public, who expect every live-stranded animal to be properly cared for, about the relative costs and benefits of each option described above. In particular the value of euthanasia at the right time should be understood.

With increasing research and a maturing of stranding programs comes a need to better manage data generated by these programs. An important current evolution in expectation from funders is the ethical position that the sharing of data constitutes good animal use. Open access to data, as outlined in an abstract by Ian Boyd to be found on-line (Littnan and Ragen 2003) should be a prerequisite of future federal funding of marine mammal stranding response and be at a defined level of data sharing above the current basic data requirement in the US. There are models for such data consortia, and the appropriate management of intellectual property, such as the multi-institutional databases maintained by the Right Whale Consortium (www.rightwhaleweb.org) that are overseen by members of the peer group within which the data are being generated and shared. In this way issues of authorship and duplication of effort are managed proactively.

Rehabilitation effort can be based on a scale of degree of animal suffering, likelihood of success, conservation value, likely destination for the animal (for example, will space be available to assimilate a non-releasable dependent dolphin calf into a

collection if it is decided to rehabilitate it), and scientific/educational value. This should follow a system that is used by Institutional Animal Care and Use Committees, among others, to determine ethical treatment of experimental animals. Stranding Networks should adopt similar guidelines for evaluating those four criteria, following experimental community techniques. In particular the three tenets of reduce, refine and replace (the three "R"s) can be interpreted in the marine mammal context by reducing the number of animals managed but, with refined (improved) protocols that maximize welfare, research and conservation goals. Replace in this context would mean examination of dead or rehabilitating animals in the place of work with live, healthy captive animals where possible. Rehabilitation centers should also establish Animal Care and Use Committees where currently absent.

Were rehabilitation only extended to threatened and endangered species, only sea otters, monk seals, sirenians, Steller's sea lions, Guadelupe fur seals and (in theory) various large whale species, would be rehabilitated in the United States. The above concerns would not be reduced (and in fact would be magnified) in a small population. Restoration programs, trying to rebuild stocks of animals using captive stocks (probably a best case scenario) have had mixed success (Griffith *et al.* 1989). Among the most popular attempts have been those involving California condors, Arabian oryxes, red wolves, peregrine falcons, golden lion tamarins and black footed ferrets.

Stranding response has been organized and regulated by law in the U.S for over a quarter of a century and many of the organizations that participate have been active in the field for a decade or more. These organizations and the networks that have grown up (formal and informal) represent an institutionalization of those efforts. As the above discussion demonstrates, however, they have done this without a central set of goals, values or ethics. As such they work within a field that must accommodate self contradictory practices, methods and purposes. Is it acceptable to rehabilitate marine mammals, but unacceptable to either retain them in captivity or release them to the wild? Or is it only acceptable to rehabilitate marine mammals IF they are released to the wild? Faced with such basic and inescapable self contradictions what direction is there for marine mammal rescue, rehabilitation and release?

There are three basic possibilities: Stop, Do Nothing or Progress. Stopping marine mammal rehabilitation and release has been the option chosen by many public display organizations once the risk of contagious disease to captive populations was clearly realized. While some organizations invested in separate treatment facilities for stranded animals, few could justify the more than doubling the efforts and simply stepped away from rehabilitation efforts. Stopping release of rehabilitated animals would also be the most conservative option for protecting wild populations and has been proposed (Measures 2004) as a policy. This option however is at odds with values for stranded marine mammals in many parts of the U.S. and require that they be left on the beach or euthanized. The former would only be viable in extremely isolated regions, where stranding response is also likely to be least active. Thus in this scenario a careful, considered policy that regards euthanasia as a desirable endpoint in certain situations is a policy that has proven to be viable in some regions, as long as care is given to educate those present on the beach, and the public at large, as to the benefit of such an approach, and the risks of other strategies.

The option to do nothing about the current state of the art best describes the present situation. A situation that is described (Lynn 1999) as a "values gridlock" where progress is impeded by an inability to resolve conflicting values.

This leaves the most acceptable option to progress. In order to do this we believe it is necessary to clearly identify those components that make up a well rounded organizational structure. Progress will require adopting, supporting and strengthening each component. In this way stranding organizations will share common values and objectives. We suggest three components: science, ethics and legal regulation. We suggest science as a core value and defining characteristic for stranding programs. Science is not value neutral and should be done within a context of appropriate ethics. Ethics would make up the second component of the organizational model. While ethics will be more varied from organization to organization and from location to location there may be some common ground. In addition to the "three Rs" mentioned above, Lynn (Lynn 2004) has outlined some useful principles that may serve as a starting point. In the field of animal experimentation ethicists use the concept of the "Burden of Justification". In the case of experiments that may cause animal suffering or produce an ecological risk, the burden to justify those activities lies with the experimenter. This would change the relationship with NMFS concerning release of rehabilitated animals where facilities are required to release animals unless legally instructed to retain them – essentially the reverse principle. "Harm Benefit Ratios" – Rehabilitation efforts should be evaluated on whether the likely benefits to science, nature or knowledge outweigh the potential harm to individuals or populations. While this concept is outlined in the language of the MMPA and it is a part of new NMFS guidelines (Whaley and Borkowski 2006), it remains a difficult task and one that should be more readily identified and supported. In other fields of animal use the concept of "End Points" is used to identify at what point an activity should cease because the cost or risk to subjects is too great to continue. Organizations should develop, identify and be responsible for establishing those points within their operations. While well intended, organizations are continually tempted to undertake actions that they may not have the capability to complete. For example, beginning the rehabilitation of a cetacean without necessary support, because it is felt that if the process is started they will "find a way". In other fields this would not be considered professional, or reasonable, and is at best, although a common practice, ethically questionable.

The final component of a program model would be sufficient legal framework to shape and guide programs without restricting them. Presently guidelines are being proposed by NMFS to improve release evaluations and set standards for rehabilitation facilities. Both are significant and needed steps. If, however these guidelines do not have the desired effect, of raising standards and reducing concerns about release risks, a second option might be to regulate the number of animals (of each species) released by a facility. This number would be based on both population dynamics of the host population and the capabilities of the organization – those with higher standards and better records of scientific contribution allowed the greater portion. In this way the regulating organization would be able to directly regulate the return of animals to the wild. This final option would likely produce a drastic change to rehabilitation procedures but, if organizations are unwilling or unable to change, there may be little alternative.

We therefore suggest that managers, in consultation with experts from the veterinary, conservation, welfare and population biology fields, develop guidelines for when to intervene with stranded marine mammals, and how to manage those in rehabilitation, so as to balance the arguments made above (for example as shown in Figure 1). Currently, these decisions are made on a case by case basis by the responder, often under the close scrutiny of the public. Strong federal guidelines based on a review of current understanding of rehabilitation costs and benefits, as discussed in this review, would remove some of the burden of inherently unpopular decisions from the responder, and transfer it to the government management agencies responsible for protection and conservation of these animals and their environment. Such management should aim to maximize animal welfare and the growth of understanding of marine mammal health and other disciplines, make the most effective use of limited funds to benefit the greatest number of marine mammals, and above all minimize the risk to the wild populations.

We recommend a decision tree be adopted by rehabilitation managers and clear criteria developed for making each animal management decision, based on animal welfare, logistics, conservation value, research possibilities and funding (Figure 1).

Acknowledgments

We thank NOAA personnel for their assistance in providing regional stranding data for this paper, and two anonymous reviewers and Nick Gales for constructive comments on the manuscript.

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Table 1[4]

Mean total per year of live and dead strandings and admitted and released rehabilitation cases

	NE	SE	SW	NW	HI	Total US
PINNIPEDS						
Live Stranding	338	5	1294	111	3	1751
Dead Stranding	278	4	921	110	1	1314
Admitted for rehab	172	2	1164	75	0	1413
Released after rehab	63	2	630	46	0	741
CETACEANS						0
Live Stranding	56	94	20	3	7	180
Dead Stranding	261	625	122	33	7	1048
Admitted for rehab	5	7	7	2	2	23
Released after rehab	1	3	0	0	0	4

Years 1995 to 2004 except NW 1995 to 2002. Data unavailable from Alaska.

[4] NOAA Data sources by personal communication March and April 2006: NE: Mendy Garron, 1 Blackburn Drive, Gloucester, MA 01930; SE: Blair Mase 75 Virginia Beach Dr Miami , FL 33149; SW: Joe Cordaro 501 West Ocean Blvd., Suite 4200 Long Beach, CA 90802; NW: Brent Norberg 7600 Sand Point Way, NE, BIN C15700, Bldg. 1 Seattle, WA 98115; HI: David Schofield. NOAA Pacific Islands Regional Office, 1601 Kapiolani Blvd, Suite 1110, Honolulu, HI 96814

Figure 1. Schematic decision tree for the management of live stranded marine mammals. At each health assessment stage the relative conflicts of cost, chronic pain, prognosis, zoonosis, and genetic and microbiological impacts vs. risks to the conservation of recipient population vs. the advancement of science must be carefully balanced.

Figure 2. a. Rehabilitation of animals entangled in fishing gear is perhaps one of the most obvious justifiable targets for rehabilitation efforts. b. Where populations such as these California sea lions verge on the pestilential, the value in routine rehabilitation efforts can be brought in to greater question.

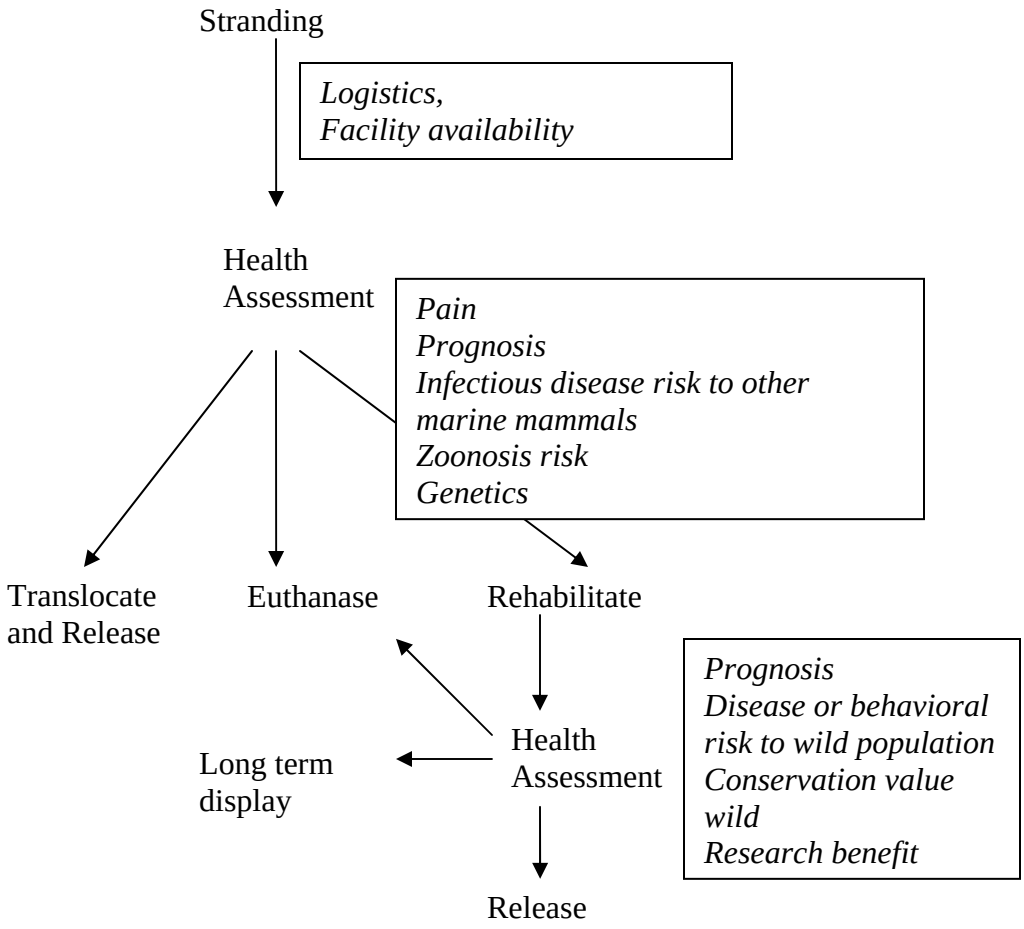
Stranding
Logistics,
Facility availability
Health
Assessment
Pain
Prognosis
Infectious disease risk to other marine mammals
Zoonosis risk
Genetics
Translocate and Release
Euthanase
Rehabilitate
Prognosis
Disease or behavioral risk to wild population
Conservation value wild
Research benefit
Health
Assessment
Long term display
Release

Figure 1

Figure 2a

Figure 2b