Rescue, Rehabilitation, and Release of Marine Mammals: An Analysis of Current Views and Practices

Proceedings of a Workshop held in Des Plaines, Illinois, 3-5 December 1991

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NOAA Technical Memorandum
NMFS-OPR-8
July 1996

U.S. Department of Commerce
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National Oceanic and Atmospheric Administration
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WORKSHOP SUMMARY AND RECOMMENDATIONS

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INTRODUCTION

Stranded marine mammals have long attracted public attention. Those that wash up dead are, for all their value to science, seldom seen by the public as more than curiosities. Animals that are sick, injured, orphaned or abandoned ignite a different response. Generally, public sentiment supports any effort to rescue, treat and return them to sea.

Institutions displaying marine mammals showed an early interest in live-stranded animals as a source of specimens -- in 1948, Marine Studios in St. Augustine, Florida, rescued a young short-finned pilot whale (*Globicephala macrorhynchus)*, the first ever in captivity (Kritzler 1952). Eventually, the public as well as government agencies looked to these institutions for their recognized expertise in marine mammal care and medicine. More recently, facilities have been established for the sole purpose of rehabilitating marine mammals and preparing them for return to the wild. Four such institutions are the Marine Mammal Center (Sausalito, CA), the Research Institute for Nature Management (Pieterburen, The Netherlands), the RSPCA, Norfolk Wildlife Hospital (Norfolk, United Kingdom) and the Institute for Wildlife Biology of Christian-Albrects University (Kiel, Germany).

In 1977, a workshop convened to examine the nature and occurrence of marine mammal strandings (Geraci and St. Aubin 1979) briefly examined the issues surrounding the fate of rehabilitated strandlings (Ridgway and Prescott 1979). At that time, placing rehabilitated animals in zoos, aquariums and research institutions was seen as a way to reduce the need to take animals from the wild. It was suggested that rehabilitated harbor seals *(Phoca vitulina)*, California sea lions *(Zalophus californianus)*, and elephant seals *(Mirounga angustirostris)* could within a few years meet the entire demand for public display of these species. Although space to accommodate rehabilitated animals was not an issue then, participants at the 1977 workshop recognized the eventual need for a sound release program.

Ten years later a second workshop reviewed the history and achievements of the national stranding plan in the US (Reynolds and Odell 1991). Regional networks had become better organized, more extensive, and capable of more effective rescue operations. The result was improved success in rehabilitating manatees *(Trichechus manatus)*, sea otters *(Enhydra lutris)*, and, particularly, pinnipeds. In 1987, many rehabilitated harbor seals and California sea lions were still being placed in domestic and foreign facilities (Hohn and Wilkinson, *this report*). At the same time, the number of animals released exceeded that being retained, as a consequence both of improved treatment programs and decreased demand for the more common species.

The trend continued, and by 1991 few opportunities remained for placing animals in permanent care; virtually all rehabilitated pinnipeds were being released (Hohn and Wilkinson, *this report*). Continued growth and efficiency of stranding networks, combined with limited space, lead to concern that crowding in some cases might lower standards of care and medicine. Other issues had also emerged. Some marine mammal populations had grown significantly under legal protection (Mansfield and Beck 1977, Le Boeuf and Bonnell 1980, Bonnell *et al.* 1983, Le Boeuf *et al.* 1983, Reilly 1984, Zwanenburg *et al.* 1985, Early and McKenzie 1991, Sergeant 1991, Siniff and Ralls 1991, Woodhouse 1991), calling into question the advisability of releasing animals into conditions where resources might be limited. Devastating morbillivirus epizootics in pinnipeds (Heide-Jorgensen *et al.* 1992) and cetaceans (Domingo *et al.* 1990), although unrelated to reintroductions, magnified concern that released animals might carry with them pathogens that could threaten the health of wild populations. Government agencies and stranding networks called for a re-examination of the practices and policies governing the approach to live-stranded marine mammals.

A workshop sponsored by the Marine Mammal Commission and the National Marine Fisheries Service (NMFS) was convened in Des Plaines, IL, on December 3-5, 1991, to address these issues. The forty-nine participants (Appendix I) represented US federal and state agencies with jurisdiction over marine mammals, and stranding centers and programs from Australia, Canada, Germany, Great Britain, The Netherlands, and the United States. Non-marine mammal biologists and veterinarians were invited to broaden the perspective. To seed the discussion, six invited speakers, including one who focused on regional and sociological differences in attitudes toward animals, addressed various elements of wildlife rehabilitation and reintroduction. Their papers are contained within this report. Participants with specific experience with each of the major groups of marine mammals -- cetaceans, phocids, otariids (including walruses), sea otters and manatees -- were organized into panels to discuss questions regarding biological, ethical, medical, and practical considerations of rescue, care, euthanasia and release. Panel moderators reported back to the assembled group, allowing further discussion on particularly controversial issues. What follows here is a summary of current practices as reported by each group, and a synthesis of opinions on larger questions, including: Do we invariably act in the best interest of the animal? Is it humane to rehabilitate an animal that is unreleasable and cannot be accommodated for long-term care? Are the standards of care suitable? Can we judge the fitness of an animal well enough to know that it will not again become helpless in the wild? Are precautions adequate to protect the wild population from introduction of exotic disease?

No attempt is made to report all the opinions expressed, nor to establish how many participants favored one view or another. Our objective is to present the scope of the discussions, identify consensus when it occurred, and highlight opposing views. Recommendations presented at the end of the report include those introduced during Workshop discussions as well as some drawn from subsequent analysis of panel reports and written responses to questionnaires provided to each of the participants.

SUMMARY OF CURRENT PRACTICES

Pinnipeds

The vast majority of strandlings in the United States are pinnipeds, particularly in the northeast and southwest regions (Hohn and Wilkinson, *this report*). Each year, several hundred animals are rescued and a high percentage of these are eventually released. The most common are California sea lions, northern elephant seals and harbor seals. These are species that have large, stable or expanding populations that do not benefit from rehabilitation programs but for which the majority of effort and funding is expended. Hawaiian (*Monachus schauinslandi*) and Mediterranean (*M. monachus*) monk seals, on the other hand, are endangered, and rescue and release operations are important elements in government-sponsored species recovery plans (Gilmartin 1983, Reijnders 1984, Gilmartin 1990).

Workshop participants reflected both personal opinion and regional policy on whether intervening to help a stranded animal is necessary or even appropriate. Regional policy is influenced by the density of human population, public opinion, character of the shoreline, logistics, and cause of the stranding. In sparsely populated or remote areas, such as the Pacific Northwest and Alaska, most stranded pinnipeds are likely to die undiscovered or be intentionally left to their own fate. The same policy of noninterference does not operate in densely populated areas, where there is increased public demand for action as well as a greater imperative to reduce public health risks and protect strandlings from possible harassment. Pinnipeds that are victims of oil spills or entangled in marine debris receive special consideration, regardless of where they strand.

Pinniped strandings generally occur in predictable waves, with most coming ashore as pups during the critical time when they are first on their own (Geraci and Lounsbury 1993). During peak periods, facilities become crowded, quarantine measures are harder to maintain, and staff are overextended; these situations make it difficult to provide good quality care and medicine. The strain on the system may force a shift in practice toward euthanizing more animals, but there seemed, among some of the participants, a greater tendency to relax guidelines for release. Because no uniform criteria for release have been established, either option is currently possible. Strandlings of less common species tend to be given special consideration regardless of the strain on the facility. Participants stressed that improved educational programs to discourage the public from mistakenly picking up healthy pups could significantly reduce demands on some facilities during peak periods.

Compared with other marine mammals, the cost and logistics of rehabilitating an individual pinniped are quite reasonable. They do well with modest accommodations, are rather resilient, and may come ashore needing only nourishment. Quarantine measures are usually taken to prevent exposure to disease during the rehabilitation period, and the majority of animals are released within a few months. Blood and fecal analyses are widely used to assess the health of strandlings. Criteria for determining whether an animal is suitable for release generally include a normal blood profile, sound nutritional state, and independence from medical and pharmaceutical support.

Of all the marine mammals, pinnipeds have generated the most concern and controversy over transmission of diseases once they are released. Discussion focused on serological testing for antibodies to morbillivirus, and whether animals with positive titers were considered releasable. [Five months later, NMFS instituted a policy requiring that seals with positive titers be retained. This was the first time that the agency made such a decision based on medical criteria.] California sea lions are also routinely screened for *Leptospira*, but the releasability of infected animals remained an unresolved issue, prompting a recommendation for more studies on endemic diseases. Everyone agreed that screening for potential pathogens should be expanded to better protect wild populations from introduced disease.

Pre-release behavioral conditioning for pinnipeds is minimal, generally limited to reducing dependence on humans, while encouraging normal foraging activities and allowing social interactions. Otariids are naturally more gregarious, and thus a greater emphasis is placed on socialization to facilitate their return into wild populations. Except for timing with the natural cycle of the species, the release itself usually involves little more than opening a cage on a nearby shore. This is fortunate because the numbers of animals involved in rehabilitation programs would make more complicated efforts practically impossible. Evidence suggests that animals held for a year or more do not adjust well in the wild (Harvey 1991) and may need more extensive preconditioning. Animals in which human-dependence cannot be extinguished -- those that continue to seek and interact with humans after release -- are usually candidates for permanent care.

Unreleasable pinnipeds are a growing problem because public display institutions are unwilling or unable to accept any more animals, particularly harbor seals and California sea lions. A number of participants were concerned that overburdened facilities may tend to release animals in marginal health. Others reported that some pinnipeds have been held in temporary quarters not governed by Animal and Plant Health Inspection Service (APHIS, US Department of Agriculture) standards for years while waiting for suitable placement. The option of euthanising unreleasable animals becomes more difficult with time in captivity and is generally considered inappropriate on the basis of unreleasability alone. Participants from Alaska warned that a problem might develop in accommodating orphaned walrus calves since the current policy is to retain them all in permanent care. It was recommended that the US Fish and Wildlife Service develop a protocol to deal with the inevitable surplus.

Seals from northern Canada are stranding farther from their home ranges with increasing frequency, particularly along the US Atlantic coast (Early and McKenzie 1991, Odell 1991). Frustration was expressed over the difficulties in returning them to their native habitat because of the cost, the red tape in dealing with several agencies in more than one government, and the possibility of transferring disease across a national border. Participants working with these animals urged that governments help clear a path for expeditious return, or assist with permanent placement of extralimital strandlings. Meanwhile, operators of rehabilitation programs must be prepared for long-term care of these animals.

Although many pinnipeds are rehabilitated and released each year, few are monitored after release. In the US, NMFS requires that all released animals be marked or tagged so that they can be identified if they restrand. Because of the cost, there is no requirement for tagging with either VHF or satellite-linked radio tags. Hence, only opportunistic observations of tagged animals are possible, and no conclusions on survival rates can be drawn. The scientific literature contains only sparse data from sightings and restrandings (Seagars 1988, Harvey 1991, Reijnders, *this report*). Participants recognized the need for long-term monitoring, perhaps on selected indicator species, and urged that funds be made available for this purpose.

<u>Manatees</u>

In the US, the endangered West Indian manatee draws the full attention of a network of marine mammal facilities and federal and state agencies operating under the same permit authority (US Fish and Wildlife Service 1989). The manatee recovery team in Florida has, over the years, worked intensively to develop a conservation program, which includes rescue and rehabilitation. Most participants in the manatee panel, as members of the recovery team, had met several weeks earlier to discuss the same issues considered at the Workshop, and their views reflected a previously established consensus.

There is no debate about whether or not to rescue a sick or injured manatee. The fact that the preponderance of injuries are human-related is further justification to intervene. Yet it is clear that rehabilitation efforts alone will not reverse the impact of damaging encounters with boats or the destruction of habitat. Members of the panel agreed that rehabilitation efforts must operate hand-in-hand with public education, tougher enforcement of pleasure craft speed limits, and habitat conservation.

Virtually every live manatee brought to a rehabilitation facility is treated until it recovers or dies. No effort is spared to restore the animal to health, irrespective of space or financial limitations. Consequently, few are euthanized. The panel expressed its concern that existing facilities may not be able to cope with a rescue operation to save several dozen manatees, for example, in the event of a power plant shut-down in winter. [An emergency contingency plan is currently in preparation by the US Fish and Wildlife Service. [2]]

New arrivals are quarantined for up to 30 days. Manatees with traumatic injuries are less stringently segregated than those with clinical evidence of disease. After quarantine, orphans or abandoned calves are sometimes placed with long-term captive females to assist them through rehabilitation. There are no specific regulations that govern quarantine; facilities have defined their own criteria, and in most cases, standards are considered satisfactory. The panel nevertheless recommended that uniform guidelines be established.

A full range of diagnostic tools, including hematology, blood chemistry, immunology, cytology and bacteriology, is employed during the initial medical examination and was considered acceptable by the panel. At the time of the Workshop, there was no known pathogen associated with widespread disease in this species. Nevertheless, the panel urged continued precautions against releasing manatees that might introduce such pathogens. [Recently, antibodies to morbillivirus have been detected in Florida manatees [3], though there is no evidence that the virus causes clinical infection.]

An effort is made to limit the amount of time that a manatee is held in captivity. Those judged by medical and behavioral criteria to have a reasonable chance of surviving are released as soon as possible. The young are generally kept until they reach sexual maturity at about five years of age. Pre-release conditioning for manatees is not complicated. As herbivores, they require no predatory skills. The main concern is that their already trusting behavior may be heightened during rehabilitation, placing them at greater risk of injury after release.

Manatees judged to be in good health are usually released in spring or early summer so they can have the longest period possible to acclimate before the onset of stressful winter conditions. The panel agreed that manatees should be released at a place and time that would allow them to resume synchronous movements with conspecifics. Mixing Gulf of Mexico and Atlantic "stocks" is avoided. All animals are freeze-branded prior to release, and depending on funding, some are equipped with VHF or satellite transmitters. From release studies, it appears that most manatees survive the critical first winter back in the wild [4].

The public must be reminded that protective measures are more effective than rescue and rehabilitation. The manatee rehabilitation program costs roughly $600,000 per year, or approximately $40,000 for each animal treated.

Sea Otters

The status of sea otter populations ranges from threatened in California, to small but growing in Washington and British Columbia, to large and expanding in Alaska. Consequently, the level of effort directed toward rehabilitation varies according to the perceived needs of the population. The threatened status of the California population has demanded the development of effective rescue and rehabilitation programs. There, sea otters observed on land for more than 24 hours are captured and taken to rehabilitation facilities. This typically involves some 4 or 5 pups and perhaps 10 adults each year. In Alaska, sick or injured sea otters usually die, in part because the remote coastline and sparse population make detection and response much more difficult. In the average year, only 1 or 2 animals may reach care facilities.

Existing facilities can comfortably accommodate the number of animals collected in a typical year. The exception, of course, was the massive response following the grounding of the ***Exxon Valdez,*** which required the construction of three new care centers (Williams and Davis 1990). Still, lack of space required that some animals be euthanized, a practice normally reserved for cases of serious injury. Panel members stressed the need for contingency plans and training programs in California to ensure treatment capability in the event of similar disasters there. They cautioned that implementation of such plans must carefully weigh the benefits of "rescuing" unoiled or lightly oiled otters against the risks associated with capture, transport, handling and confinement.

Rehabilitating sea otters is costly and challenging; the animals have a specialized diet, high metabolic rate, and a tendency toward stress and thermal imbalance. Their social needs must also be met, and this may be a reason to limit the time spent in isolation. Pups are especially demanding and may need several months of constant attention, including formula-feeding and careful management of their pelage. In California, each sea otter pup took on average eight months to rehabilitate, at a cost of about $20,000. Because of construction expenses and location, the cost of treating oiled sea otters following the ***Exxon Valdez*** incident was more than $80,000 per animal (Estes 1991).

Most rehabilitated adults are released, some within days of rescue. Many pups, however, never meet the established release criteria either because they remain weak or become too dependent on humans. The panel considered any sea otter kept longer than two years to be unreleasable. Presently, there are enough facilities to accommodate such animals. However, the panel felt that the situation may soon change because the number of sea otters in captivity is increasing and captive breeding programs are being developed. Rehabilitation centers were urged to emphasize programs aimed at conditioning pups for successful release. Panel members agreed that obligatory release of all animals was unacceptable, and that there would always be the need to evaluate animals on a case-by-case basis.

Prior to release, otters are given a routine health examination, including blood analysis and screening for herpes virus infection. The animals must also demonstrate normal behavioral profiles, particularly with respect to foraging and grooming, before being returned to the wild. Release usually takes place in an area occupied by animals of the same sex and similar age (Garshelis and Garshelis 1984, Jameson 1989). In California, animals captured in extralimital areas are released within the population's natural range.

All sea otters are tagged on the flipper before release. Intra-peritoneal radio transmitters that allow long-term monitoring (up to 2 years) have also proved successful and have been recommended for use whenever possible (Siniff and Ralls 1988). Survival of released otters is unpredictable, and their strong homing behavior may result in animals returning to the release site. Experimental translocation of apparently healthy individuals has met with mixed success (Jameson *et al.* 1982, Rathbun *et al.* 1990); animals graduating from a rigorous rehabilitation program cannot be expected to fare any better. Survival of otters released after the ***Exxon Valdez*** spill was poor, perhaps because of re-exposure to oil rather than to any particular deficiency in the rehabilitation effort (Estes 1991). The panel agreed that more detailed monitoring studies using implanted radio transmitters are needed to determine the effectiveness of rehabilitation programs.

Cetaceans

Cetacean strandings, even in remote areas, evoke great public reaction (Scheffer 1989). The level of interest seems to be directed to these animals as a group, irrespective of whether their population is endangered, threatened or abundant. The primary determinants of whether a strandling is immediately returned to sea, euthanized, or taken for rehabilitation are the animal's size and health, the stranding location, logistic capabilities for moving and transport, and the availability of a suitable care facility.

Strandlings in remote areas are rarely found alive, and if they are they are difficult to rescue. Large cetaceans, such as sperm or baleen whales, are generally beyond help unless they simply need to be herded or towed into deeper water. Singly stranded animals tend to be sick or debilitated and often die before or shortly after discovery (Geraci and St. Aubin 1979). Even healthy animals may succumb to the stress of stranding in a matter of hours. Of the cetaceans that come ashore alive, relatively few reach rehabilitation centers.

The fate of a stranded cetacean is usually determined after consultation among veterinarians, representatives from rehabilitation facilities, and the regional stranding network coordinator. Small animals (i.e., independent juveniles or young adults) are easily transported and handled and are generally better choices for rehabilitation. Success rates for dependent calves are steadily improving. Mass strandings are a problem, as few facilities have the resources or budget required to deal with more than a single animal or two. Hence, most of the action must be taken on the beach -- either for immediate release or euthanasia. The confusion and urgency that so often accompany these events can complicate matters, and public pressure may sway the decision to retain or release an animal that should, perhaps, be euthanized. Panel members suggested that more explicit criteria for assessing health, including species-related information (e.g., cannot withstand long transport, easily stressed) would aid in this decision-making process. The panel also endorsed the mandatory involvement of a veterinarian in medical decisions, particularly those entailing euthanasia. It also recommended that all commitments for long-term care be confirmed before any animal is taken for rehabilitation. In the case of endangered baleen whales, where survival of an individual may benefit the population, every effort should be made to return the strandlings to sea.

Euthanasia of stranded cetaceans is considered appropriate when animals are judged to be suffering and there is no hope for survival. Methods of euthanizing small cetaceans (reviewed by Geraci and Lounsbury 1993) were considered effective, safe and humane when practiced by a qualified person, but participants expressed the need for better techniques for dealing with large whales. They further noted that the improving success in raising orphaned dependent young argues against a policy to euthanize otherwise healthy calves.

Historically, the prognosis for rehabilitating a stranded cetacean has been poor. Until recently, few ever achieved the level of fitness necessary for surviving in the wild, and so they were retained for long-term care. Recent advances in husbandry and medicine have improved an animal's prospects for survival after release, but the rehabilitation process is longer, more labor-intensive, and costlier than for other marine mammals. This limits the number of centers able to take cetaceans. Those that do may be pressured to take additional animals even when resources are inadequate.

Criteria for release include good health and nutritional status, normal behavior, and normal blood profiles, but as yet do not include requirements for serological tests. The risk of introduced disease was a concern in light of a recent morbillivirus epizootic in striped dolphins (*Stenella coeruleoalba*) (Domingo *et al.* 1990). [Subsequent studies have established the widespread occurrence of morbillivirus in a number of cetacean species in the North Atlantic (-Duignan *et al.*, 1995 a, b)]. The panel stressed the need for more information on disease in wild populations. It recommended immunological screening, particularly for morbillivirus, herpes, hepatitis, and parvovirus, and consideration of the results of these tests among the criteria for judging releasability.

Present knowledge was considered insufficient to establish release criteria based on such factors as age at time of stranding, duration of captivity, age at release, and social organization of the species. Mandatory release of cetaceans was considered unreasonable and unacceptable. Some individuals simply do not meet criteria that will assure their own survival; others may place the population at risk.

Preconditioning a rehabilitated cetacean for release demands time and resources. The animal may require several weeks of acclimation in a sea pen, a program to diminish reliance on humans, adaptation to live prey, and ongoing medical and behavioral evaluation. This process can be expected to be significantly more complex for animals in long-term care or captivity.

Animals should be released within their home range, although for some species this can be difficult to determine. This may require transporting pelagic animals some distance from shore to locate herds of the same species, making the release more challenging. In addition, it increases the cost. Participants estimated that the effort involved in rehabilitating dolphins that can be released inshore may cost $40-50,000 per animal; up to $100,000 may be required for a cetacean needing lengthy rehabilitation and more elaborate support for release. As an added note, in 1992, the US Navy held a workshop to discuss reintroduction as an option for cetaceans in their care (Brill and Friedl 1993). A panel of biologists, trainers and conservationists concluded that 7-11 years of preparation may be necessary to condition long-term captives and captive-born animals for release and to develop appropriate monitoring equipment and follow-up programs. The calculated costs involved in such reintroduction efforts were judged to greatly exceed the expense of providing for the animals in their current environment.

Compared with other marine mammals, few rehabilitated cetaceans have been released, and even fewer have been tracked or monitored (Bruni *et al.* 1990, Kastelein *et al.* 1990). In 1987, three stranded long-finned pilot whales (*Globicephala melas*) that had been rehabilitated at the New England Aquarium were released in the vicinity of a wild pod offshore. One of the whales was equipped with an Argos satellite-linked transmitter and successfully tracked for 95 days. Data derived from satellite readings on dive time, movements, location and swimming speed indicated that the whale's activities were normal for this species (Mate 1989). Subsequent attempts to track released cetaceans have been less successful. An Atlantic white-sided dolphin (*Lagenorhynchus acutus)* (Mate *et al.* 1994), two long-finned pilot whales [5], and a young female Bryde's whale (*Balaenoptera edeni)* (Walsh *et al.* 1991) were tracked for 4, 8, and 10 days, respectively, before the signals were lost. One short-finned pilot whale, released in 1991, was sighted 3 years later within a large pod of short-finned pilot whales [6]. Clearly, more information on post-release behavior and survival is needed to develop meaningful release criteria.

Although the Workshop's principal focus was the reintroduction of rehabilitated stranded cetaceans, the panel also reviewed the mixed results of the few instances in which long-term captive and captive-bred cetaceans have been released. Preparations then in progress to release long-term captive dolphins from an Australian facility[7] were ultimately disappointing, despite careful planning and thorough preconditioning (Waples and Gales 1993). Of the 9 animals released, five were thought to have acclimated successfully, one calf was presumed to have died, and three were recaptured for permanent holding after unsuccessful foraging resulted in significant weight loss. Apparently healthy animals, captured for study and later released, have met with better success. A gray whale calf taken from Scammon's Lagoon in 1971 and raised at Sea World in San Diego for one year was radio-tracked for 2 months after release into a small group of migrating whales, suggesting that the animal had readapted successfully (Evans 1974). Two young male bottlenose dolphins (*Tursiops truncatus*) captured in Florida, held for two years and released back into their home range in October 1990, readapted quickly (Wells 1989, Bassos *et al.* 1991) and were still being monitored at the time of this Workshop, over one year later.

The current policy is to visually mark or tag all released cetaceans, though participants recommended the additional use of radio transmitters (VHF for coastal species and satellite-linked for pelagic forms) whenever possible. The need for more extensive monitoring programs was emphasized, in view of the limited information available and the controversy surrounding cetacean release programs (Advisory Committee on Marine Mammals 1992). Federal sponsorship would be needed to underwrite the costs of monitoring, which should be continued for a minimum of one to two months after release. Yet such sponsorship is unlikely unless the release involved an endangered species or was part of a comprehensive program designed to test rehabilitation success.

ETHICS, RESPONSIBILITIES, AND ISSUES

Against the backdrop of current practices, participants explored the ethical, legal and practical context in which rescue, rehabilitation, and release programs operate. Regional and international differences in approach and philosophy were apparent in debates, making it clear that many issues are not likely to be resolved to the satisfaction of everyone with an interest in rehabilitation programs.

Much of the following discussion applies broadly to all marine mammal groups, with some distinctions made for endangered and abundant species. Principal topics considered include the motives underlying intervention, the obligations involved in caring for the animals after they are rescued, and the responsibilities associated with returning the animals to the wild.

Why Intervene?

Programs to rescue and rehabilitate sick and injured animals are founded on two general principles -- altruistic assistance to the sick or injured, and conservation of wild populations. In the process we gain scientific and medical knowledge, though this benefit is rarely proposed as a principal objective. Conservation is a realistic motive for reintroduction programs benefiting threatened terrestrial species such as the golden lion tamarin (*Leontopithecus rosalia*) (Montali and Bush, *this report*), and this may apply to some marine mammals as well. Endangered monk seals in Hawaii and the Mediterranean (Gilmartin 1983, Gilmartin 1990, R-eijnders *et al.*, *this report*), manatees in Florida (US Fish and Wildlife Service 1989), and sea otters in California may be benefiting from reintroduction of even a few to the wild. At the present rate of their decline, northern fur seals (*Callorhinus ursinus*) and Steller sea lions (*Eumetopias jubatus*) may soon require similar assistance (York 1987, Cranmore 1990, Loughlin *et al.* 1992, Marine Mammal Commission 1993). [Since the Workshop, the northern fur seal population appears to have stabilized.]

For robust populations, conservation is not a defensible argument for rehabilitating animals; participants were in agreement on this point. In the years since marine mammals in the United States and Canada have been placed under legal protection, several populations of pinnipeds -- California sea lions, gray seals (*Halichoerus grypus*), harp seals (*Phoca groenlandica*) -- have grown substantially (Le Boeuf and Bonnell 1980, Le Boeuf *et al.* 1983, Zwanenburg *et al.* 1985, Sergeant 1991). Reintroducing a few or even a few hundred of these animals will be of little benefit to most stocks, and of less benefit to the overall population.

Yet, because they are so numerous and accessible, these animals contribute to the developing reservoir of information on care and medicine that can be applied to species needing help. Through strandings we have learned about diseases and other causes of natural mortality (Gilmartin *et al.* 1976, Domingo *et al.* 1990, Kennedy 1990), and have gained insights into physiology, metabolism (Walsh *et al.* 1991) and aspects of life history and behavior that help determine when and where a strandling can be rehabilitated and reintroduced with a reasonable chance of survival (Geraci and Lounsbury 1993). A stranding may be the first lead to an unusual mortality event (Geraci *et al.* 1989, O'Shea *et al.* 1991), alerting those monitoring marine mammals and their environment. Stranding rates can provide a rough index of abundance. As top-level predators, marine mammals accumulate contaminants and thereby provide clues to the health of their habitat (-Reijnders 1980, Addison 1989, Muir *et al.* 1990). But this kind of information, valuable as it is to science, is not likely to sustain the energy and popularity of rescue and rehabilitation programs.

The motive behind most such efforts is humane concern for an animal in distress. Loew (*this report*) has described how demographic changes in the United States and, by inference, other developed nations, are intertwined with evolving perceptions of animals and nature. The ethical operative is that humans do not ignore suffering in wildlife, and help whenever they can. At no time is the obligation to intervene felt more than when a strandling is a victim of our own activities (e.g., gun shot wounding, entanglement in fishing gear, fouling with oil). Marine mammal display and rehabilitation centers have been instrumental in bringing this plea for empathy to the public.

Antithetical to this view was one, perhaps more widely held than expressed in the Workshop's public forum, that rescue programs in some cases interfere with natural selection and population regulation. Intervention should therefore be limited to euthanizing ailing animals, with rescue efforts directed only toward enhancing the survival and recovery of threatened or endangered species. Such practice is endorsed by some biologists and employed as policy in at least one European country. The general public in most regions of North America would likely oppose widespread implementation of such a policy.

RESPONSIBLE INTERVENTION

Those assisting a strandling assume responsibilities to the animal, its parent population, the public, and the government agencies sanctioning the actions of the rescue operation. The animal may require expensive medical care and housing, and careful monitoring to assure survival after its return to the wild. The population as a whole must be protected from any introduced disease, disruption of the social order, or perhaps burdensome additions to a habitat already at or beyond carrying capacity. Rehabilitation centers must balance biologically and medically sound programs with sometimes conflicting directives from regulatory agencies responsible for the welfare of the population at large and from public supporters that may encourage the return of all rescued animals.

Standards of Care

The United States Department of Agriculture has established minimum standards of marine mammal care (APHIS 1993) which govern the physical environment and husbandry practices of any display and research facility. APHIS regulations do not apply to stranding quarters at these institutions or at all to those dedicated entirely to strandings. The rationale has been that a sub-standard facility is better than no facility at all. Workshop participants expressed the view that this approach was unacceptable. There was a call for enforceable minimum standards (*see Critical Needs and Recommendations*), with recognition that these requirements might be less than those for public display and research facilities, and that some operations, unable to bear increased costs of meeting even these standards, might be forced to close.

Medical Treatment

Rehabilitation centers are essentially hospital operations with veterinary supervision. Newly admitted animals require a thorough examination, which veterinarians attending the Workshop agreed should encompass: assessing the animal's behavior (e.g., responsive, comatose, convulsing), physical condition (e.g., injuries and deformities) and vital signs (e.g., body temperature, heart and respiratory rates), and blood, parasitological, microbiological and treatment. At one end of the spectrum are those who balance the animal's condition with its prospects for release, long-term care and available space. At the other are those who accept any animal that has a reasonable chance of recovering from its ailments, and defer other considerations. There was concern that the latter approach can quickly outstrip a center's ability to provide full medical attention when dealing with a large number of animals.

Need for Quarantine

Stranded marine mammals, even those without clinical evidence of disease, can carry pathogens that may be transmitted to others in a rehabilitation facility or permanent colony. New arrivals that are ill may themselves be more susceptible to infections from resident animals. Strandlings should therefore be isolated until appropriate diagnostic tests are performed and treatment instituted. Done well, isolation involves a discrete water supply, separate area for food preparation, strict disinfection procedures, no access by the public, pets or other domestic animals, and separate protective clothing, or better still, a separate staff.

It was pointed out that meeting this objective is costly and difficult, but should be considered essential and incorporated into the design of the facility. Some facilities use recirculating water in a closed system; others have several pools in a common filtration system, or contiguous pens and no control over air movement. Under trying circumstances, some centers attempt reasonable quarantine measures; others improvise as they can. Where no quarantine exists, it is possible for a strandling to arrive at a busy facility more or less free of disease, and become infected with a serious pathogen hours before release.

Quarantine space can be quickly overtaxed by a sudden influx of animals, rendering the system ineffective when it is most needed. One alternative solution has been to isolate the entire rehabilitation colony for a time. But this step requires a schedule under which each animal is eventually released from quarantine conditions. Lack of agreement on the criteria for removal of quarantine has led, in the experience of one participant [8], to instances in which animals have been isolated for weeks or months after the point when they no longer represent a threat to the health of other individuals.

Public Health

There was little discussion on zoonotic infections associated with handling strandlings. Though problems of this kind are not common, handling stranded marine mammals nevertheless carries certain health risks (Geraci and Lounsbury 1993). Rehabilitation centers are responsible for making their staff aware that certain conditions may be transmitted to handlers. Among these are "seal-finger" (Beck and Smith 1977) caused by a mycoplasma (Madoff *et al.* 1991), a condition on the Pacific coast known by the same name but caused by a bacterium (Suer and Vedros 1988), influenza (Webster *et al.* 1981), parapox virus (Hicks and Worthy 1987), calicivirus (Smith *et al.* 1978) and Lobo's disease (Symmers 1983). The unusual occurrence of rabies in a ringed seal (*Phoca hispida*) (Odegaard and Krogsrud 1981) has raised the possibility of even more serious threats. Any number of bacteria can be a problem to susceptible individuals (Geraci and Ridgway 1991).

Euthanasia

Euthanasia is the humane alternative for animals unlikely to recover from their illness or injury. [Techniques and issues relating to euthanasia of marine mammals have since been reviewed (Geraci and Lounsbury 1993)]. The procedure is generally accepted among those involved with strandings, but the criteria for employing it, the Workshop revealed, differ among facilities and with circumstances.

Some use flexible criteria that take into account the animal's condition and prospects for release, and available resources. When filled to capacity and faced with new arrivals, they maintain a constant number by euthanizing animals in poorer health and concentrating care on those with better prospects. Others employ a firmer routine based almost entirely on the animals' medical condition. As space diminishes, this approach places pressure on the quality of animal care and either conflicts with or forces a change in criteria for holding or releasing animals. Participants distinguished between "medical" and "non-medical" euthanasia. While euthanasia for medical reasons was determined to be the decision of the attending veterinarian, killing for non-medical reasons (e.g., lack of space) alone was considered unethical.

Euthanasia is a sensitive issue for some centers that rely on public funding and volunteer staff. Participants expressed concern that resorting to this alternative except in extreme cases is often interpreted by the public as a failure of the rehabilitation program. Euthanizing an animal in irreversible condition at the outset, before care-givers invest time and emotion, will help reduce staff disenchantment and frustration.

RELEASE

Preparation

Rehabilitated animals are normally given some type of medical examination before being released. The purpose is to ensure that the animal is healthy enough to live a reasonably normal life, cope with conditions endemic in the wild, and not place the population at risk by introducing serious pathogens. Yet, participants agreed that freedom from detectable disease alone is no guarantee that the animal will thrive.

Some animals, held for lengthy periods in captivity or raised from birth without the benefit of maternal (milk-borne) antibodies, may lack immunity to pathogens ubiquitous in the wild. Prolonged therapy with antibiotics or immunosuppressive agents such as corticosteroids may also abate the immune response. The pre-release examination should help define whether the animal is immunologically competent to meet the microbial challenges in the wild, but many important aspects of immune function are not evaluated by the routine tests currently employed. A full panel of immunological assays, including lymphocyte culture and antibody production, is beyond the scope of most diagnostic laboratories.

A certain degree of pre-release conditioning may be needed to prepare the animal to sustain itself, depending on the species, the reason it came ashore, and the length of its stay. The environment during the transition period should promote a diminishing dependence on humans and greater opportunity for socializing with conspecifics. This period will enable experienced handlers to assess the animal's ability to interact normally with others. Live prey given to advance the animal's progress, though desirable, is costly, time-consuming and not a general practice. Participants were not convinced that this was necessary for all species.

The release of an animal should be planned to give it a reasonable chance of meeting others of its kind. Current guidelines require that this be done. Many of the coastal species have predictable movements or migrations that are linked to environmental conditions such as food availability and oceanic temperatures, and encompass breeding or molting cycles. Certain animals, such as sea otters, distribute according to age and sex (Garshelis and Garshelis 1984, Jameson 1989). Finding a suitable time and place to release an animal of this kind may not be difficult or costly, but it may be for others. Hooded (*Cystophora cristata*), harp and ringed seals from the Canadian Arctic have foundered ashore as far away as Florida and California (Odell 1991, Dudley 1992). Returning them to their home waters would require agreement between corresponding agencies in two governments and transportation over long distances. The practice may also provoke adversity among maritime residents who may not welcome the return of a stray. This clearly presents a dilemma, which for the moment can be resolved by simply maintaining animals that cannot be released locally. Limited space will inevitably cancel that option and will create pressure either to stop rescuing such strays, relax conditions of release or establish a contingency fund to cover the cost.

Monitoring

The effectiveness of a rehabilitation program is best gauged by assessing post-release survival, but current programs were judged unequipped, unprepared and underfunded for this task. The most cost-effective approach is to apply a mark or tag so that the bearer can be identified if it restrands. But estimates of survival based on such recoveries are misleading because most animals die at sea and not on the beach. Resighting or tracking an animal provides a better indicator of its recovery (Seagars 1988, Scott *et al.* 1990, Harvey 1991). Satellite telemetry units, while providing accurate and reliable data, cost $2,000-5,000 each, and are too expensive to be applied to every animal released. Conventional radio telemetry is less costly, perhaps a few hundred dollars per unit, but requires the expense of a dedicated vessel for tracking animals offshore (Mate 1989). Thus, in most cases, we are not in a position to evaluate and compare release programs on the basis of survivorship.

Yet such data are needed, especially to guide decisions about individuals that are at best marginal when returned to the wild. Are "target weights" reasonable and useful criteria? Can animals compensate for physical impairment such as blindness? Answers to such questions are necessary to ensure that humane decisions are made on behalf of the animal (*see Critical Needs and Recommendations*).

At what point is a released animal fully integrated? Some argue that the whole exercise has no benefit to the population unless the individual reaches sexual maturity and reproduces (Le Boeuf, *this report*). At the very least, the animal should have an annual expectation of survival appropriate for its age class in that population. Anything less has simply postponed the animal's fate by the number of days or months it was undergoing rehabilitation.

Currently, federal agencies encourage the application of some mark or tag to all released marine mammals. For some threatened species, such as manatees, sufficient funds have been allocated to support satellite tracking studies as part of the recovery plan (Sirenia Project 1991). However, for virtually all others, rehabilitation centers must finance the monitoring programs themselves, often through public donations.

Associated Risks

Biological and Social Disruption

Rehabilitation centers deal with animals that may be unfit and unable to compete. To encourage their rehabilitation and release may therefore propagate maladaptive traits. This reasoning underlies selective reintroduction of golden lion tamarins (Montali and Bush, *this report*). However, there is no evidence linking marine mammal strandings to genetic defects. Most strandlings are victims of circumstances that have more to do with chance than biological inadequacies, and returning them to their natural habitat was considered unlikely to promote undesirable genetic characteristics because the number of reintroductions is truly small compared to the size of the parent population. Paradoxically, threatened or endangered species, which stand to gain most from reintroductions, face a greater risk because each animal may make a significant contribution to the relatively small genetic pool.

At the other end of the spectrum, consider a population near or at the carrying capacity of the environment. Competition for food and habitat might be an important factor contributing to the incidence of strandings. Would the return of a strandling place still more burden on the habitat and increase the competition for limited resources? Some stocks, such as those of harbor and gray seals in the western North Atlantic, sea otters in parts of Alaska, and California sea lions may be approaching this limit. Release programs for these species bear close monitoring to ensure they are not counterproductive. For others, this is not an issue.

Marine mammals have complex and sometimes fragile social orders that might suffer from arbitrary reintroductions. Territoriality and male competition is a dominant feature of the life history of many species. To spare young male elephant seals from damaging encounters with aggressive bulls, releases are scheduled outside the breeding season [9]. We know the detrimental effect of an unbalanced sex ratio on female Hawaiian monk seals (Hiruki *et al.* 1993), and for this reason, males are simply not released (Gilmartin 1983, Gilmartin 1990). We can only speculate on what might happen if a disproportionate number of male bottlenose dolphins attempted, upon release, to force their way into a stable group. The consequent disruption may offset any benefit that the individual or the population might gain by the reintroduction.

Reintroductions may take on a political dimension if they compound already existing problems between marine mammals and people. Conflicts between commercial fisheries and marine mammals have already led to control measures such as removing or translocating offending animals (Rathbun *et al.* 1990). Workshop participants felt that released animals were no more likely than members of the wild population to become "nuisance animals" interfering with fisheries by raiding nets or long-lines. Other behaviors are not only annoying but can be risky. For example, California sea lions sometimes return to the care facility after release (Ridgway and Robison 1985) or seek attention and food from humans. Though infrequent, such occurrences are highly visible and command attention out of proportion to the extent of the problem.

Disease

Looming large in the minds of r-ehabilitators is the prospect of introducing serious disease. Miller (*this report*) has cited several examples of the harm of exposing naive populations of terrestrial animals to virulent organisms. This threat for marine mammals has been accentuated by the recent rash of mass mortalities caused by morbillivirus infection in pinnipeds and cetaceans (Domingo *et al.* 1990, Kennedy 1990, Heide-Jorgensen *et al.* 1992). Because the virus has a broad geographic and biological range, there is heated debate over what should be done with rehabilitated animals that have been infected, as evidenced by serum antibodies. Are these animals potentially infective to others and therefore a risk when released, or are they merely indicators of an endemic infection in the population, posing no additional threat? Workshop participants urged the formation of an expert panel (*see Critical Needs and Recommendations*) to recommend a framework for dealing with this and other viral conditions, among them influenza (Geraci *et al.* 1982), herpes (Osterhaus *et al.* 1985, Kennedy *et al.* 1992), and caliciviruses (Smith *et al.* 1973, Smith 1987), and others sure to emerge as we broaden our understanding of marine mammal pathogens.

Other conditions that might be threatening on a smaller scale include leptospirosis, especially in California sea lions (Dierauf *et al.* 1985), and tuberculosis in Australian sea lions (*Neophoca cinerea)* (Forshaw and Phelps 1991). Marine mammals also harbor a host of parasites (Delyamure 1955) with identifiable effects on the individual (Geraci and St. Aubin 1987). However, parasites in their natural host and carried by released animals are not considered to have the same potential for population-wide impact.

We are not likely to precipitate a serious problem when dealing with conditions that are endemic in local populations. The danger lies in returning, to a distant naive population, a stray that may have encountered foreign pathogens somewhere along the way. Scrutiny for exotic diseases will help prevent the kind of problem that arose when a spirurid intestinal nematode of the slow loris (*Nyctecebus coucang*) was introduced into golden lion tamarins (Montali and Bush, *this report*). Such an event in a marine mammal population would cancel any benefit derived from saving a few strandlings and would encourage more stringent, perhaps impossible, criteria for release. Rather than risk introducing disease, most participants concurred that they would chose to retain or euthanize suspect animals.

THE REGULATORY PROCESS

In the United States, the Marine Mammal Protection Act (MMPA) placed all activities relating to these animals under the jurisdiction of the National Marine Fisheries Service and the Fish and Wildlife Service. With this jurisdiction comes the authority to license and control rescue and rehabilitation operations. Though not as far-reaching as the MMPA, some legislation exists in many other nations, requiring that treatment centers operate in accordance with government agencies or programs. Participants representing centers and government agencies expressed their views on how current policies affect their operations.

In the 20 years since the MMPA was enacted, arrangements between rescue and rehabilitation centers and government agencies in the US have evolved to the point where most of the activities have become routine and based on mutual understanding. Though regulations seem to be clear, some participants felt that implementation was uneven, reflecting different priorities among regions. For example, some regions are more insistent than others in enforcing the requirement that all stranded animals be eventually released. For example, pressure to release a sea otter is greater in California than in Alaska. Such practice may encourage either premature release or inappropriate detention. In view of regional differences in priorities, social attitudes, and animal populations, it is unrealistic to expect that a national policy would be applied consistently throughout the country.

While fulfilling their own mission, rehabilitation centers perform a service for local, state and federal government agencies by rescuing animals in distress, removing carcasses that are a potential public health risk from the beach, and collecting baseline data which help to formulate marine mammal management plans. Rehabilitation centers not only bear the cost of care and treatment, but also must collect samples and conduct viral screening, apply tags when animals are released, maintain records, and prepare timely reports on their activities. Yet, in the US at least, no reimbursement is provided or expected, except to support programs for endangered species.

Participants agreed that government agencies must continue to support recovery efforts for endangered marine mammals; the Florida Manatee Recovery Plan (US Fish and Wildlife 1989) is one such example. Some expressed concern that there is no analogous policy nor funding for rehabilitating animals from robust populations. They argued that benefits derived by government agencies from the rescue centers' activities warrant at least some financial support.

CRITICAL NEEDS AND RECOMMENDATIONS

In the course of the discussions, workshop participants were able to make a number of procedural recommendations, many of which are noted throughout the text of this report. Some examples include advocating training programs for staff, encouraging more efficient mechanisms for moving animals across international borders, and requiring that new arrivals be quarantined. For other issues left unresolved, the participants recommended the formation of expert committees to deal with: standards for care and facilities, criteria for releasing rehabilitated animals, risks of introducing disease, and determining survivorship through monitoring released animals. The committees would develop further recommendations to address the following critical needs.

Inspection and Licensing

Standards of marine mammal care as governed by APHIS regulations do not apply to stranded animals unless they become part of a permanent exhibit or research colony. Yet most of these regulations are in keeping with what is known of an animal's basic needs in captivity, irrespective of duration. Exceptions might be the amount of pool and haul-out space needed for temporary housing, and social groupings required over the short term. A panel of medical and husbandry specialists is needed to establish which of the existing APHIS standards are appropriate for a rehabilitation facility, and to provide an explanation and a substitute recommendation for any regulation determined to be inapplicable. If adopted, at least on a voluntary basis, such guidelines will ensure a more uniform level of basic care and humane treatment, and increase the likelihood that animals will meet the criteria for release in reasonable time. It will remain for regulatory agencies to decide whether or not to implement a licensing and inspection procedure based on these standards.

Criteria for Releasability

A panel of medical and behavioral specialists is needed to recommend criteria for assuring that released animals will prosper humanely and pose no undesirable risk to the wild population. The guidelines should include a recommended set of medical determinations by species, with appropriate reference ranges for blood constituents and other clinical measures, morphometric limits (weight at length and age), a checklist for physical examination, and a means of scoring behavioral attributes that would influence survival in the wild. Minimum values should be set for each of these criteria, such that no animal failing any measure would be released. The panel would incorporate the

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Disease Transmission

Marine mammals are exposed to pathogens, certain of which may jeopardize the health of populations. A panel with expertise in marine mammal medicine is needed to review the known infectious agents of each marine mammal group, rank them according to their potential to transmit disease, and determine which pose an unacceptable risk if introduced to the marine environment. The panel s hould recommend to the Working Group on Criteria for Releasability (*see above*) procedures for identifying these agents or exposure to them. It should define the clinical condition or carrier state that determines if and when an animal exposed to these pathogens can be released. The panel also should consider and, as possible, recommend procedures for detecting and avoiding the spread of new infectious agents.

Monitoring

A panel of population biologists familiar with telemetry technology is needed to review available data on survival, assess the efficacy of the tagging, marking and tracking techniques that have been used, and recommend the best approaches to determining mortality rates in rehabilitated animals. The group might also be charged with designing a study, using representative species for which there are sufficient numbers of animals handled, to test the assumptions underlying criteria for release. For example, animals that do not meet target weights or are partially disabled but otherwise healthy, could be released and tracked along with a matched set of individuals in optimal condition. Such a study might reasonably be funded by federal agencies seeking to resolve uncertainties over the efficacy of rehabilitation and release programs.

ACKNOWLEDGMENTS

The success of the Workshop was due in large part to the enthusiastic participation of all the attendees, and the skillful guidance of the Panel Chairs - R. Hofman, A. Hohn, M. Johnson, B. Le Boeuf, and R. Turner. We also thank S. Murphy and M. Patterson for carefully recording the proceedings of their groups, and H. Copland for assisting with all aspects of the Workshop, from convening to preparation of the report. R. Hofman provided many valuable comments during the preparation of this report. Partial financial support was received from the Office of the Dean, Ontario Veterinary College, University of Guelph.

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CHANGING VIEWS OF ANIMALS: THE ETHICAL FRAMEWORK OF REHABILITATION PROGRAMS

Prepared from a Presentation Delivered by

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America today is much different than it was during its development through the last century, and this transformation has had a significant impact on its inhabitants' perspectives on animals. Ninety-eight percent of the population does not live on farms. Urban Americans now own more cats and dogs (110 million) than there are people in any of the countries of the European Community. There are more horses now in urban/suburban America (some 7 million or so) than at any time since the horse cavalry ceased to be an effective fighting force after World War I. More horse now graze in Massachusetts than do dairy cattle, the first time that's been true for a century.

The shift away from an agricultural society has redefined our behavior toward animals (Loew 1993). Urban Americans view their cats, dogs and horses more as "companions" than as pets, more as fellow creatures than as the mere chattels the law still holds them to be. And these feelings have been increasingly transferred to wild animals. A decade of "animal rights" activism has, in its less extreme forms, resonated in the psyches of most citizens in the form of concerns about whether animals in at least some kinds of research or testing are really needed, the ways in which at least some kinds of livestock are raised for food, the wearing of furs, and hunting and trapping. Concern for the welfare of individual animals now surpasses that for the species in many situations.

Within this broad framework, there exist strong regional tendencies that vary sharply across the country. Kellert (1988) has distinguished ten basic attitudes that define fundamental views of animals, and charted the prevalence of these attitudes within various geographic and demongraphic sectors of the United States. Most prevalent, and closely linked to the evolution from a rural life-style, is the "humanistic" view, which emphasizes feelings of strong affection for individual animals. Those engaged in livestock production, hunters, and fishermen see the practical or material value of animals from a"utilitarian" or "dominionistic" perspective. Differences in the public and political response to stranded marine mammals can be traced in some measure to the strength of these value sets within each region of the nation.

While some groups in the population are well informed of issues concerning wild animals, the American public as a whole has an extremely limited knowledge of animals (Kellert 1988). The problem of biological iilliteracy in society complicates the decision-making processes of politicians and government agents, who must perform an ethical calculus that incorporates factors such as time, money and politics against a broad, and sometimes conflicting, ethical framework within each geographical region. Combining national and local perspectives into a generally accepted value system may prove to be a difficult challenge.

Among wild animals, marine mammals are viewed with a particular reverence. Strong opposition to seal harvests and the whaling industry resulted in significant reduction or elimination of these activities on an international scale. Attention has now shifted to the issue of marine mammals in captivity. Initially this attention was to ensure high standards for maintaining the animals in good health, but it is evolving into the more fundamental question of the moral justification for confining them at all. Confinement for the purpose of rehabilitation is more readily accepted. There is widespread public support for the rescue of a stranded marine mammal for its own sake, regardless of the scientific or educational motives that might underlie such activities (Scheffer 1989). These are the values that will chart the course of marine mammal rescue and rehabilitation programs.

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REHABILITATING STRANDED CETACEANS AND PINNIPEDS: MANAGEMENT ISSUES AND DATA SUMMARY

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It's almost time to go home, Friday afternoon after a long week. Visions of a night on the town and a relaxing weekend at home suddenly evaporate when the stranding telephone rings. There's a live marine mammal stranded on the beach and it needs help, NOW.

Public interest in "saving" marine mammals and the goodwill of professional marine mammalogists and various facilities have resulted in an active stranding-rescue network in the US. Over the years, these efforts have led to an increase in the number of stranded animals rehabilitated and released. Concurrently, there has been an increase in concern over the handling of live-stranded marine mammals, the decision-making process involved when releasing or retaining treated animals, and potential impacts of releasing animals into wild populations.

Since the passage of the Marine Mammal Protection Act (MMPA) in 1972, the National Marine Fisheries Service (NMFS) has developed regulations, policies, and recommendations regarding the proper response to s-tranded cetaceans and pinnipeds (except walrus), and their dispositions once they are rehabilitated (Wilkinson 1991). This paper focuses on these issues, summarizes existing data and concludes with recommendations for standards in treating and releasing cetaceans and p innipeds. Walruses, sea otters, manatees, dugongs and polar bears are under the jurisdiction of the Fish and Wildlife Service, and are not considered here.

In this paper, we make a distinction between *rehabilitate* and *treat*. Webster's II dictionary defines *rehabilitate* as "to restore...to customary activity through education and therapy" and *treat* as "to give medical aid to". Although the goal is to rehabilitate live-stranded marine mammals, it is seldom known whether individuals that have been treated and released have in fact been rehabilitated.

APPLICABLE STATUTES, REGULATIONS, AND POLICIES

Statutory Requirements

The MMPA explicitly states that rescued marine mammals be released if feasible and the animals are judged likely to survive (Section 109(h)(3)). However, NMFS has adopted the policy that the welfare of the wild population overrides that of any individual. In other words, release must not be to the detriment of the wild population, and may be denied if NMFS determines that an unnecessary risk exists. This authority has been exercised recently, for example, in preventing release of pinnipeds with titers to morbillivirus because it was uncertain whether the animals were infectious.

Mandatory release may also be suspended for reasons other than a potentially adverse effect on a population. For example, live-stranded pinnipeds have been retained for public display *in lieu* of removing others from the wild [1].

Animals on the Beach

In practical terms there are no regulations, policies, or guidelines for rescuing an animal on the beach, transferring it, or e u thanizing it. The MMPA, as passed in 1972, generally viewed both live and dead stranded marine mammals as public health hazards which are the responsibility of local governments. The value of stranded animals to science and conservation was pointed out in a 1977 workshop (Geraci and St. Aubin 1979), and in 1981 the Act was amended to allow federal involvement. Subsequently, NMFS established regional marine mammal stranding networks.

Three NMFS regions (Northeast, Northwest, Southwest) have a policy that pinnipeds be observed for 24-48 hours before any action is taken. Currently the decision on the fate and handling of a beached animal lies with the attending veterinarian or qualified member of the stranding network; qualified individuals are identified as such when authorized to participate in a stranding network (i.e., in a Letter of Authorization from the regional offices of NMFS).

At the Rehabilitation Facility

The course of medical treatment at a rehabilitation facility is left to the discretion of the attending veterinarian. NMFS has not suggested treatment protocols or standards, but provides two guidelines on maintenance: animals undergoing rehabilitation are to be segregated from those used for public display during an unspecified quarantine period; and animals undergoing rehabilitation are not to be used for public display.

Permanent Retention of Treated Animals

There are no specific regulations or policies for retaining animals except those that might pose an unnecessary risk to the wild population. Generally, that decision is made by the attending veterinarian. Unreleasable animals must enter a permanent colony or be euthanized.

Those retained must be placed in a facility that meets APHIS (Animal and Plant Health Inspection Service, US Department of Agriculture) standards. Until recently, regional offices of NMFS issued a Letter of Agreement authorizing public display facilities for this purpose; a public display permit was not required. This procedure had the advantage of allowing expeditious placement of animals and reducing the burden on facilities providing treatment. It also circumvented public review regarding the placement of animals, and precipitated a controversy when, in 1989, a bottlenose dolphin (*Tursiops truncatus*) was permanently placed under a Letter of Agreement in a facility that did not have a public display permit. As a result, NMFS policy was changed to require that facilities lacking such a permit had to obtain one following inspection and full public review before they could permanently retain a cetacean. The policy of placing rehabilitated pinnipeds in public display facilities under Letters of Agreement has continued.

Non-releasable animals may also be used for scientific research. Authorization for this purpose requires a scientific research permit.

Releasing Treated Animals

In the past, NMFS has left the determination of releasability to the individual institutions. This practice is being re-evaluated, particularly for cetaceans. As a first step, NMFS placed conditions on the release of cetaceans, and applied them on a case-by-case basis. The conditions include: (1) "normal" swimming behavior (upright orientation and multidirectional movements), (2) stable body weight maintained by freely feeding animals, (3) "normal" blood chemistry and hematology, and (4) no indication of infectious disease. In 1991, additional conditions delayed for several months the release of a harbor porpoise (*Phocoena phocoena*) calf that had stranded on the Pacific coast. NMFS required that the animal be retained until it was closer to the estimated age at weaning for this species, and others of its kind had returned to nearby waters.

Once a decision is made to release an animal, NMFS has three additional requirements. The facility must notify NMFS of the release, the animal must be tagged [2], and the release must be in the vicinity of conspecifics. An exception to the last requirement has been authorized in the Northeast Region where an increasing number of species are stranding (including gray seals, *Halichoerus grypus*, hooded seals, *Cystophora cristata*, and harp seals, *Phoca groenlandica*) outside the core range of their populations. Releasing these species in their core range may not be feasible. As an alternative, the Northeast Region has adopted a policy that release could be in the vicinity of the original stranding at the same time of year. NMFS also recommends that a species normally occurring in social groups in the wild be released in the vicinity of others of the same species or that at least two treated individuals be released simultaneously.

It has been standard practice for NMFS Regions to require that released animals be marked or tagged. The Southwest and Northwest Regions provide roto-tags for this purpose. Additional information about the movements and, possibly, survival of released animals can be obtained by attaching radio tags or satellite-linked transmitters. Until recently, a scientific research permit was required to apply any type of tag. Recognizing the need to verify survivorship of animals rehabilitated and released, NMFS changed the policy, and no longer requires a permit to tag cetaceans or pinnipeds with transmitters prior to release [3].

THE NUMBER OF PINNIPEDS AND CETACEANS RELEASED OR RETAINED

NMFS regional offices maintain records of cetaceans and pinnipeds taken to rehabilitation facilities. The data presented here are based on reports submitted by the rehabilitation centers for 1973-1991, and include all regions of the continental United States. Data on the number of number of animals permanently retained in captivity are likely accurate because they come from various sources. These include the NMFS inventory of captive marine mammals, Letters of Agreement for transferring or holding in captivity, and permit records. In this paper, an animal is considered "retained" if it had been (1) held at least one year without a formal decision to retain it permanently, or (2) if a formal decision was made, by Letter of Agreement or permit, for permanent care even if it died within one year of that determination. Excluded from the data set are animals that died within one year without a formal determination on their status, and those held longer than a year but later released. The latter category applies more frequently to cetaceans.

Records are less complete on stranded pinnipeds and cetaceans that were released. Most, if not all, of the cetaceans in this category have been accounted for since 1973 but in some cases the exact dates (or even years) of stranding or release are uncertain. Data on released pinnipeds have been systematically kept only in more recent years: since 1982 for California sea lions (*Zalophus californianus*) and northern elephant seals (*Mirounga angustirostris*) in the Southwest Region, and since 1986 for all other species including *Mirounga* in the Northwest Region.

Most of the live-stranded individuals taken to rehabilitation facilities are pinnipeds (Fig. 1); the majority of those are California sea lions, followed by elephant seals and harbor seals (*Phoca vitulina*). Seven other species have been recorded (Table 1). The recorded number of individuals of all species of pinnipeds that are treated and released has generally risen since

1973 (Fig. 1). Some of the increase may be attributed to better reporting and record keeping, but other factors are likely involved as well. These include greater effort to rehabilitate, improved medical knowledge, better equipped facilities, and recent catastrophic events that resulted in large numbers of strandings. Expanding populations or range extensions may also account for an increase in strandings.

The marked annual variation in stranding records for *Zalophus* reflects the combined influence of epizootics and environmental conditions. A 1983 outbreak of leptospirosis coincided with a significant El Niño - Southern Oscillation event that affected the coastal waters of California (Trillmich and Ono 1991). Two other leptospirosis outbreaks account for increases in the number of stranded *Zalophus* in 1988 and 1991, the latter also including animals affected by other diseases. The comparatively low numbers in 1985-87 likely reflect more normal stranding rates, and are not an artifact of incomplete records, which on *Zalophus* have been systematically kept since 1982.

Very few cetaceans are treated (Fig. 1) Individuals representing twelve species have survived long enough at rehabilitation facilities to be released or considered permanently captive (Table 2): the most common are pilot whales, *Globicephala macrorhynchus* and *G. melas*, and bottlenose dolphins. Only one or two individuals from each of the eight remaining species has been treated.

Most cetaceans die on the beach or shortly after arriving at a treatment facility. Even in mass strandings, where some of the animals may not be "sick", the stranding event itself can cause physiological stress, shock and hyperthermia. Without timely intervention, animals in this condition are unlikely to survive. In addition, logistic difficulties are great. Some animals are too large to transport, or be kept at a rehabilitation facility. The number of cetaceans treated at rehabilitation facilities remained relatively constant at low levels from 1973-1990 (mean = 2.1/year) then increased in 1991 when 12 live-stranded cetaceans were collected. Though dwarfed by the hundreds of pinnipeds that are now being treated and released each year, the few cetaceans released or retained draw considerable public attention and controversy.

The number of stranded marine mammals placed in permanent captivity has varied widely since the passage of the MMPA (Fig. 1). In 1977, NMFS adopted a policy to place rehabilitated pinnipeds *in lieu* of a take from the wild. Almost without exception, no permit has been issued since that time allowing a pinniped to be taken from the wild for permanent captive maintenance. This policy is reflected in the large number of *Zalophus* retained in 1978 and 1979. Subsequently, the numbers of pinnipeds retained has declined, reflecting a saturation of public display facilities. Only a few treated pinnipeds or cetaceans are now retained in permanent captivity (Fig. 1).

The profile of retained species is driven by the number that strand, the size of the animal, and the cost of maintenance. As with California sea lions, more elephant seals have been released than retained (Figs. 2 and 3). In contrast, about as many harbor seals and cetaceans have been retained as released (Figs. 4 and 5). Most of the other pinniped species strand outside their expected population range, and most of them are released.

RECOMMENDATIONS

The biological justification for rescuing and rehabilitating most stranded marine mammals is arguable. Such efforts do not contribute to the enhancement of most species. For that reason, NMFS provides few resources for rescue programs. However institutions dedicated to this end are likely to endure and even increase in number; centers are now emerging with the sole purpose of treating stranded animals. These centers currently are not licensed or inspected by APHIS, and therefore operate autonomously.

This raises concern that animals might be released without adequate health evaluation, and could pose a risk of transmitting disease to the population. Standards are needed that address these issues, beginning with criteria for rescue and release (Geraci and Lounsbury 1993) and guidelines for medical and quarantine measures (St. Aubin *et al. this report*) that will safeguard the animal and the population to which it is introduced.

ACKNOWLEDGMENTS

The data included here were reported to the NMFS regional offices by rehabilitation facilities and members of the stranding network. We are grateful to Kathy Horstman for assistance in editing the data and reports received from the regions. Constructive reviews of the manuscript were provided by Cindy Driscoll, Nancy Foster, Brent Norberg, Michael Payne, Michael Scott, Ann Terbush and Michael Tillman.

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FOOTNOTES

[1] memo from W. Meibohn, Associate Director, NMFS, to the Regional Directors, July 5, 1977; a copy can be found in Wilkinson 1991, Appendix D

[2] implemented as a policy per letter from W.W. Fox, Jr. to NMFS Regional Directors, January 9, 1992

[3] formalized as a policy per letter from W.W. Fox, Jr. to NMFS Regional Directors, July 9, 1991

Table 1. For species of pinnipeds treated at rehabilitation facilities infrequently, the number of individuals treated at a rehabilitation facility and retained or released. Retained animals are those that survived one year or more or currently have been held at a facility for greater than one year. Data for all species except *Zalophus* are incomplete prior to 1986; data for *Zalophus* are incomplete prior to 1982.

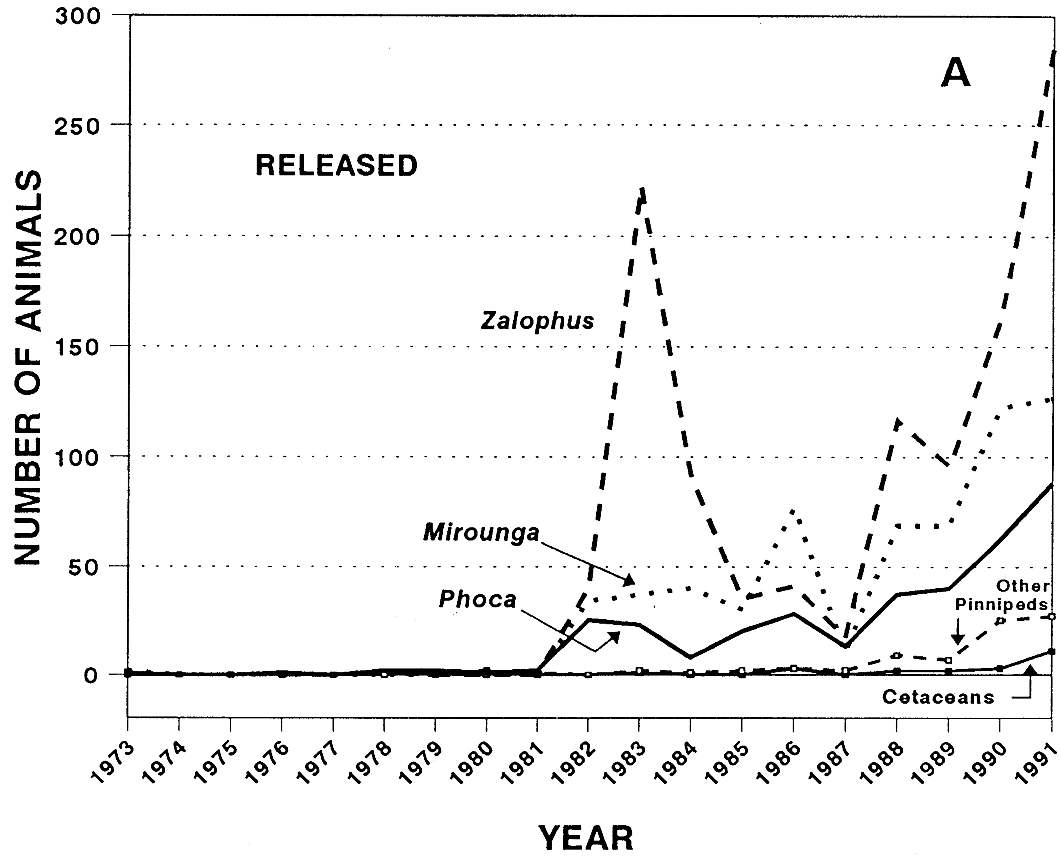
Year	*Artocephalus townsendi*		*Callorhinus ursinus*		*Cystophora cristata*		*Eumetopias jubatus*		*Halichoerus grypus*		*Phoca groenlandica*		*Phoca hispida*	
	Retained	Released	Retained	Released	Retained	Released	Retained	Released	Retained	Released	Retained	Released	Retained	Released
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	1	0	0	0	0	0	1	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	2	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	1	2	0	0	0	0	0	0	0	0	0
1985	0	0	1	1	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	1	0	0	0	0	3	0	0	0	0
1987	0	0	1	0	1	0	0	1	0	0	0	0	0	0
1988	0	0	0	2	4	2	0	0	0	5	0	0	0	0
1989	0	0	0	1	1	0	0	0	0	6	0	1	1	0
1990	0	1	0	2	0	6	0	0	0	14	0	1	0	1
1991	0	0	0	7	0	5	0	1	0	6	0	3	0	3
Total	0	1	3	16	9	13	0	2	2	34	0	5	1	4

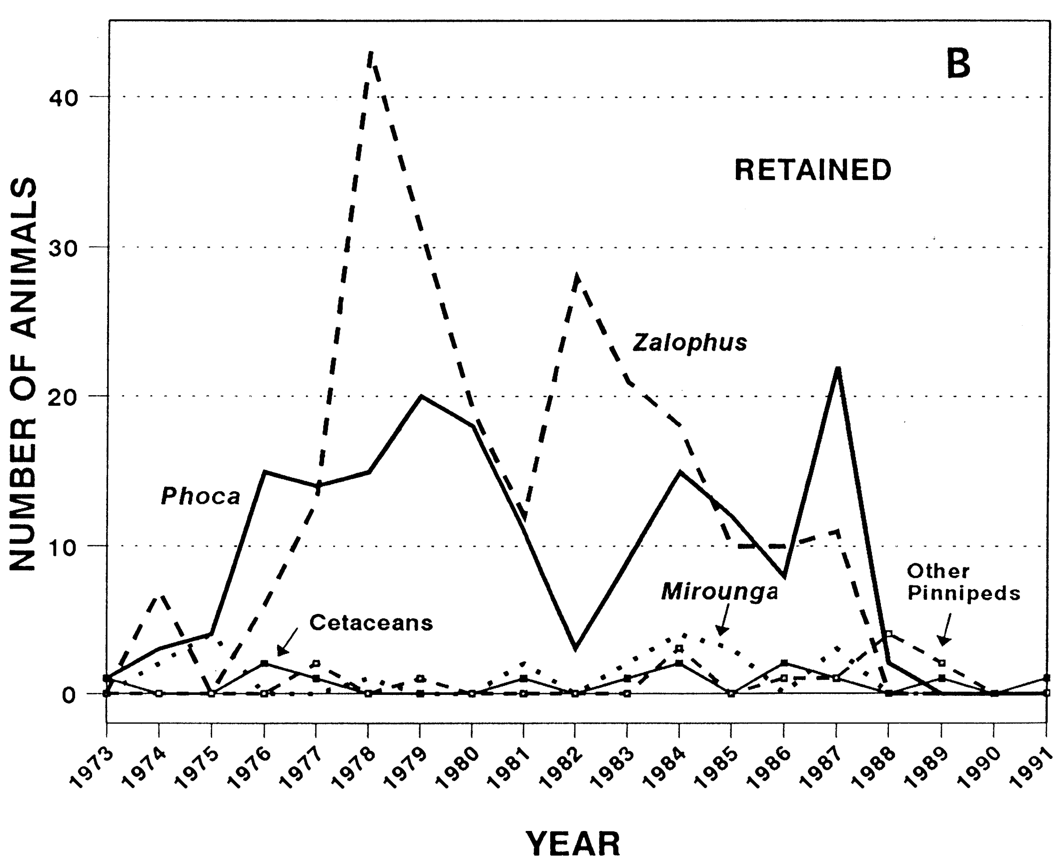
Table 2. The number of live-stranded cetaceans treated at rehabilitation facilities and retained ("Ret") or released ("Rel"). Retained animals are those that survived one year or more or currently have been held at a facility for greater than one year.

Year	*Balaenoptera edeni*		*Delphinus delphis*		*Globicephala macrorynchus*		*G. melaena*		*Kogia breviceps*		*L.*[1] *acutus*		*L.*[1] *obliquidens*		*Orcinus orca*		*Phocoena phocoena*		Spotted dolphin[2]		*Steno bredanensis*		*Tursiops truncatus*	
	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel	Ret	Rel
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1[3]
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2[4]
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	8	0	2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Total	0	1	2	0	0	8	1	6	0	1	0	2	1	0	1	0	3	1	1	0	1	0	2	5

[1]Genus *Lagenorhynchus*
[2]Genus *Stenella* , species not identified
[3]Represents release date because date of stranding is unavailable

Figure 1. (see next page) The number of live-stranded pinnipeds and cetaceans transported to a rehabilitation facility, treated, then released or retained for permanent captivity. Records are complete for all cetaceans and for retained pinnipeds since passage of the Marine Mammal Protection Act in 1972. Records are incomplete for (A) Zalophus and Mirounga released prior to 1982, except for any Mirounga that might have been released in the Northwest Region prior to 1986 (this number is likely to be very small, and (B) all other species of pinnipeds released prior to 1986. Retained animals are those that either have been determined to be permanently captive and are designated as such by Letter of Agreement or permit, or those that have survived one year or more as permanently captive animals even if they have not been determined to be permanently captive.


A
RELEASED
NUMBER OF ANIMALS
YEAR
Zalophus
Mirounga
Phoca
Other Pinnipeds
Cetaceans
300
250
200
150
100
50
0
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991


B
RETAINED
NUMBER OF ANIMALS
YEAR
Zalophus
Phoca
Mirounga
Cetaceans
Other Pinnipeds
40
30
20
10
0
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991

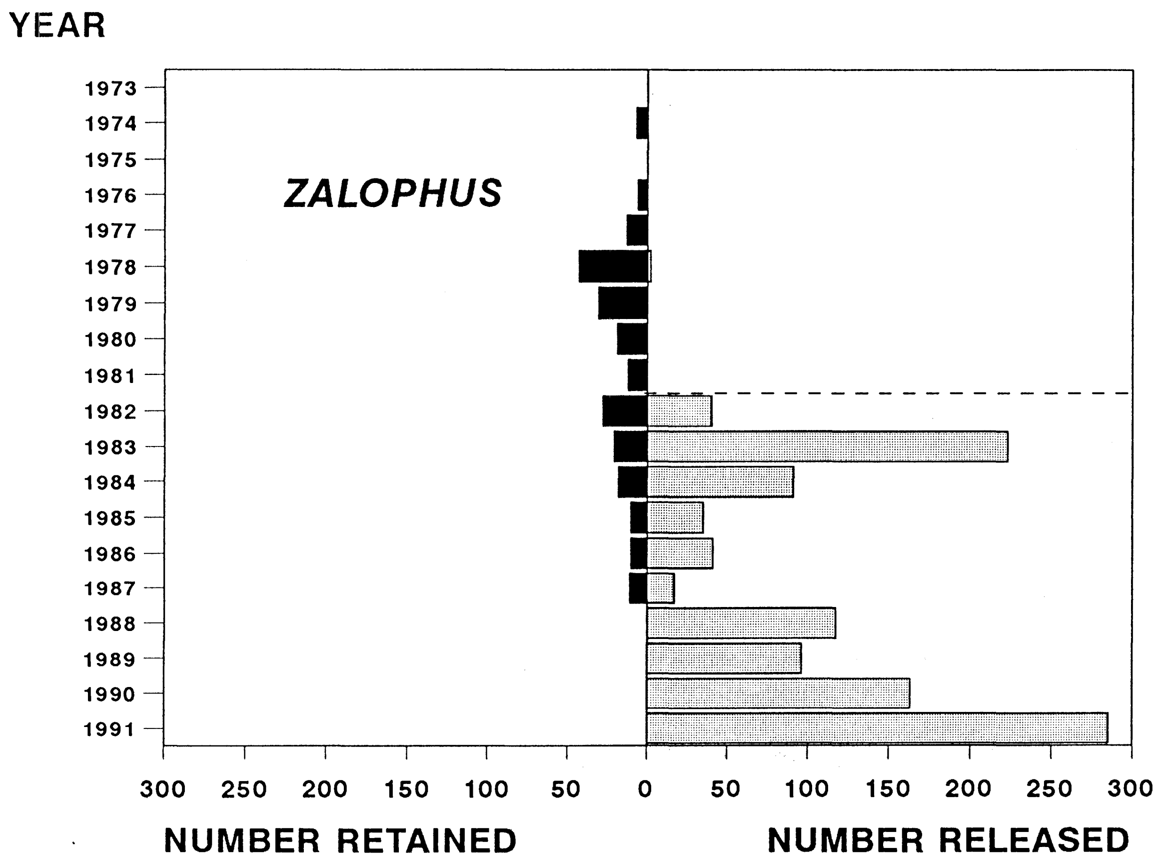


Figure 2. The number of California sea lions, *Zalophus californianus*, treated at a rehabilitation facility and released or retained. Data on the numbers released are incomplete prior to 1982. For a definition of retained, see Figure 1.

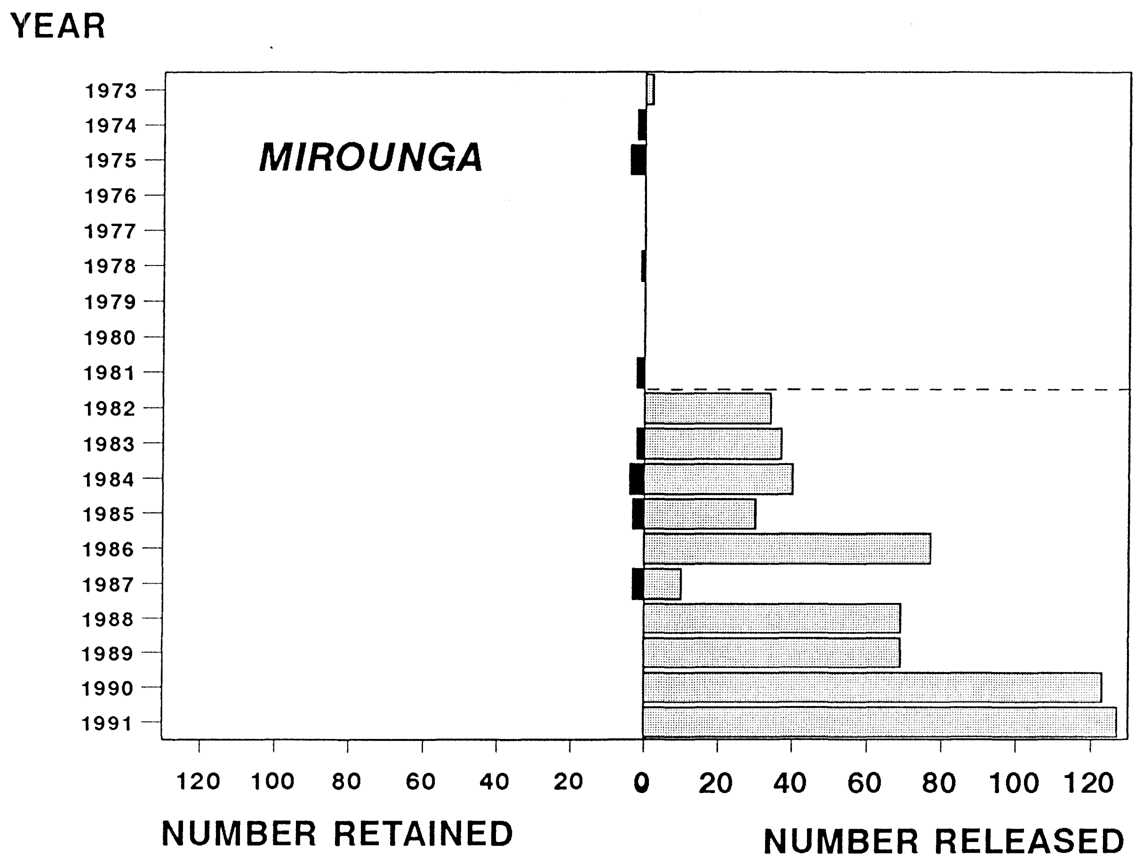


Figure 3. The number of northern elephant seals, *Mirounga angustirostris*, treated at a rehabilitation facility and released or retained. Data on the numbers of released in the Southwest Region are complete beginning in 1982. Although they are not complete in the Northwest Region until 1986, relatively few *Mirounga* have been released there. For a definition of retained, see Figure 1.

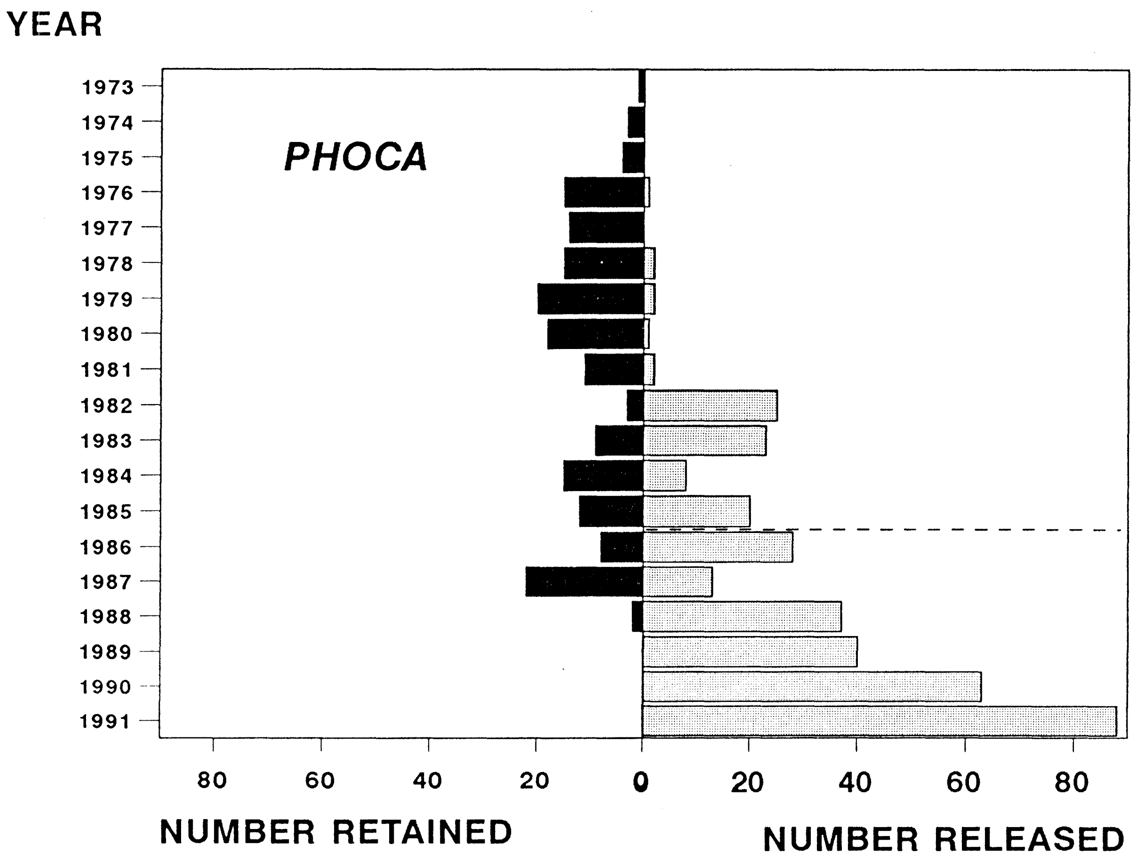


Figure 4. The number of harbor seals, *Phoca vitulina*, treated at a rehabilitation facility and released or retained. Data on the numbers released are incomplete prior to 1986. For a definition of retained, see Figure 1.

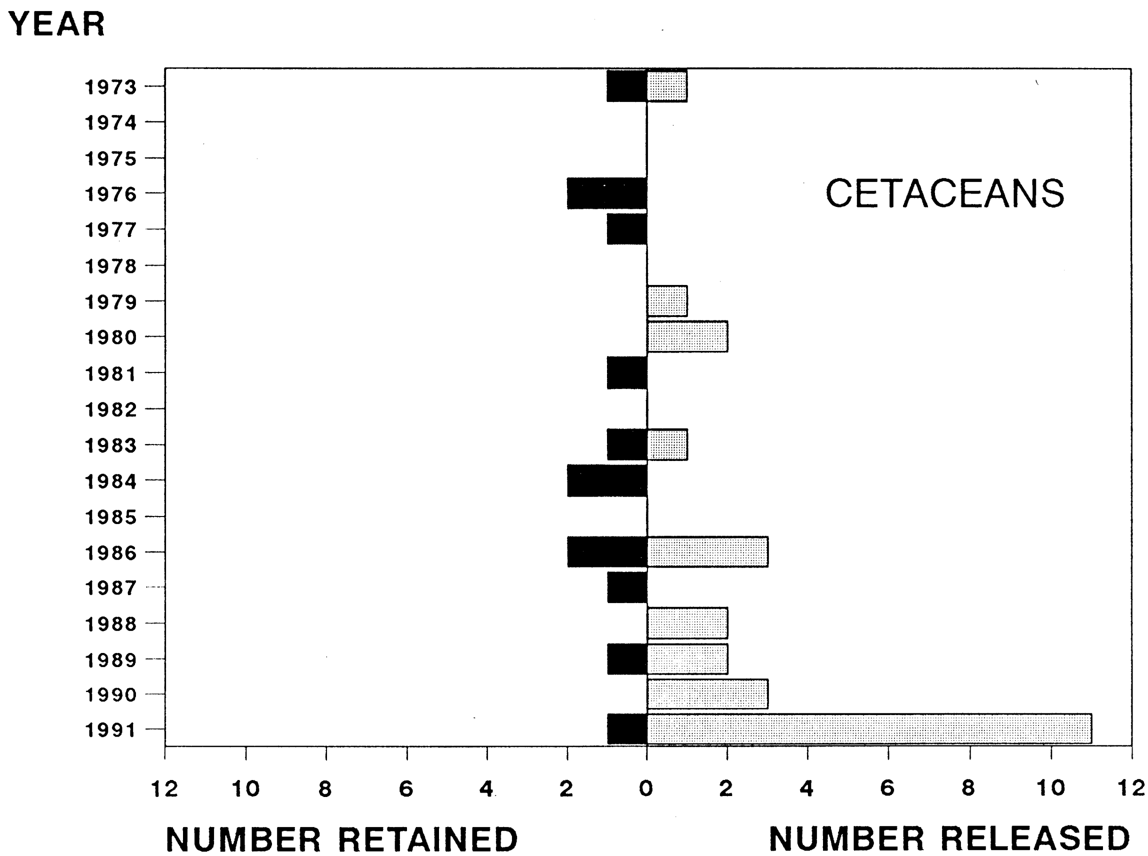


Figure 5. The number of cetaceans of all species treated at a rehabilitation facility and released or retained. Data should be complete since passage of the Marine Mammal Protection Act for both released and retained individuals. For a definition of retained, see Figure 1.

DISEASE AND REINTRODUCTIONS - AN OVERVIEW

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Disease can have a major impact on wild populations. Consider the extinction of wild black-footed ferrets (*Mustela nigripes*) and the current precipitous decline of the African wild dog (*Lycaon pictus*) due to canine distemper. In many cases, disease introductions result from the activities of man. For example, exposure to lungworm infections and viral diseases of domestic sheep has had a notable and negative effect on the North American populations of Rocky Mountain bighorn sheep (*Ovis canadensis*). Like the "Hawaiian syndrome" in man, where measles nearly exterminated the native populations, the potential impact of disease introductions in immunologically naive wildlife populations is not surprising.

As reintroductions of rehabilitated or captive-bred animals take place, it is critical that these new arrivals do not bring with them disease entities that will affect the health and survival of their compatriots still afield. Although this presentation focuses on the problems and prevention of disease introduced from captive animals returned to the wild, it is important to remember that there is similar concern when wild animals are translocated to areas with diseases to which they have not developed resistance. A notable example is the introduction of white rhinoceroses (*Ceratotherium simum*) into Kenya's Meru National Park. There, several newly arrived rhinoceroses died of trypanosomal infections, although rhinoceroses already exposed had developed resistance and survived.

Reintroduction of captive animals to the wild is not new. Several of the bison (*Bison bison*) herds that currently inhabit the American West are descended from animals reintroduced from the New York Zoological Society in 1907. Arabian oryx (*Oryx leucooryx*) from the Phoenix and San Diego Zoos are currently being used to found new herds in the Middle East, and golden lion tamarins (*Leontopithecus rosalia*) from the National Zoological Park and other institutions are being returned to the coastal Brazilian rain forest (Montali and Bush, *this report*). These projects are increasingly important for species threatened by dramatic changes in their natural habitat (Foose 1983). Captive populations may represent the last hope for some. It is now estimated that there are more captive Siberian tigers (*Panthera tigris altaica*) (600-700) than wild ones (300-400). Other species, such as the Asian wild horse (*Equus przwalskii*), exist only in captivity.

To maintain the genetic diversity of small populations, intensive genetic management is required (Soule *et al.* 1986). Genetic models have defined the "saving" of a species as the maintenance of 90% of its genetic diversity over 200 years or 50 generations (Soule *et al.* 1986). That principle is perhaps best expressed by Aldo Leopold's statement, "The first rule of intelligent tinkering is to save all of the parts."

Genetic variability encompasses not only body shape or color, but also factors that affect susceptibility to disease. For example, the genetic impoverishment of the cheetah (*Acionyx* *jubatus*) may be directly responsible for increased morbidity due to feline infectious peritonitis (FIP) in this population (O'Brien *et al.* 1985).

No single institution can hold enough animals to maintain a genetically viable population, and so cooperative programs have been organized. In North America, Species Survival Plans (SSPs) are managed under the auspices of the American Association of Zoological Parks and Aquariums (AAZPA). An integral part of these plans is the transfer of animals from institution to institution for breeding purposes. Though genetically necessary, these transfers also increase the risk of the spread of disease, similar to the risks encountered when reintroducing animals to the wild or performing translocations there.

Many SSP Committees have appointed veterinary advisors to help determine what diseases are significant in each species. Sound conclusions must be based on accumulated clinical and post-mortem data, rather than on anecdotal or incidental information. Serum and tissue banks are integral to retrospective studies necessary to determine the history of exposure to infectious agents in captive and free-living animals.

Clearly, preventive medicine and testing depend on the species involved. The spread of tuberculosis in hoofstock and great apes, equine rhinotracheitis (a herpes virus) in Asian wild horses, paramyxovirus in Aruba Island rattlesnakes (*Crotalus unicolor*), herpes viruses in cheetahs, lion-tailed macaques (*Macaca silenus*) and cranes have been checked by specific testing programs. Additional attention must be given to preventing mixing species that may carry diseases adapted to one, but dangerous to others. For example the virus of simian hemorrhagic fever in Patas monkeys (*Eeythrocebus patas*) may be inconsequential to that species, but lethal to other primates. It is also important that captive species not be exposed to domestic animals which may transfer disease to them. In Saudi Arabia, tuberculosis was transferred from domestic hoofstock to Arabian oryx being held for release.

We are confident in our ability to diagnose most of these diseases. Yet problems still arise. Up to 60% of orangutans (*Pongo pygmaeus*) tested for tuberculosis react positively, but many are "false positive" reactors, seriously complicating the interpretation of this basic test. Even common diseases can be difficult to diagnose in their acute stages. This has been the case with leptospirosis in black rhinoceroses (*Diceros bicornis*), for which serological tests vary widely, leaving only the fluorescent antibody (FA) test as a reliable indicator in acute infection (Miller *et al.* 1987).

A further dilemma can result when a biologist asks "What diseases do we need to be concerned about?" In giving a "clean bill of health", a veterinarian naturally considers diseases that have already been described in that species, and though disease entities continue to surface, such as herpetic skin lesions in cheetahs (Junge *et al.* 1991) and coronaviral hepatitis in golden lion tamarins (Ramsay *et al.* 1989), wide gaps still exist in our understanding of disease agents in a host of other "exotic" species. How then can one certify that herpes, retroviral or some other viral infection is not significant in rhinoceroses or whales or seals?

Obviously, there are no quick and easy answers. The best approach is to develop protocols based on the most current medical knowledge available for each species. To this end, centralized data and tissue banks have proved to be invaluable. Whether it is a question of releasing long-term captives, captive-born animals, rehabilitated wildlife, or simply translocating free-ranging animals, the issues are often the same. Those responsible for regulating the transfer and reintroduction of marine mammals might benefit by examining programs developed by the Captive Breeding Specialist Group (CBSG) of the International Union for the Conservation of Nature (IUCN). Information can be obtained by contacting:

Captive Breeding Specialist Group
c/o Minnesota Zoological Park
13000 Zoo Boulevard
Apple Valley, MN 55124.

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MODELS FOR DISEASE CONTAINMENT IN CAPTIVE TERRESTRIAL MAMMALS DESTINED FOR REINTRODUCTION

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Zoological institutions throughout the world are propagating threatened and endangered species with the intention of reintroducing and maintaining them in natural habitats. This activity is based on major advances made in the last 25 years in captive management, nutrition and zoological medicine, and the collaborative efforts of professionals in the behavioral and veterinary sciences.

The National Zoological Park in Washington, D.C., has developed programs to reintroduce golden lion tamarins (*Leontopithecus rosalia*) to Brazil (Beck *et al.* 1988) and to reinforce Guam rail (*Rallus owstoni*) populations by establishing them on the island of Rota (Derrickson 1987). In addition, cooperative programs have been underway to replenish natural habitats with black-footed ferrets (*Mustela nigripes*) (Thorn and Williams 1988) and more recently red wolves (*Canis rufus*) in the United States. Inherent in such restoration programs have been a number of obstacles, not the least of which are animal health issues. Other programs involving endangered carnivores and parrot and crane species have been stymied by disease problems (Thorn and Williams 1988, Cooper 1989, Derrickson and Snyder 1992). Therefore, strict guidelines must be developed to prevent the dissemination of diseases that might arise during the captive breeding phase.

The purpose of this communication is to describe some important types of diseases that might develop during *in situ* propagation of endangered animals and to prevent the perpetuation of these diseases into wild populations during the release phase. Of particular concern are genetic and infectious diseases, some of which will be illustrated using the collaborative program of the Brazilian government and the National Zoological Park's golden lion tamarin reintroduction program as a model (Kleiman *et al.* 1991).

Communicable diseases are of utmost importance and perhaps the greatest threat to annihilating groups of susceptible, valuable animals. This process can work both ways. Animals from captive sources could transmit diseases to conspecifics in the wild and potentially to other wild and domestic species in the areas of release. Conversely, captive animals naive to indigenous infectious agents could contract diseases to which the wild population is most likely immune. For example, a new virulent viral infection of captive marmosets and tamarins emerged in the early 1980's with a high incidence in the endangered golden tamarin (Montali *et al.* 1989, Ramsey *et al.* 1989). Callitrichid hepatitis virus (CHV) caused fatal epizootics at 10 zoos between 1981 and 1991 before zoo researchers identified the causative agent as an arenavirus that was carried by mice (Stephensen *et al.* 1991). The primates were exposed to the virus either through their food (suckling mice -"pinkies") or from contact with wild mice inhabiting their exhibits (Montali *et al.* 1993). The overriding concern was that this newly emergent disease not be introduced into the native habitat of this endangered species during reintroduction. Preliminary serosurveys of wild-born golden lion tamarins from Brazil have been negative for CHV antibodies, suggesting that callitrichid hepatitis is not an indigenous disease in this species. Efforts to prevent the introduction of CHV have included strict quarantine practices, elimination of mouse-feeding, and control of rodent contact with the animals. Although transmission between tamarins has not been established, those seropositive for CHV have been eliminated from the reintroduction programs.

Another medical concern in this species involved a spirurid intestinal nematode, *Pterygodermatites nycticebi*, whose indigenous host is the slow loris (*Nycticebus coucang*). The parasite insidiously adapted itself to the golden lion tamarin colony during the earlier propagating phase of this species at the National Zoological Park. Before its recognition as a potential problem, it "spilled over" to other tamarin colonies via animal exchanges, resulting in a high morbidity but low mortality (Montali *et al.* 1983). The concern of introducing this captive-adapted parasite into the wild was lessened by the fact that the German cockroach (*Blattela germanica*) served as an obligate intermediate host and it would be unlikely for the parasite to be perpetuated under these conditions in the wild. Furthermore, the parasite can be eliminated during quarantine with effective anthelminthics.

Animals with genetically-based defects are another major area of concern. Recognition of a putative familial diaphragmatic defect in the golden lion tamarin led to a diagnostic surveillance program to prevent animals phenotypically expressing this trait from being reintroduced (Bush *et al.* 1992). The defects ranged from trivial changes to wide gaps that could lead to fatal diaphragmatic hernias (Montali *et al.* 1980). A relatively high incidence was reduced precipitously by eliminating over-represented founders in the breeding stock at several facilities.

In summary, a number of disease problems, both infectious and genetically-based, were identified over a fifteen year period in captive golden lion tamarins selectively propagated by various zoos for eventual reintroduction. These conditions had been previously unrecognized in wild populations. The tamarin reintroduction program has served as a prototype for developing the rationale and methods to prevent the perpetuation of diseases like these into areas of release. After approximately a decade of reintroducing golden lion tamarins into their native habitat in Brazil, none of the captive-acquired infectious conditions has yet been recognized in survivors of multiple reintroduced groups (Beck *et al.* 1991). One critical element of such a preventative health program for reintroduction, therefore, is the capability of clinical and pathological monitoring during and after the reintroduction period.

In general, all aspects of this program, including breeding strategies and health monitoring procedures, are applicable to most animal species whether they be terrestrial or aquatic. However, protocols should be tailored to the specific disease problems of the species in question. Much of the information gained about these infectious and genetic conditions in golden lion tamarins has been gathered and shared globally by breeders through Studbook and in the preparation of Species Survival Plans (SSP) drafted through the auspices of the American Association of Zoological Parks and Aquariums (AAZPA, now the American Zoo and Aquarium Association). Medical protocols for disease problems, necropsies and quarantine procedures germane to the golden lion tamarin have been established and are now in use by all zoos contributing animals to the reintroduction programs.

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BEHAVIORAL ISSUES IN RETURNING MARINE MAMMALS TO THEIR HABITAT

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Central to rehabilitating stranded animals is the question "does it work?" In the broadest sense, we are talking about returning animals to their habitat after removal from it and determining whether they survive, resume normal activities and reproduce. *A priori*, two categories of variables are expected to influence the ease, speed and efficacy of reintroduction. The first concerns the cause of initial dislocation. Successful reintroduction might depend on whether initial dislocation from the habitat was due to maternal abandonment, illness, accident, inclement weather, choice or force from without such as capture. The second set of variables that is expected to influence the success of reintroduction deals with behaviorally mediated effects associated with the period of "habitat displacement." These effects can be graded along several dimensions:

1) Temporal dimension. The length of time the animal is away from its habitat. This may also depend on the animal's age, for critical periods of development may be involved.

2) Spatial dimension. The distance the animal is removed from its habitat (e.g., time zones, daylength differences, temperature) and how different it is from "home".

3) Operational or experiential dimension. The degree to which the animal is affected by the activities experienced during detainment, for example drug immobilization, blood sampling, forced feeding, and manipulation. To what extent did the animal experience stress, discomfort, pain, or amnesia that would affect its subsequent behavior?

4) Intrinsic dimension. Change in normal behavior, daily rhythm of activities, or normal experience as a result of dislocation. What did the animal miss during habitat displacement that it would normally have experienced?

ASSESSING REINTRODUCTION

Documenting survival and reproduction of reintroduced animals relative to appropriate controls is critical for assessing the value of rehabilitation or treatments effected during the period of removal. Reproduction is the ultimate dependent variable, for if an animal does not reproduce it does not contribute to the propagation of the species. However, although rehabilitation and release of injured wildlife has become a widespread activity in North America

(Martell *et al.* 1991), little effort has been made to document survival or breeding success of released animals. It is first necessary to document whether the reintroduced animal survives. If not, why not? Has the dislocation lowered the animal's chances of surviving relative to conspecifics of the same sex, same age, and same health? Has the experience affected its foraging success, altered its risk of predation, made it more accident prone, made it more a risk to conflict with human fishing?

Is the animal as likely to reproduce as "controls"? Is it as likely to wean its offspring? Does a female cycle normally, join a harem or herd, become receptive to males, conceive, give birth and treat her pup normally? Do males compete as effectively? If not, why not? Assessing reproduction is more difficult than assessing survival in most species, and doing so with appropriate controls may be possible for few species.

Are the animal's habits changed in subtle ways that might eventually affect survival or reproduction? For example, does it use the same resting sites, breeding sites, molting sites, migratory path, foraging areas, etc.? Is it received by conspecifics in the area or is it treated as an outcast (a lone wolf)?

Desideratum

We want to know which variables are most important in bringing about successful reintroductions. For example, eagles and hawks remain near release sites for the first few days after release (Servheen and English 1979, Hamilton *et al.* 1988, Martell *et al.* 1991). Reijnders *et al.* (*this report*) present evidence that some phocid seals do as well. For those species, it appears that the release site should be chosen so that it fulfills immediate needs of the released animal, i.e., food and shelter and no humans. Evidently, identifying key variables will involve a great deal of parametric study, e.g., how long one can hold a dolphin in an enclosed tank before it is too late to release it successfully and what is the optimal age for release of a female harbor seal. An effective monitoring program will depend on a complete description of the physical condition of the animal prior to or at the time of dislocation and at the time of reintroduction. It is imperative that normal behavior, survivorship, reproductive success for a particular age/sex group be known in order to fully assess the success of reintroduction. That is, one must have a standard of comparison.

BEHAVIOR OF REINTRODUCED EXPERIMENTAL SEALS

To illustrate an approach that a release-monitoring program might take, I present preliminary data on experimentally manipulated seals, viewing them as reintroduced animals. Some of you may think that this is like the drunk who lost his wallet in the middle of the block but looked for it on the corner because there was more light there. But this is not so. Reintroduced experimentally treated animals can be considered along the same dimensions that affect reintroduction of rehabilitated stranded animals. The major difference between the two is that many stranded animals are initially sick or weak while experimental animals usually are assumed to be healthy at the time of capture. Treatment during detainment and the duration of detainment are often similar. As a result, reintroduced experimental animals provide a valuable comparison with reintroduced rehabilitated animals, or more to the point, a control for initial health.

During the course of a ten year study of northern elephant seals (*Mirounga angustirostris*) at Año Nuevo, California, my colleagues and I transported pups and yearlings from the rookery to the Long Marine Laboratory for a variety of experiments and then returned them to the field. We also drugged, restrained, and conducted field experiments with seals of both sexes and all age groups. Subsequently, we sought to determine whether these operations affected behavior promoting survivorship and reproductive success.

Weanling Lab Studies

During the 2.5-month period following weaning, elephant seal pups were captured by placing a bag over their heads, putting them into a cage, and then transporting them by pickup truck to the lab 30 km away. Here, the pups were housed outdoors in a fenced enclosure on a cement slab covered with sand for 2-4 weeks and were involved in a variety of experiments to study thermoregulation and energy metabolism, The studies varied in duration and degree of manipulation; most involved blood sampling and physical restraint. The animals were not fed (unless involved in a feeding experiment) because they are normally fasting at this time. At the end of experiments, the pups were tagged and released in good health at the site where they were captured. They weighed approximately 25% less than at the time of capture, the same weight loss that untreated pups incur normally.

Nursing Female Field Studies

Adult females, 3 to 12 years old, were involved in studies of the energetics of lactation (Costa *et al.* 1986) and in the collection of diving data (Le Boeuf *et al.* 1986, 1988, and 1989). Each female was immobilized with ketamine, blood samples were taken, and radioactively labeled water and Evan's blue dye were injected. Each female was weighed and measured and kept under low levels of immobilization for up to three hours. This procedure was used three times during lactation for some females: within two days after parturition, in mid-lactation, and 1-2 days before weaning. For most of them, the mid-lactation procedure was omitted. During the last treatment, a time-depth recorder and radio transmitter were glued to the female's back with marine epoxy.

Controls

To evaluate the effects of the treatments on the experimental animals, matched controls were designated for both weaned pups and adult females. The animals were equated with respect to several factors that might affect recapture rates: sex, weight, time in the season tagged, and the number of tags.

Weanling Survival to One Year of Age

The survival rate of 74 experimental pups to one year of age was not significantly different from that of an equal number of control pups ($X^2 = 0.027$, df = 1, P > 0.05) or from that of the population mean ($X^2 = 0.164$, df = 1, P > 0.05) (Table 1). Juvenile survivorship did not vary significantly as a function of sex ($X^2 = 2.5$, df = 1, P > 0.05), weight at the end of the experiment (t = 0.24, df = 65, P > 0.05), the number of days held in the laboratory ($X^2 = 4.90$, df = 3, P > 0.05), or the date of reintroduction into the wild ($X^2 = 0.22$, df = 3, P > 0.05) (Tables 1-4). There is a trend for survivorship to decrease with time held in the laboratory (Table 3), so we separated the sample into animals held for up to 12 days and those held for longer. With this analysis, survivorship was significantly lower for animals held for more than 12 days ($X^2 = 4.51$, df =1, P <0.05).

Adult Female Survival, Reproduction and Site Tenacity

Survival of 43 field-treated adult females over the 2.5-month post-breeding period at sea was not significantly different from that of an equal number of control females, 86% vs. 88.4%, respectively (z = 0.32, P > 0.05). Similarly, there was no difference in site tenacity; 45% of the experimentals and 42% of the controls returned to breed in the same location a year later ($X^2 = 0.067$, df = 1, P > 0.05). Females in the two groups had equal levels of reproductive success as measured by number of pups produced and number of pups weaned successfully. The foraging period at sea of experimental females (mean = 71 days) was not significantly different from that of controls (mean = 73.4 6.6 days, N = 28).

CONCLUSIONS

We conclude that these experimental operations had little discernible effect on the survival of pups and adult females and on the subsequent breeding behavior of adult females. Similarly, no effects on the subsequent behavior of yearlings and adult males drugged for attachment of diving recorders were noted. As a final note, 74 of 77 yearlings translocated from Año Nuevo in spring or fall to a release point within 80 km of the island (after being drugged, subjected to diving instrument attachment, weighed and held overnight at the Long Marine Laboratory) returned to the capture site or nearby within seven days.

These data show that healthy elephant seal pups can be brought to the laboratory shortly after weaning from March to May (the time when the majority of elephant seals are stranded (Seagars *et al.* 1986), subjected to treatments and detainment similar to that experienced during the rehabilitation process, and held for up to twelve days, and then returned to their habitat with no ill effects. Do pups of the same age that strand fare equally well? Data are accumulating from elephant seal pups recovered, brought to good health, tagged and released by the Marine Mammal Center (Sausalito, CA). During the years 1977-1987, 183 northern elephant seal pups percentage of resights is significantly less than the survival rate of weanlings to one year, which is 45%. Unfortunately, these data are not directly comparable with those of the experiment presented. However, it would be possible to release stranded animals at the rehabilitated for 2-6 months (generally from March to August) were released [1]. In the next 3.25 years, 19.1% were resighted alive, with most of the resights within two months of release at Farallon Island, during various stages of lactation, adult females showed no long-term effects of the experience. the rookery nearest the release site at Point Reyes peninsula. This same place and at the same time of year as experimental animals, and in effect, conduct a controlled study.

These data, and the few successful reintroductions of monk seals (*Monachus monachus* and *M. shauinslandi*) (Gilmartin and Gerrodette 1986, Gerrodette and Gilmartin 1990, Reijnders *et al. this report*), harbor seals (*Phoca vitulina*) (Seagars 1988, Reijnders *et al. this volume*), bottlenose dolphins (*Tursiops truncatus*) (Bassos *et al.* 1991) and manatees (*Trichechus manatus*) (Sirenia Project 1991), suggest that marine mammals may be easier to reintroduce successfully to their habitat than other animals such as birds, terrestrial carnivores and primates.

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FOOTNOTE

[1] C. Gavette, J. Roletto and K. Hanni, Marine Mammal Center, Sausalito CA.

THE RELEASE OF SEALS FROM CAPTIVE BREEDING AND REHABILITATION PROGRAMS: A USEFUL CONSERVATION MANAGEMENT TOOL?

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INTRODUCTION

The general approach to managing endangered and threatened species is strict protection of habitat. However, additional measures might be necessary in situations where either the size of the population has declined below a critical number or when external threats are difficult to control. Under these conditions, releasing rehabilitated and captive-bred animals might be considered, to bridge a critical period of population recovery.

The benefits of releasing captive-born or rehabilitated animals can be offset by the risks inherent in this effort. The possible introduction of pathogens and interference with the selection processes that regulate population size and fitness are factors that apply to terrestrial animals as well as marine mammals (Miller, Montali and Bush, *this report*).

For non-threatened populations, rehabilitating injured or diseased animals is more an issue of animal welfare than of conservation and management. The objective is clearly to assist the individual animal, rather than a population. Consequently, the risks and benefits involved should be evaluated differently.

This paper presents our observations on the adaptability and survivorship of rehabilitated harbor (*Phoca vitulina*) and Mediterranean monk (*Monachus monachus*) seals released to the wild, and considers whether such individuals can contribute to the population. Three distinct approaches, differing by species, origin of animals, and post-release monitoring, are discussed.

CASE STUDIES

Harbor seals in the Wadden Sea

Stemming from the concern that the harbor seal population in the Wadden Sea has decreased significantly during this century (Reijnders 1992), captive breeding, rescue, rehabilitation and release programs were instituted to support the small numbers remaining (Reijnders 1983). To determine the outcome of these operations, we evaluated the movements and survivorship of reintroduced seals from returns of flipper tags fitted on each of the released animals. Data from a separate study on tag recoveries from free-ranging seals were used for comparison.

Dispersal

Since 1973, nearly all animals released in the Wadden Sea have been juveniles. It is known that young seals can disperse widely, some travelling distances of over 6000 km (Peterson *et al.* 1968, King 1983), a behavior known as "removal migration" (Baker 1978). Tag recoveries from released and feral seals show a similar pattern in both the proportion of returns and their distribution (Figs. 1 and 2). The majority of seals stay within 100 km of the release site; in fact approximately one third of al recoveries have been obtained within 25 km.

Survival

Assuming that the probability of recovering a tagged seal is the same for released and wild animals, the percentage of tag-returns can be considered a relative indicator of the survival of each group. Tag returns from stranded seals during the first five years after release were examined in five groups (Fig. 3):

1) wild - captured, tagged and released (n=18)

2) bred 1 - born in captivity and released as subadults (n=13)

3) bred 2 - born in captivity and released as juveniles (n=16)

4) rehabilitated 1 - born in the wild, rehabiltated and released (n=27); excluding those classified as "rehabilitated 2"

5) rehabilitated 2 - born in the wild, rehabiltated and released during the same time of year as the "bred 2" group (n=52).

Since the two groups of "bred" seals differed not only in the age of the animals at the time of release, but also in the time of year that they were released, the tag returns for the "bred 2" group were compared with those for rehabilitated seals released at the same time ("rehabilitated 2"). No significant difference was found (Fisher's exact test, $P>0.8$). Since the tag return rates of the two rehabilitated groups were similar, it was concluded that the timing of release did not influence survivorship.

Statistical comparison of the findings from the "bred-2" animals with those from the "wild", "bred-1", and "rehabilitated-1" seals revealed no significant difference (Fisher's exact test, $p>0.5$). There was a tendency for greater tag-return from captive-born seals released as subadults ("bred-1), whereas "rehabilitated-1" seals had the lowest percentage return.

A temporal analysis of tag-returns over time shows that most recoveries were obtained within the first two years after release (Fig. 4). Again, the percentage recoveries are the lowest in rehabilitated seals and the highest for animals born in captivity and released as subadults, indicating higher survival in the former.

The conclusion is that rehabilitated animals and captive-born seals released as juveniles adapted well to their environment, whereas captive born animals released as subadults do not fare as well.

Significance to the Population

The impact of the captive breeding and rehabilitation program on the free-ranging population was evaluated using data from aerial surveys. Calculations of population size indicate that the number of seals in the Wadden Sea would have declined without the contributions from immigration and the release program (Fig. 5). The decrease noted in the mid-1970s would have been more profound, and the recovery during the early 1980s only half of what was observed. Released animals compensated at least in part for the low productivity in this population (Reijnders 1983).

Harbor seals in the Oosterschelde

Harbor seals were historically abundant in the Oosterschelde (S.W. Netherlands). Overhunting, followed by habitat destruction, has reduced the population to the point where only some 15 seals are observed there each year (Reijnders 1985, Reijnders *et al.* 1990). Hunting has been banned since 1962, and the quality of the habitat has improved since the heavily polluted waters of the Rhine River were diverted from the area. Efforts to recolonize the region have begun, particularly since the morbillivirus epizootic of 1988 slowed the immigration of young seals from the Wadden Sea.

Three juveniles and two 5-6 year old seals, rehabilitated for 3 to 5 months and fitted with VHF-radiotransmitters, were released in the spring of 1989. The transmitters were glued to the fur, and were expected to fall off during the moult in June or July of the same year. The seals' activities were recorded by an automatic registration system, manual tracking and direct observations. The animals apparently began to feed after a few days. Within two weeks, diurnal and nocturnal haulout patterns were similar to those of the free-ranging seals. Four of the seals stayed in the area that season, and three were resighted throughout 1990. Two of the tagged animals joined a group of four wild seals and interacted with them normally (Reijnders *et al.* 1990). Their reactions to human disturbances were similar as well, showing that handling in captivity had not diminished their wariness towards humans. The reintroduction attempt was considered successful, and will be continued in an attempt to repopulate the improved habitat of the Oosterschelde.

Monk Seals in Greece

The Mediterranean monk seal is highly endangered (Reijnders *et al.* 1988). A stranding alert and rescue network, established in Greek waters to help avert extinction of the species (Reijnders 1984, Reijnders *et al.* 1986), retrieved two orphaned monk seal pups and brought them to the Seal Rehabilitation and Research Centre (SRRC) in Pieterburen, The Netherlands. After successful rehabilitation over a seven month period ('t Hart and Vedder 1990), the seals were released in "Northern Sporades", a marine park inhabited by monk seals where some protection could be afforded (Reijnders & Ries 1989). VHF-radiotransmitters were glued to the fur on the top of the seals' heads and were expected to fall off during moult in that same year. The movements of the animals were monitored for several months by an automatic recording station and mobile tracking units operated from air, sea and land. The animals remained within 50 km of where they were released. Within a short period, their activity pattern changed from the daytime feeding schedule in captivity to a predominately nocturnal routine.

Their readaptation to the wild can also be judged from data on diving behavior of one of the animals. During the first two weeks after release, almost 90% of its dives were shorter than 120 seconds (s) and no dive exceeded 240 s. After about two months, approximately 50% of the dives exceeded 240 s and only 30% were less than 120 s (Fig.6). The duration of the longest dives also changed significantly. The average of the ten longest dives increased from 207 s after release to 345 s two months later (Student t-test, $p<0.001$). A comparable change was observed in a young, wild harbor seal (E. Ries and P. Paffen, *unpub. data*). The average of the five longest dives of this juvenile increased nearly two fold between 6 weeks and 3 months of age, whereas no difference was found in subadults and adults in the same period of that year. These changes indicate increased underwater exploration and exploitation of the habitat, possibly related to increased diving capacity. Increased dive times might also reflect low prey density.

The results of this first attempt are promising, and an expanded program could play a significant role in attempts to safeguard this species. At present, an emergency rescue and rehabilitation centre has been established on the island of Alonissos (Northern Sporades, Greece), where another monk seal pup was succesfully rehabilitated (Visser 1991).

CONCLUSIONS

We conclude that captive-bred and rehabilitated seals can be successfully reintroduced into their natural environment. Tag-recoveries and radiotelemetry studies demonstrate that survival of the released animals was similar to that of free-ranging seals of the same species. After several weeks in the wild, seals show normal activity patterns and disperse as expected within their habitat. Rehabilitated seals appear to adapt most readily, followed by captive-born animals released as juveniles; seals born in captivity and released as adults appear not to fare as well. Programs designed to breed seals in captivity for subsequent release should deliver the pups to the wild as soon as they are self sufficient.

These conclusions should not be interpreted as advocating captive breeding or rehabilitation programs as the solution to declining wild populations. This approach addresses only a symptom, and not the cause, of threats to the survival of a species, and can divert attention from efforts to determine the nature of the underlying threats. Each case needs to be evaluated separately, with due consideration of the potential risks as well as the benefits to the wild population. Until all the dangers are identified and investigated, a cautious approach to rehabilitation and release programs is recommended. At present, the only possible exception is the highly endangered monk seal, for which many urgent steps must be taken to save it from extinction.

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FIGURE LEGENDS

Fig.1. Distribution of juvenile harbor seals in different areas of the Wadden sea.

Fig.2. Percentage of tag-recoveries of juvenile harbor seals in relation to distance covered.

Fig.3. Percentage tag-recoveries of seals, five years after their release. See text for description of groups.

Fig.4. Percentage tag-recoveries of seals, followed over the first five years after their release.

Fig.5. Counts of harbor seals in the Dutch Wadden Sea based on aerial surveys, and estimated numbers if no immigration and no release had occured.

Fig.6. Diving time distribution of a monk seal during three periods after its release, based on periods lasting 6 to 8 hours.

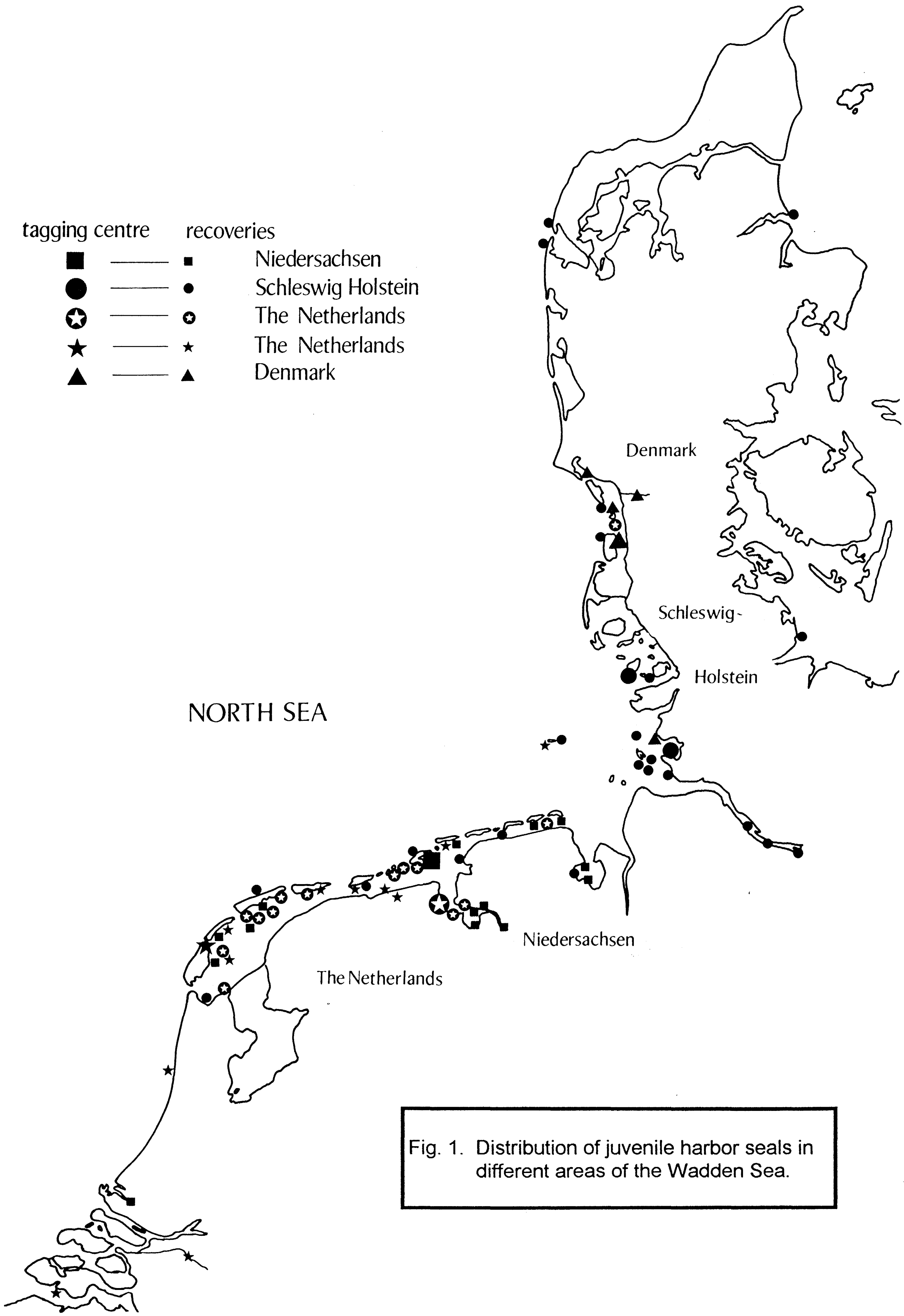

Fig. 1. Distribution of juvenile harbor seals in different areas of the Wadden Sea.

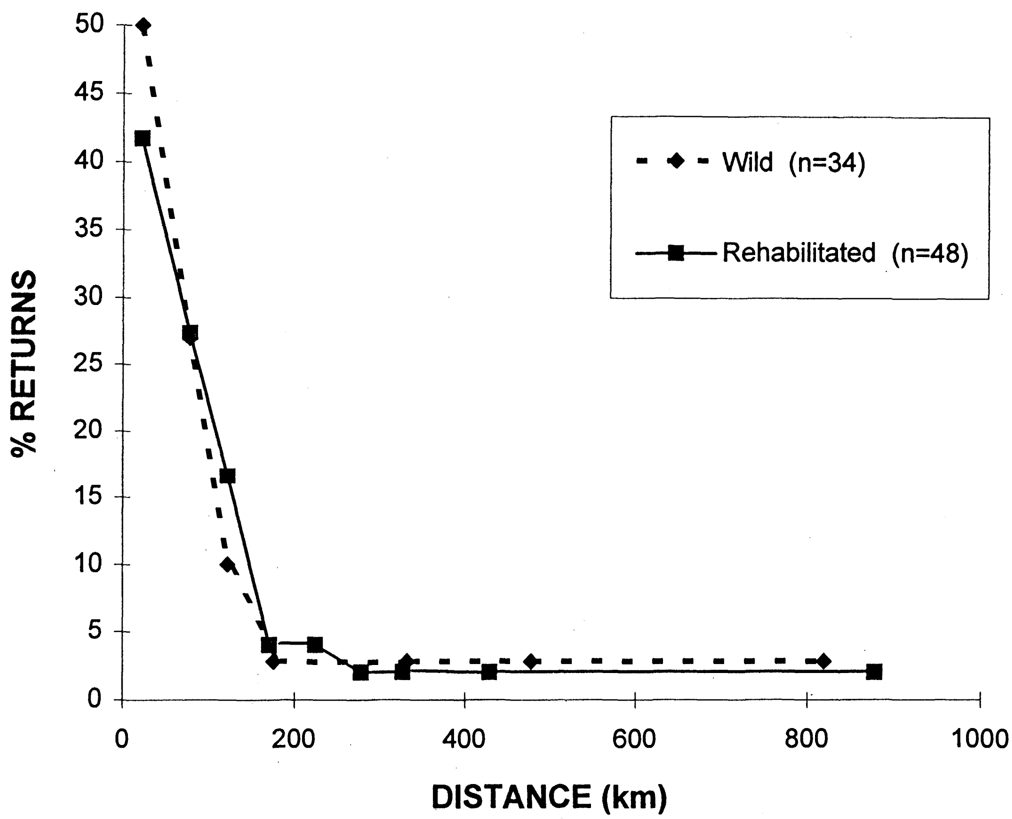

Fig. 2. Percentage of tag-returns from juvenile harbor seals in relation to distance from the release site.

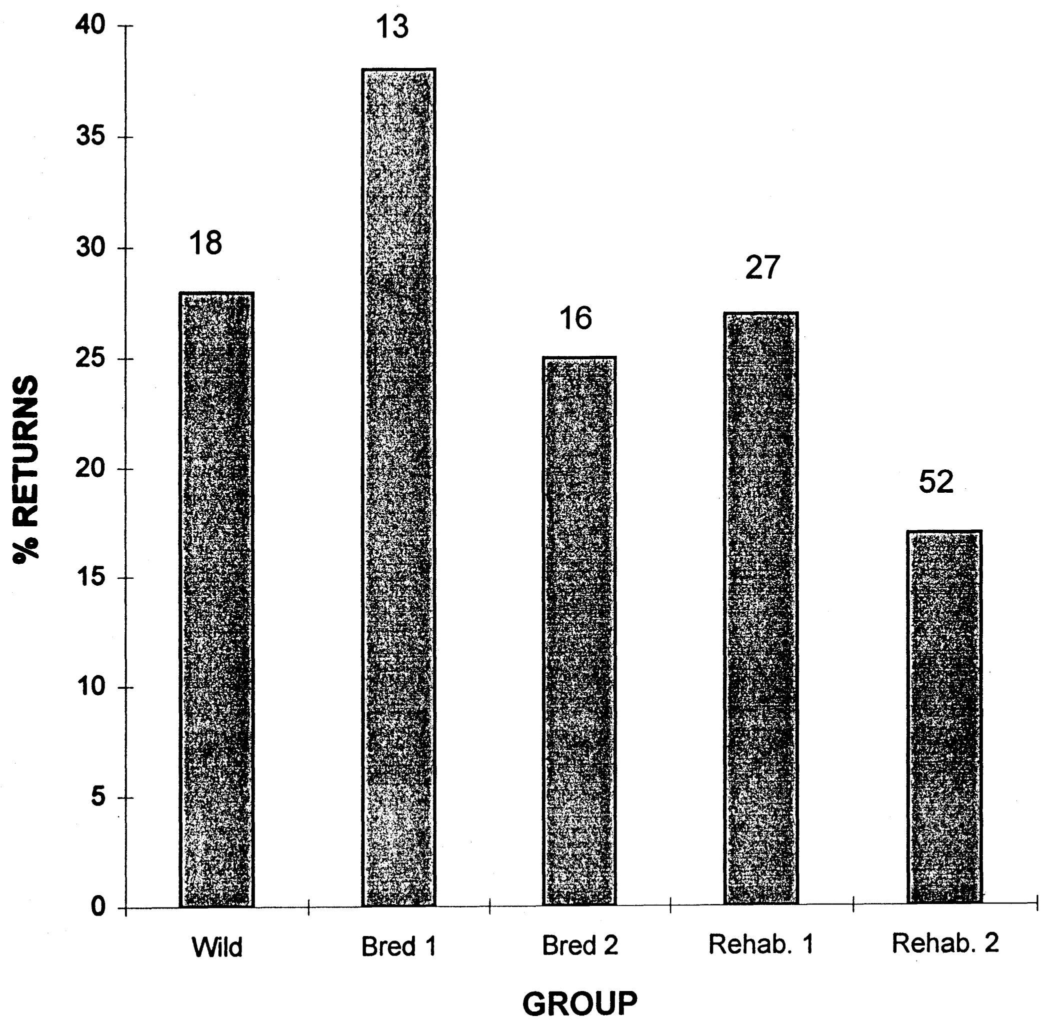

Fig. 3. Percentage of tag-returns for juvenile harbor seals, five years after their release. See text for description of groups.

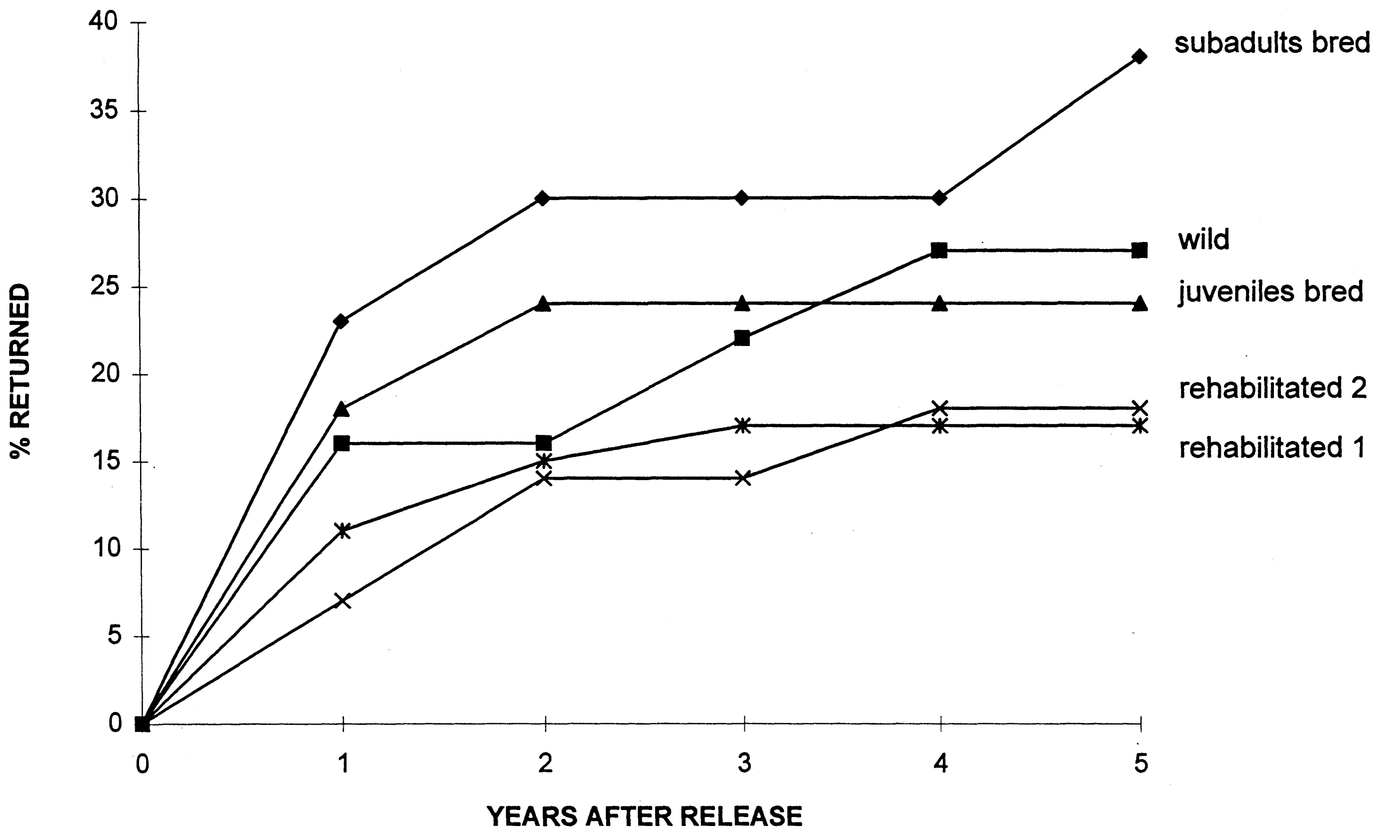

Fig. 4. Percentage tag-returns from seals followed over the first five years after release.

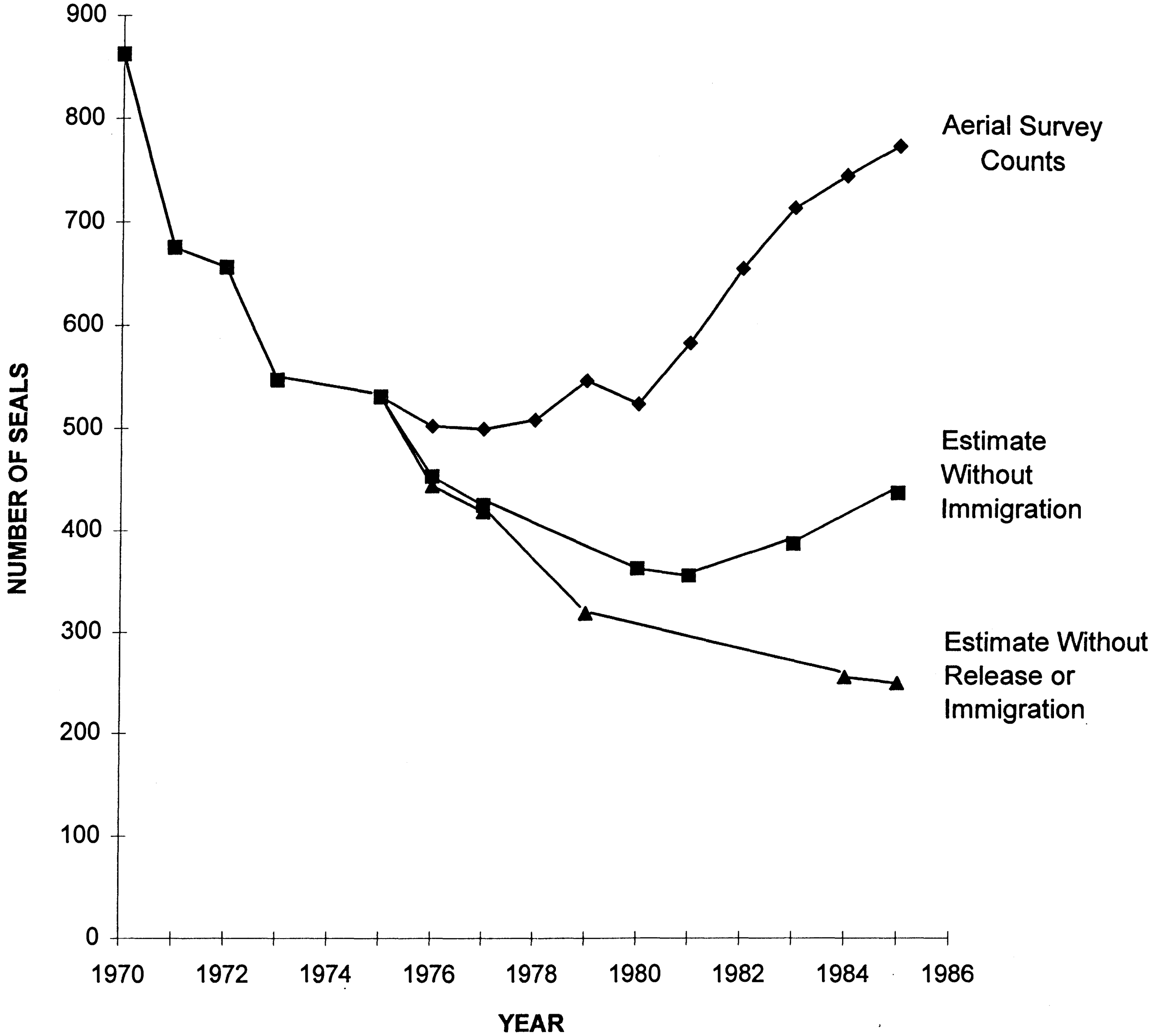

Fig. 5. Counts of harbor seals in the Dutch Wadden Sea based on aerial surveys, and estimated numbers if no immigration and no release had occured.

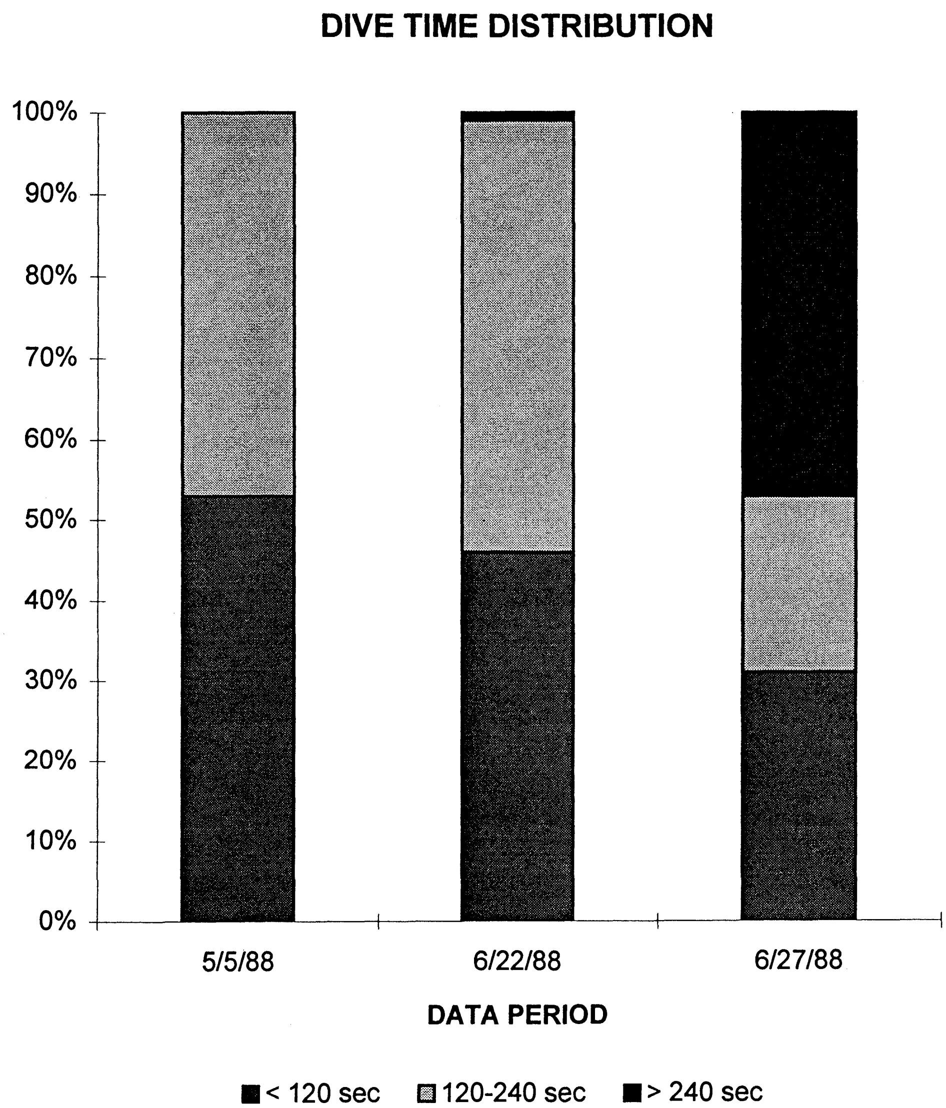

Fig. 6. Distribution of dive times of a monk seal during three 6-8 hour periods after release.