EVALUATION OF REHABILITATION AS AN OPTION FOR STRANDED DOLPHINS, PORPOISES AND WHALES

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Introduction

The background to cetacean strandings management in the UK

A significant welfare problem is generated every year in the United Kingdom, when up to 40 cetaceans – porpoises, dolphins and whales – strand alive around our shores. Historically, many individuals and organisations have responded to stranded cetaceans, often independently and with little advice or help from their peers. Inappropriate action, despite the good intentions driving it, can exacerbate the animal welfare problem generated by these strandings, and prolong the animals' suffering. Determining the appropriate course of action in the emotionally charged atmosphere surrounding a helpless, beached animal in the spotlight of the public and media can place those attending to it under great pressure.

In 1992, a coalition of rescue and welfare groups, the Marine Animal Rescue Coalition (MARC), was established, whose aim was to improve the management of live cetacean strandings. The coalition recognised that there were three options for the disposition of stranded cetaceans: refloatation, that is the release of animals after a variable period of treatment on the beach, rehabilitation, i.e. release after a period of assessment and treatment in captivity, and euthanasia.

The rationale behind the use of refloatation in the management of stranded cetaceans in the U.K. has been based in part on evidence from the post mortem examination of stranded cetaceans in Scotland, England and Wales by the Marine Mammal Strandings Programme of the Department for the Environment, Food and Rural Affairs (DEFRA). This has shown that one half of pelagic species that live stranded and subsequently died and were subjected to post mortem examination in Scotland between 1996 and 1999, and two thirds in England and Wales between 1990 and 1999 had no evidence of significant pathology prior to stranding (Paul Jepson and Tony Patterson, personal communications). The reason why healthy animals strand is not clear, but one explanation is that pelagic species are relatively naive when navigating close inshore, and may strand through navigational error, particularly on encountering confusing topographical features such as gently shelving beaches (Walsh *et al.*, 1990, Geraci and Lounsbury, 1993). Whatever the reason, with prompt action and careful assessment refloatation is potentially an appropriate option for at least some of these pelagic animals. In her review of live strandings of cetaceans, Mayer (1996) reported that, between 1992 and 1995, 18 of 21 refloatations with single stranded animals and all 18 animals refloated in mass strandings were apparently successful.

Rehabilitation to date has not proved to be a viable option in the U.K.. Unlike countries such as the United States and the Netherlands, presently there are no facilities specifically set up for the rehabilitation of cetaceans in this country. Furthermore, without getting into the ethical debate surrounding the keeping of cetaceans in a captive environment, one consequence of the demise of the dolphinarium industry in this country has been that few pools capable of suitably accommodating a stranded cetacean, even for a few weeks, are readily available. The requirements of such a facility were summarised by Mayer (1996):

a minimum 9 metre diameter pool with padded sides,
support systems for animals in the water,
fully treated salt water supply,
controlled environment,
isolation from the public,
handling facilities,
24 hour observation facilities,
experienced and qualified carers.

Rehabilitation has been attempted in the UK in the past, but in what were generally considered to be sub optimal facilities. Success rates have been poor, for example, only 3 out of 17 animals were released following attempted rehabilitation between 1992 and 1995 (Mayer, 1996).

As a result of Mayer's review, the coalition elected to concentrate strandings management on a two-option approach, namely refloatation and euthanasia. Since the time of the review, several apparently successful refloatation attempts have taken place. No cetaceans have been successfully rehabilitated, and very few rehabilitation attempts have actually been made. This is highlighted by the options taken by one rescue group in the U.K., British Divers Marine Life Rescue. Between 1995 and 2001, the group has only been involved in one rehabilitation attempt, a harbour porpoise that died. Of 34 live strandings attended by the group, 15 animals were refloated, with 12 apparent successes, including two harbour porpoises (Barnett *et al.*, 2001).

The debate over the use of refloatation with stranded cetaceans

Outside of the United Kingdom, many cetacean experts argue against the use of refloatation as an option for the management of stranded cetaceans. It is known that clinical assessment of a stranded cetacean on the beach is not always optimal, with prognosis based on clinical signs rather than the diagnosis of specific conditions. Assessment and prognosis determination is complicated further by the insidious onset of shock, organ failure and muscle damage following stranding, with the pooling of blood in the thoracic and abdominal viscera and subsequent ischaemia and metabolic acidosis (Geraci and Lounsbury, 1993, Needham, 1993). In the United States, a capture myopathy like syndrome causing cardiac and skeletal muscle damage also has been observed in many stranded cetaceans, probably following the release of catecholamines (Turnbull and Cowan, 1998). These life-threatening sequelae will occur in stranded cetaceans regardless of their condition at the time of stranding. Outwardly, affected animals may appear healthy and blood sampling is required to reveal many of the deleterious changes in the animal's physiological state. Furthermore, these changes will worsen the longer the animal remains out of the water.

It is highly likely therefore, particularly where response is not immediate, that animals that appear superficially 'healthy' are being refloated inappropriately, as they are no longer viable. This has been illustrated already by the post mortem examination of a number of animals refloated that subsequently restranded. A far larger number of animals have not been observed to restrand. Here, a successful outcome is often assumed, but in reality this assumption is very difficult to justify as no animals were monitored effectively post release. This was highlighted at a meeting of veterinary surgeons involved in MARC in December 1999, and it concluded that a program of improved post release monitoring needed to be developed. Of the techniques available, satellite telemetry is the only one that will provide information on survival for a period of 60 days, generally accepted as the time needed to give a reasonable assessment of the animal's likely survival after release (Greg Early, personal communication).

Satellite tagging stranded cetaceans is not without its issues, both ethical and logistical. The technique requires the tag to be bolted on to the dorsal fin and the potentially deleterious effects of satellite tags on the hydrodynamics of tagged marine animals have been illustrated, for example in penguins (Culik *et al.*, 1994). However, with tags becoming smaller and lighter and casings more hydrodynamic, drag effects and energy costs associated with dorsal fin mounted satellite tags have been reduced considerably. Funding remains an obstacle, with around £40,000 required to deploy ten satellite tags in the UK and finding sponsors and grants is proving difficult. There are also considerable practical problems that have to be overcome, associated with deploying tags on suitable candidates without delaying refloatation in a country where many strandings occur on remote coasts. However, it is hoped that a satellite tracking programme can be launched before the end of 2004 and the results of this may influence the way stranded cetaceans are managed in the U.K. in the future.

Further evaluation of rehabilitation as an option for stranded cetaceans in the UK

Some argue that a long period of intensive care is the only chance stranded cetaceans have of survival (Geraci and Lounsbury, 1993). The number of animals rehabilitated and released has been quite small, for example in the United States only 65 cetaceans were released between 1972 and 1995 (Wilkinson and Worthy, 1999), and there is little published information on survival rates with rehabilitation, apart from a small number of individual strandings events, e.g. Walsh (1990). However, St Aubin *et al.* (1996) argue that advances in cetacean husbandry and medicine in recent years may have improved the chances of survival for rehabilitated and released animals. They also point out that cetacean rehabilitation is longer, more labour intensive and more costly than for other marine mammals.

A further conclusion of the meeting of MARC veterinary surgeons in 1999 was that, in parallel to setting up a programme of post release monitoring, the option of cetacean rehabilitation should be further evaluated. With this in mind, I applied for and was fortunate enough to win a travel fellowship with the Winston Churchill Memorial Trust.

Aim of the Fellowship

The aim of my fellowship was to determine the potential value of rehabilitation in the management of stranded cetaceans in the U.K., and whether a non-profit orientated rehabilitation facility could be justified in this country. I chose to visit the United States, a country where rehabilitation is considered an essential option in the management of stranded cetaceans. I visited rehabilitation facilities and reviewed with veterinary surgeons and rehabilitation staff the motivation, ethics, standards and justification of cetacean rehabilitation. The tour of facilities was carried over 4 weeks in October/November 2002.

Cetacean rehabilitation facilities visited in the United States

All facilities visited were licensed ‘letter holders’, i.e. facilities holding a Letter of Authority from the National Marine Fisheries Service (NMFS), which permits them to rescue and rehabilitate marine mammals, including cetaceans, within a given area, under the auspices of the Marine Mammal Protection Act (1972). The facilities visited, in chronological order, were:

Harbor Branch Oceanographic Institution

Located in Fort Pierce, on the Atlantic coast of Florida, this facility has been rehabilitating live stranded cetaceans for 4 years and attends between 6 and 15 1ive strandings a year over approximately 180 miles of coastline. Apart from a small facility in north Miami (the Marine Animal Rescue Society), the facility takes cetaceans for rehabilitation from the whole of the east coast of Florida. If the facility is full, animals are transported to the gulf coast facilities of Mote Marine Laboratory and Clearwater Marine Aquarium.

The cetacean rehabilitation facility at Harbour Branch consists presently of two pools. Incoming animals are initially held in a 24 feet (7.2 metre) diameter, 4 feet (1.2 metre) deep round holding pool, with flexible sides of rubber coated nylon supported on a steel frame. Under the base of the pool, a layer of polystyrene sits on a flat, concrete floor. Although kept permanently erected, the pool is designed for rapid erection in a matter of hours, being mass produced as a domestic swimming pool, and is useful for not only for the initial stages of support in the water and free swimming of smaller species, but also to allow bigger animals to support themselves with their flukes resting on the bottom, the polystyrene lined floor providing some cushioning. These pools cost $2,500 - $3,000 and are easy to maintain and assemble. This pool is contained in a strong canvas frame tent.

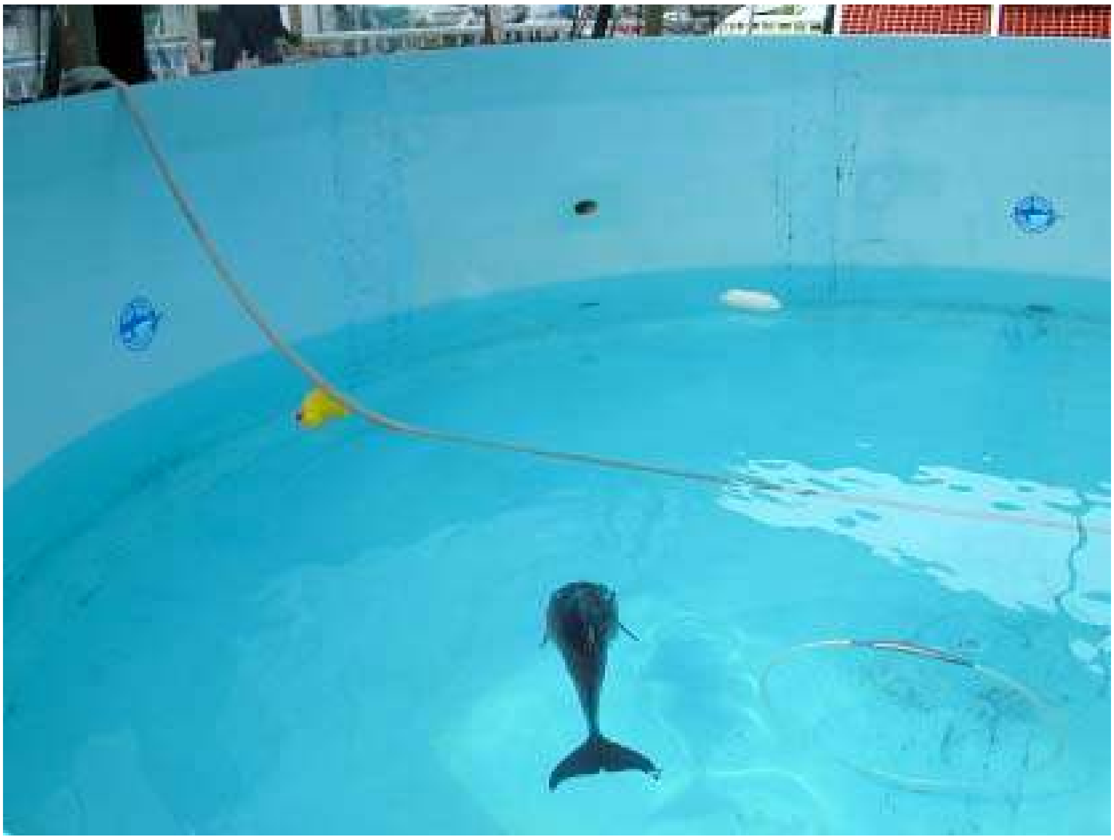
Initial holding pool at Harbor Branch housed in a tent

Rehabilitation of viable animals is continued in an outdoor 60 feet (18 metre) diameter, 4.5 feet (1.35 metre) deep, 100,000 US gallon (380,000 litre), round, concrete lined pool.   This is actually a swimming pool, which can be switched to a saltwater regime. It is outdoors, but housed under a mosquito net supported on a large dome shaped frame.

Staff interviewed:
Robin Friday (Manager of Animal Care, Marine Mammal Research and Conservation Center)
Mark Trimm (Animal Care Supervisor, Marine Mammal Research and Conservation Center)
Dr Gregory Bossart (Director of Marine Mammal Research and Conservation, veterinarian)
Dr Rene Varela (post doctoral fellow, Division of Marine Mammal Research and Conservation, veterinarian)

Mote Marine Laboratory

Located in Sarasota, on the Gulf coast of Florida, this facility has been rehabilitating live stranded cetaceans for 13 years and attends between 10 and 12 1ive strandings a year over approximately 150 miles of coastline. The facility will take animals from all over Florida, and also from Georgia and the Carolinas, the next large facility north of Florida being the National Aquarium in Baltimore. Mote is recognised by the National Marine Fisheries Service (NMFS) as being the experts in Kogia (pigmy and dwarf sperm whale) rehabilitation in the United States. Mote uses Clearwater Marine Aquarium as its overspill if they are full and has a close working relationship with that facility.



Rehabilitation pool held at lower level at Mote, with dwarf sperm whale calf

The cetacean rehabilitation facility consists of three pools. The majority of the rehabilitation process is carried out in one of two outdoor round fibreglass tanks, bought 'off the shelf' from Texas and shipped to Mote in pieces, where they were assembled. Both are 30 feet (9 metres) in diameter. Pool depth can be varied according to whether the animal is free swimming or not. Depth is maintained at 4 feet (1.2 metres) when supporting or catching the animal up regularly. When animals are free swimming and not being regularly handled, the depth is increased to 8 to 9 feet (2.4 to 2.7 metres). Animals are moved into a larger, outdoor rectangular 'lagoon' pool as their health improves (120 feet (36 metres) x 50 feet (15 metres) x 10 feet (3 metres) deep).

Staff interviewed:
Dr Charles Manire (Animal Care Manager and Staff Veterinarian)
Dr Randall Wells (Program Manager, Marine Mammal Program)

Clearwater Marine Aquarium

Located in Clearwater, on the Gulf coast of Florida, this facility has been rehabilitating live stranded cetaceans for 23 years and attends between 0 and 5 1ive strandings a year over approximately 250 miles of coastline. The facility will take animals from the entire state of

Empty rehabilitation pool at Clearwater from observation platform

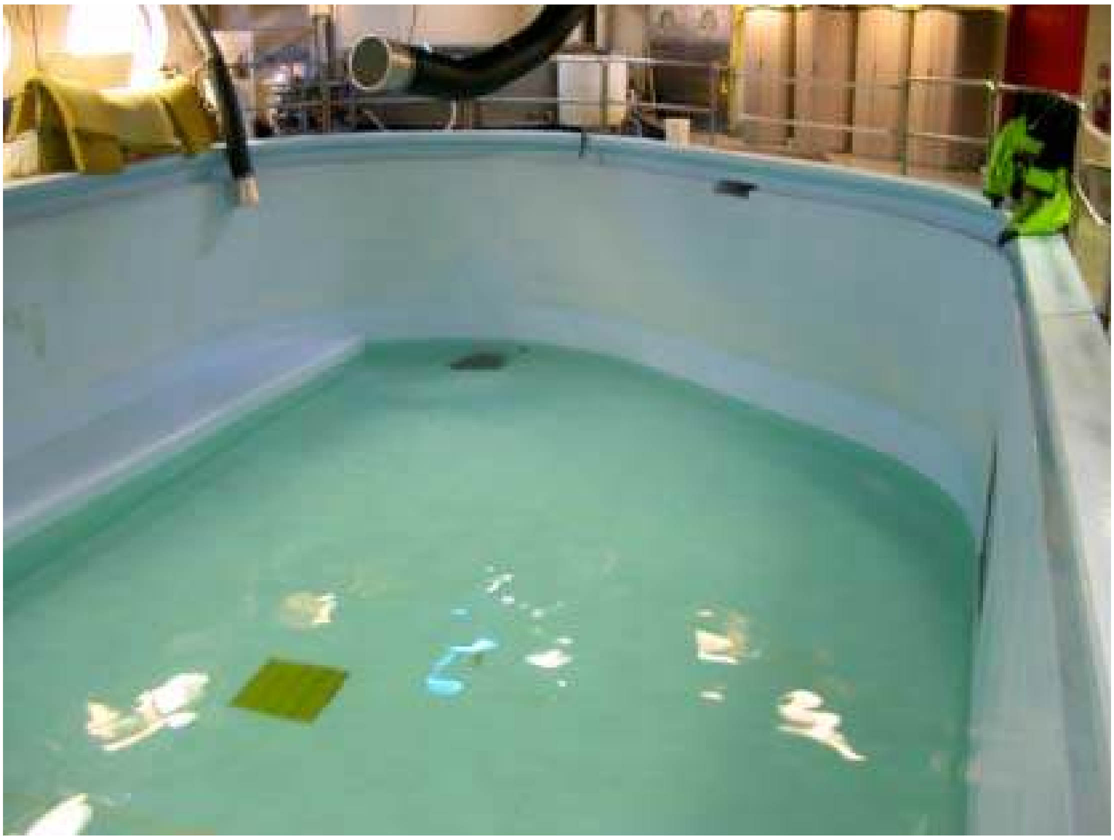
Florida, including the Florida Panhandle (which are initially stabilised by Gulf World) and also from Mote Marine Laboratory and Harbor Branch Oceanographic Institution. Clearwater also sends animals to these facilities if it is full. Clearwater is frequently asked by NMFS to take animals from outside the state, although only one animal to date, a striped dolphin from Virginia, has survived long enough for arrangements to be made and was strong enough to tolerate the transport.

The cetacean rehabilitation facility consists of an outdoor 40 feet (12 metres) diameter round pool, part of an old sewage treatment plant, which can be filled to a depth of 16 feet (4.8 metres) when animals are free swimming, giving a volume of 150,000 US gallons (570,000 litres). The pool is held at 4 feet (1.2 metres) when animals are being supported. An outdoor 20 feet (6 metres) diameter round flexible pool, of the same design as Harbor Branch, also can be used as a holding pool for initial stabilisation.

Staff interviewed:
Dr Robin Moore (Veterinarian),
Kaz Perryman (Volunteer Trainer)

National Aquarium in Baltimore

Located in Baltimore, Maryland, this facility has been rehabilitating live stranded cetaceans for 12 years and attends between 2 and 3 1ive strandings a year over approximately 1400 miles of coastline. The facility will take animals from as far away as Maine and Massachusetts, but no longer takes harbour porpoises now that New England Aquarium has harbour porpoise rehabilitation facilities. If the facility is full, e.g. with turtles, then cetaceans are moved to New England Aquarium, the Marine Mammal Stranding Center in New Jersey, or the River Head Foundation in New York. Some of these facilities, however, are set up for short-term care only. The aquarium also responds to 'out of habitat' animals in Chesapeake Bay.



Indoor rehabilitation pool at Baltimore, with ledge for beaching

The cetacean rehabilitation facility consists of a rectangular indoor pool, 60 feet (18 metres) x 33 feet (10 metres) in size with rounded corners, which is held at a lower depth of 4 feet (1.2 metres) when supporting animals, but can be filled to a depth of approximately 13 feet (4 metres), when animals are free swimming and limited handling is occurring. The pool has a volume of approximately100,000 US gallons (380,000 litres), is concrete lined and painted with rubberised paint.

Staff interviewed:
David Schofield (Manager of Ocean Health Programs)
Cindi Perry (Marine Animal Rescue Program)
Dr Ian Walker (Associate Veterinarian)
Dr Brent Whittaker (Director of Animal Health, veterinarian)

Mystic Aquarium

Located in Mystic, Connecticut, this facility has been rehabilitating live stranded cetaceans for 26 years and attends between 0 and 4 1ive strandings a year over approximately 600 miles of coastline. The facility will take cetaceans from outside their area of cover, as it has the largest pools in the North East Strandings Network and is the most extensive facility on the Atlantic coast north of Florida. Animals have been taken from Maine to New Jersey (and even Texas).

Rehabilitation pool with underwater viewing at Mystic

The cetacean rehabilitation facility consists of two outdoor 40 feet (12 metres) diameter round fibreglass pools, held at 4 feet (1.2 metres) when supporting animals in the water and 10 feet (3 metres) when animals are free swimming. The pools hold 96,000 US gallons (360,000 litres) each. They are connected by a 15 feet (4.5 metres) diameter, 6 feet (1.8 metres) deep examination pool by two sliding doors. The small pool can be held at half depth, but is rarely used, as it was found to be impractical.

Staff interviewed:
Dr Lawrence Dunn (Staff Veterinarian),
Heather Medic (Stranding Coordinator)
Dr Allison Tuttle (Veterinary Intern)

Sea World of California

Located in San Diego, California, this facility has been rehabilitating live stranded cetaceans for 37 years and attends between 0 and 5 1ive strandings a year over approximately 280 miles of coastline. The facility is the only large, long-term facility on the west coast of the United States, so other facilities essentially act as satellite facilities for Sea World, particularly for larger species. Some of these can carry out short term stabilisation of dolphins before they are sent to Sea World. The facility also may be asked to take for long term rehabilitation, any cetacean that is too large for The Marine Mammal Center.

Main rehabilitation pool with hoist and initial holding pool at Sea World

The cetacean rehabilitation facility consists of an outdoor 30 feet (9 metres) diameter fibreglass, round pool, held at a depth of approximately 3.5 feet (1.05 metres) when supporting animals and at approximately 8 feet (2.4 metres) when animals are free swimming. This pool is used for long-term rehabilitation and is constructed from fibreglass sections glued together, with sand under the floor. A 20 feet (6 metres) diameter, 3.5 feet (1.05 metres) deep, Harbor Branch style, small flexible pool on a sandy base is also available for initial holding of pelagic dolphins, which were found to fare better in pools with flexible sides as they often bounced off the sides on first arriving. Pools up to 6.5 million litres have been made available at Sea World when the park's dedicated stranding pools are not large enough for long term care of some over sized cetaceans.

Staff interviewed:
Dr Jim McBain (Senior Veterinarian)

The Marine Mammal Center

Located in Sausalito, California, this facility has been responding to live cetacean strandings for 27 years, rehabilitating live stranded cetaceans for 2 years and attends on average 3 live strandings a year (range: 0 to 13), over approximately 600 miles of coastline. The facility will take animals from as far north as Oregon, but is only able to rehabilitate smaller animals, e.g. porpoises and possibly small dolphins. Larger animals are passed on to Sea World in San Diego, Marine World Africa USA and Long Marine Lab, Santa Cruz, and even those rehabilitated at the Center will be sent to one of these facilities for the final stages of rehabilitation.

Plumbing for filtration behind the rehabilitation pool at the Marine Mammal Center

The cetacean rehabilitation facility consists of a 24 feet (7.2 metres) diameter, 4 feet (1.2 metres) deep, soft sided, Harbor Branch style round pool, which is housed inside a rented tent when a stranded cetacean is brought in.

Staff interviewed:
Dr Frances Gulland (Director of Veterinary Services, veterinarian)
Dr Martin Haulena (Staff Veterinarian)

In addition, I had the opportunity to discuss in detail and view images of one offsite facility without visiting it:

New England Aquarium

Located in Boston, Massachusetts (rehabilitation facility in Duxbury, Massachusetts), this facility has been rehabilitating live stranded cetaceans for 34 years and attends between 5 and 10 1ive strandings a year (some of over 100 animals, if in a year with mass strandings) over approximately 2500 miles of coastline. In the last few years, a lot of the burden for the large area of coverage has been taken up by other groups operating within New England's region that have been granted their own Letters of Authority by NMFS, e.g. the Cape Cod Strandings Network. Therefore, the actual region New England are exclusively responsible for now is considerably less than 2500 miles, although they are still authorized to respond throughout this 2500 mile region. Thus, New England frequently interacts with other response organisations in their region, some of which began as their 'sub letter holders'.

Corralling a porpoise in the main rehabilitation pool at New England (photograph courtesy of Jim Rice)

The cetacean rehabilitation facility used to consist of an outdoor pool by the aquarium in Boston, which was capable of taking pilot whales, but this no longer exists. A facility was built at Duxbury, 45 minutes outside Boston in 1999 and this consists of two round fibreglass pools. The critical care holding pool, for initial examination and stabilisation, is 10 feet (3 metres) in diameter by 4 feet (1.2 metres) deep and housed in one of two buildings on the site (this pool is rarely used since the larger pool was fitted out with skimmers at 4 feet (1.2 metres) depth). The main pool is 30 feet (9 metres) in diameter by 8 feet (2.4 metres) deep and is housed in a tent.

Staff interviewed:
Dr Scott Weber (Head Veterinarian)
Jim Rice (Senior Technician / Biologist)

Species seen and nature of strandings encountered

Species seen

The species attended at strandings by these facilities are listed in Table 1. Those facilities with the species complement closest to that seen in the UK are on the north east of the Atlantic seaboard of the United States, i.e. Mystic and New England, followed by the Marine Mammal Center and Baltimore. The bottlenose dolphin was encountered by all facilities visited. The following propensities for particular species could be determined:

Harbor Branch:	bottlenose dolphins and pigmy sperm whales
Mote:	bottlenose dolphins and pigmy sperm whales
Clearwater:	bottlenose dolphins
Baltimore:	bottlenose dolphins and harbour porpoises
Mystic:	Atlantic white-sided dolphins, harbour porpoises and long-finned pilot whales
New England:	Atlantic white-sided dolphins, and long-finned pilot whales
Sea World:	common dolphins
Marine Mammal Center:	harbour porpoises and common dolphins

Seasonal variation in the incidence of strandings

Some seasonal variation was seen by some facilities.

In Harbor Branch, there appears to be an increase in strandings in the winter and, on a smaller time scale, after rough storms in late summer. The latter is also seen by Clearwater in the Gulf of Mexico.

Baltimore observes a peak in harbour porpoise strandings and entanglements from February to April, and a peak for dolphin strandings from May to October. At Mystic, late summer and autumn are relatively quiet and a peak in harbour porpoise strandings occurs in the spring, as yearlings. This is also seen at New England, plus white-sided dolphins in winter and spring and pilot whales in winter and summer.

Sea World sees grey whale strandings in December and January at calving time. The Marine Mammal Center sees the same species in December and January as they migrate south and again in April and May as they return.

Incidence of mass strandings

Mote has attended mass strandings of rough toothed dolphins and Fraser's dolphins and Clearwater of pantropical spotted dolphins and clymene dolphins. New England has attended mass strandings on Cape Cod, primarily of Atlantic white-sided dolphins and long-finned pilot whales, and also of common dolphins and Risso's dolphins. Mystic and Baltimore do not tend to see mass strandings in their area of coverage, but both have helped with mass strandings response on Cape Cod. The other facilities have not attended mass strandings.

Table 1 - Species attended at strandings by facilities

	Harbor Branch	Mote	Clearwater	Baltimore	Mystic	Sea World	Marine Mammal Center	New England
Harbour porpoise	✓			✓	✓		✓	✓
Bottlenose dolphin	✓	✓	✓	✓	✓	✓	✓	✓
Common dolphin		✓		✓	✓	✓	✓	✓
Striped dolphin				✓	✓		✓	✓
Atlantic white-sided dolphin					✓			✓
White-beaked dolphin					✓			✓
Risso's dolphin	✓					✓	✓	✓
pilot whale species	✓			✓	✓	✓	✓	✓
Orca							✓	✓
Sperm whale	✓		✓			✓	✓	✓
beaked whale species		✓	✓	✓			✓	✓
Minke whale	✓			✓		✓	✓	✓
Humpback whale				✓			✓	
Fin whale					✓			✓
Sei whale				✓				
Blue whale							✓	✓
Rough toothed dolphin		✓	✓	✓			✓	
other Stenella species		✓	✓		✓			✓
Pacific white-sided dolphin						✓	✓	
Northern right whale dolphin						✓	✓	
Fraser's dolphin		✓						
Dall's porpoise						✓	✓	
Pigmy sperm whale	✓	✓	✓	✓	✓	✓	✓	✓

Table 1 (continued) - Species attended at strandings by facilities

	Harbor Branch	Mote	Clearwater	Baltimore	Mystic	Sea World	Marine Mammal Center	New England
Dwarf sperm whale	✓	✓	✓		✓			✓
Pigmy killer whale		✓						
False killer whale	✓							✓
Beluga whale								✓
Bryde's whale	✓							
Right whale	✓			✓				✓
Grey whale						✓	✓	

Options taken with stranded cetaceans

Refloatation

With relatively few exceptions, the use of refloatation, i.e. beach release, is only considered during mass strandings (see 'Criteria used to assess options taken'). The reason for the limited use of refloatation is the evidence from post mortem examination of animals in the United States that very few animals stranding singly strand in healthy condition. As Lawrence Dunn put it, single stranded animals very rarely are suitable for refloatation as they are very young, old or sick.

One exception appears to be on the Pacific coast, where Jim McBain does consider that refloatation occasionally may be an option with single stranded animals caught in the rough Pacific surf, and which have then lain on wet sand in a cool environment and are free from hyperthermia and sunburn. Furthermore, in this part of the United States, the southwest regional office of NMFS rules that an attempt has to be made to allow an animal to swim back out to sea if it will. This is usually carried out in a controlled manner to determine if the animal has normal righting ability and can swim in a straight line. If not, the animal is retrieved and transported to a rehabilitation centre.

New England and Mystic have refloated some single stranded animals in the north east (see 'Criteria used to assess options taken'), as occasionally dolphins have come ashore in good health and may be suitable for refloatation if only beached for a short time. Particularly on Cape Cod, the geography of the peninsula appears to trap animals in the shallow waters close to shore.

It is widely recognised, however, that even those animals that do strand in healthy condition in mass or single strandings will suffer from irreversible complications associated with being on the beach, which often preclude the use of refloatation. These include muscle damage, scoliosis, and organ failure including liver damage and the problems are compounded in larger, heavier animals. Pneumonia also may develop, if water enters the blowhole.

In the opinion of Jim Rice, refloatation, even on Cape Cod, is a rather unattractive option, not only for the reasons described above, but also due to difficulties in releasing these often pelagic animals into deep water, where they may have a chance of finding conspecifics quickly. New England's experience is that many of these animals will restrand within a few days of being refloated.

Charlie Manire pointed out that almost none of the groups advocating refloating animals from the beach have ever tracked released animals to show whether they survive or not. He is of the opinion that if these animals are tracked, they will be found to restrand in other areas or die in the open ocean, where their bodies can never be recovered.

Rehabilitation

This option is used regularly in the facilities visited. Apart from the belief that rehabilitation is the only option giving most single stranded animals, at least, any chance of survival, other justifications for its use included the enormous amount of information that can be gained from rehabilitated animals versus refloated animals, and the good publicity generated for the facility. The option is not restricted to single strandings; animals also may be brought in for rehabilitation from mass strandings at some facilities.

Charlie Manire expressed his belief in rehabilitation succinctly: since cetacean medicine is still in its infancy, the attempted rehabilitation of each stranding is a chance to learn everything they can, as long as the animal is not suffering for it. Even if they can only keep an animal alive for a day or two, they may be able to learn something that will help keep the next animal alive for a few more days, which might eventually help them to save one that would otherwise have been lost. He illustrated this with the example of pigmy sperm whales that frequently strand in the south eastern United States. Mote has taken in about 8 of these animals in the last 4 years. The first 7 died, the early ones in hours or a few days, and the later ones in 40-75 days. The eighth one died after 17-18 months. They have learned enough from the last that they think they can probably save a number of the next ones that are seen. Jim McBain also believes that significant learning opportunities are lost when rehabilitation is not an option and that the "significant impact that we humans are having on the oceans carries a moral obligation to examine, care for and learn from those individuals that may have suffered at our hands."

Greg Bossart, a veterinarian with many years' experience in the pathological investigation of stranded cetaceans, questioned the value of rehabilitation as an option. He stated that most (95%+) single stranded cetaceans in the United States are terminally ill and, in his view, the ability to rehabilitate them is not going to improve, as they have conditions that cannot be treated. In summary, welfare, health and financial costs have to be considered when trying to rehabilitate stranded animals. The exception, in his view, is the rehabilitation of neonates, as an enormous amount of information can be gained on nutrition.

Euthanasia

Euthanasia is obviously an option that is employed with stranded cetaceans in the United States. Charlie Manire summed up the view held by most facilities by saying that animals that are obviously in distress with no hope of being saved, or are too big to transport are euthanased.

There was, however, a difference of opinion expressed on whether to defer the decision to euthanase until after transport. Half the facilities would defer as the likely reaction of the public and also, in some cases, the media would preclude euthanasia on the beach. As Jim McBain explained, "Southern Californians are probably less rational about this sort of thing than the average resident of Britain. They could probably benefit from a little more reality but Hollywood continually fights us on this". He went on to say that Sea World tends to euthanase few cetaceans anyway, as they have the experience, ability and equipment to save many of those that do strand.

Facilities not deferring euthanasia either had not found the public to be a problem, as long as they were consulted first, or were unconcerned about public reaction, and all wished to avoid unnecessary suffering in transport. Even in these facilities, animals occasionally were transported that would otherwise have been euthanased on the beach, usually when facility vets did not attend the stranding in person. Occasionally, as Jim Rice pointed out, some animals may appear suitable candidates for rehabilitation before transport, but poor response during transport to the facility results in euthanasia then becoming the best option after transport has been initiated.

Criteria used to assess options taken

Clinical condition, including nutritive state

The importance of fully evaluating animals prior to decision-making was stressed by all vets. Key components are a full physical examination including rectal temperature, and blood sampling for basic haematology and biochemistry parameters. No facility worked to a set written triage, although a number of facilities had written guidelines for their volunteers attending strandings.

Clinical conditions leading to euthanasia on the beach include:

- signs of chronic ill health, including respiratory distress, bad breath, sunken eyes and pale mucous membranes.
- serious shark attack and other serious trauma, e.g. spinal fractures, wounds penetrating the thorax or abdomen, mandibular and maxillary fractures
- rectal temperature of 42^{o}C and above - animals with temperatures under 42^{o}C are assessed for response to cooling - air temperature and amount of time on the beach are major factors affecting viability
- blistering and sloughing of a major proportion of the skin
- loss of reflexes, unresponsiveness
- blindness

Other animals generally are taken in for rehabilitation. As indicated under the section 'Options with stranded cetaceans', the exception is when an animal strands clearly through navigational error in California or Cape Cod, is in good clinical condition on assessment and responds well to refloatation.

More than half the facilities visited carry out blood analyses on the beach, using portable analysers for basic haematology and biochemistry profiles and, in some cases, blood gases, or using nearby local practice laboratory facilities. As dry chemistry techniques are used, only major abnormalities in muscle enzymes, packed cell volume and other parameters will influence the option taken. Thermistor probes also should be available for assessing rectal temperatures on the beach. Cardiomyopathy in Kogia species (pigmy and dwarf sperm whales) is associated with a poor prognosis, and would lead to euthanasia but, as Charlie Manire pointed out, it is unlikely that this will be detected on the beach, as an echocardiogram is generally needed.

In some facilities, if an animal's condition meant it was likely to become a permanent captive, this would influence the decision taken on the beach, as placing such animals can be difficult.

Species – pelagic vs. coastal

In most facilities, this doesn't influence the decision to take an animal in for rehabilitation. Harbor Branch will not attempt the rehabilitation of pelagic species themselves, with the exception of offshore bottlenose dolphins. Some opinion was expressed that pelagic species are rather worse at adapting to captive conditions.

Jim Rice elaborated further on the refloatation of pelagic and coastal species on Cape Cod, where this has been attempted on a number of occasions. As elsewhere, New England has found that single stranded pelagic animals often have chronic health problems that make them unsuitable refloatation candidates. However, some animals may strand relatively healthy, including sub-adult males apparently displaced prior to stranding. The beach release of these animals and also pelagic animals involved in mass strandings is complicated by the need to give them access to open and deep water, to minimise the probability of re-stranding. On Cape Cod, this frequently requires over-land transport. Furthermore, suitable habitat for most pelagic species is far offshore (several tens of miles), and the logistics of getting animals out there safely in a short time and finding a group of conspecifics to release the animal(s) into are rather unrealistic. A number of pelagic animals have been released from the shore on Cape Cod, generally with poor results, animals restranding dead within a few days. The reason why these animals are restranding is unclear, i.e. whether it is due to stranding-related health complications, pre-existing conditions, or from a failure for the animal to find its way back to its normal habitat.

Coastal species, such as harbour porpoises, also may single strand apparently through navigational error on Cape Cod, e.g. getting caught in marshes at low tide, and may be found in good physical shape. Here, refloatation is considered more likely to succeed, as the animals are released into their proper habitat, where they are better equipped to navigate, find food and meet with conspecifics.

Species size

Sea World is the only facility not limited by the size of the animal under consideration for rehabilitation, as larger display pools will be freed up for larger animals. A juvenile grey whale, JJ, rehabilitated at Sea World in 1997, was the largest whale in captivity when she was released, weighing 9000 kg and measuring 9.5 metres in length.

Other facilities do have size limits. Mote and Clearwater do not tend to take animals over 4.5-5 metres (Mote once took a Gervais beaked whale of 5 metres). Harbor Branch, Baltimore and Mystic have an upper limit of approximately 3.5 metres, taking animals as large as adult offshore bottlenose dolphins, the latter two also taking juvenile pilot whales of up to this size (Mystic would be willing to take up to three at once). The Marine Mammal Center and New England will take animals up to 2.5 metres, but those near this limit would only be held for stabilisation before being moved on to another facility. New England will only take harbour porpoises the whole way through rehabilitation and the Marine Mammal Center will move even these on for the final stages of rehabilitation.

If too large an animal is placed in a facility it tends to have problems navigating the pool. Generally, if an animal exceeds the capacity of a facility, the decision as to what to do with it is left to NMFS and often such animals have to be euthanased.

In mass strandings (see below), larger animals such as pilot whales are often less suitable for refloatation than smaller animals, as their size and weight exacerbates stranding related problems. In winter, refloatation of pilot whales is perhaps more likely to succeed, as hyperthermia is less of a risk. Historically, on Cape Cod, refloated pilot whales have often repeatedly restranded.

Species-specific behaviour and ability to adapt to captivity

This does not tend to influence the decision to accept an animal for rehabilitation, although some species such as sperm whale calves are recognised as being very difficult to rehabilitate. At Harbor Branch, also, the decision has been taken to concentrate rehabilitation efforts on bottlenose dolphins.

It is recognised that certain dolphin species, particularly Stenella species (striped, spotted and clymene dolphins) may have more difficulty acclimatising to captivity, as they are very active and easily stressed. Here diazepam may be used in the early stages of rehabilitation to settle them down. Pelagic species initially will tend to crash into the sides of the pool, and social species such as Pacific white sided and rough toothed dolphins tend to be less stressed and make faster clinical progress when in groups.

Age, i.e. neonates and old animals

All facilities will attempt to rehabilitate neonates of species of reasonable size, although the need to be able to permanently place neonates if they are to be admitted was emphasised. The only species where this is never a problem is the bottlenose dolphin. Mystic generally will not rehabilitate neonates that strand outside their own area. Neonates are not refloated.

Older animals with unresolvable chronic disease, in poor bodily condition or with few remaining teeth tend to be euthanased. Old animals are not refloated.

Single strandings versus mass strandings

As indicated earlier, very few single stranded animals are refloated, as single stranded animals often present with chronic health problems. Single stranded animals tend to be brought in for rehabilitation or euthanased. On Cape Cod, where single stranded animals may be refloated, the best candidates are animals known to have only been ashore for a short time, and on physical examination appear to be in excellent condition.

With mass strandings, most facilities will use all three options, i.e. rehabilitation, refloatation and euthanasia. Facilities responding to mass strandings on Cape Cod have the most experience with these events. New England is an authorised letter holder for the peninsula but Mystic and, to a lesser extent, Baltimore has assisted with response and Mystic has rehabilitated a number of animals from mass strandings on Cape Cod. Mass strandings are relatively rare events in Florida, but Mote and Clearwater have been involved in mass strandings response.

On Cape Cod, most animals involved are usually healthy before stranding, but strandings-related pathology can be a major complicating factor. New England triage animals with an initial physical assessment and blood work, which determines which animals will be immediately transported to a release site, immediately transported to a rehabilitation facility, or euthanased. The option decided upon depends on the factors discussed in earlier sections. Those considered suitable for refloatation on initial assessment are assessed physically again at the release site by a vet, further blood analyses are carried out, and the animals are once more placed into categories of release, rehabilitate, or euthanase. Historically, animals involved in mass strandings on the peninsula often are found to be too compromised for refloatation. Rehabilitation as an option is limited by the space available, which is primarily at Mystic. Euthanasia is thus often the most humane option. Jim Rice pointed out the profound logistical problems on Cape Cod (rapid tides, mud, the cold in winter and the enclosed nature of the peninsula) that make effective strandings response so difficult. In many cases, animals strand far from open water, in creeks and marshes, making it virtually impossible to release them, or transport them in decent condition for refloatation or rehabilitation. If mass stranded animals can be refloated, however, they have the best chance of survival when released in cohesive groups.

In California, Jim McBain stated that the trauma of stranding would be an issue in a mass stranding, as animals thrashing around in the strong Pacific surf would soon become unsuitable for refloatation. This highlights the importance of speed of response in a mass stranding, as well as effective triage.

Not all facilities agreed with having refloatation as an option in mass strandings. Greg Bossart believes the animals involved tend to be unfit for immediate release and he made it clear that the only circumstances under which he would consider refloating mass stranded animals is if the logistics dictated that all the animals would be lost otherwise. Robin Friday stated that, in every case he has been exposed to, the animals have eventually re-beached themselves, hours or sometimes weeks later, nearby or several miles from their first stranding site. In his opinion, some of these animals may have had a much better chance of survival with more effective triage and suitable candidates taken in for rehabilitation and eventual release.

The role of rehabilitation in mass strandings is also not straightforward. As Greg Bossart pointed out, pod integrity is lost during a stranding event and social stresses may arise during rehabilitation. Dave Schofield raised another concern, that if only a small number of animals are rehabilitated from a mass stranding, they can be very disorientated on release, and consequently have trouble joining up with conspecifics. Animals have been rehabilitated and released successfully from mass strandings, however, as illustrated by the post release monitoring of two juvenile pilot whales rehabilitated at Mystic in 1999.

Other considerations with mass strandings are financial and labour constraints. As Robin Friday pointed out, coordinating mass strandings involves a host of players from government, both state and federal, law enforcement, volunteers, sometimes military branches, transport and holding facilities, and the events are both financially taxing and taxing on people.

Introducing disease to facility

For facilities where only one animal tended to be rehabilitated at a time, this was not an issue. Facilities such as Clearwater, Mystic and Sea World, housing captive and rehabilitated cetaceans, are confident that they could contain disease within the rehabilitation facility. However, some facilities with captive cetaceans not visited had stopped taking cetaceans in for rehabilitation due to concerns over the spread of morbillivirus into the captive collection. Miami Seaquarium experienced a large outbreak of morbillivirus a number of years ago, where there was transfer of disease between the rehabilitation and captive facilities despite careful hygiene and isolation of animals.

At the Marine Mammal Center, where several hundred marine mammals are rehabilitated annually, the possibility that an animal was carrying a serious infectious disease such as morbillivirus would influence the option taken. Such an animal could pose a significant threat to the facility.

Transport protocols

Essential requirements for optimum transport of cetaceans

Most facilities transport cetaceans from the stranding site to the facility on open or closed cell foam. Some facilities will transport animals off the beach in stretchers suspended in bladder bags, supported in collapsible metal frames, with foam underneath the stretcher to cushion the animal. Misters and sprayers are used to keep the animals moist and ice may be taken to pack around the animal. Harbor Branch has an air filled burns patient bed, which senses areas of increased pressure and adjusts support accordingly.

Animals generally are transported between facilities or to release sites using full water transport, i.e. in tanks (which may just be bladder bags) within which they are partially or totally floated in water, suspended in a stretcher, with open cell foam for cushioning and support underneath and on either side. Animals are not fed before transport.

Steve McCulloch demonstrating the transport vehicle for stranded cetaceans at Harbor Branch (photograph courtesy of Alan Knight)

Ambient temperature is always a concern when transporting marine mammals. For long transports, Robin Friday prefers to maintain air temperature between 60 and 65°F (15.5-18.5°C). He stressed that minimising human restraint during transport is also important, as the more restraint placed on an animal, the more likely they will become stressed. Each animal's disposition has to be evaluated to determine the level of contact they require. People should be prepared at all times to handle all scenarios, but also to get out of harms way, e.g. if an animals starts going into death throws, when there is nothing anyone can do to subdue the animal. Loud voices, quick changes from dark to light, use of a flashlight, or shadows can induce an immediate response from an animal, which usually results in it having to be repositioned during transport.

Facilities such as the Marine Mammal Centre are prepared to administer intravenous fluids and drugs, e.g. propanolol, dexamethasone, diazepam, to animals during transport.

Differing transport requirements experienced between different species, ages, etc.

Transportation of larger animals is complicated by the fact that the larger the animal, the more physiological stress is imposed on the animal during transport. Robin Friday had found that, once larger animals are positioned in a truck or flatbed vehicle, they will tend to calm down, but repositioning after disturbance is very difficult without putting the handlers in a potentially dangerous situation. Also, if they need to be moved using heavy equipment, they tend to react defensively to the noise and being suspended in the air. Pilot whales can be totally unpredictable in their behaviour, particularly bigger ones.

Stenella species also can be risky candidates for transport due to their highly strung nature, and extra care needs to be taken over a quick and smooth transition from the beach to the transport vehicle and rapid, smooth transport. Additional variables include the need to transport pregnant females floating in water, and to protect the delicate skin of pigmy sperm whales with vitamin A ointment. Robin Friday also had found that mother-calf pairs generally transport much more calmly if they are allowed to have direct contact with each other, and this is also the case with any two (or more) animals transported in the same vehicle.

Maximum transport times for stranded cetaceans, by land

All facilities agreed that minimising transport time off the beach was important to maximise the chances of an animal's survival, with gravity and compression effects on animals during transport being a problem. Some facilities felt that a reasonable maximum transport time is 3-4 hours, if this could be accomplished. However, maximum transport times largely have been governed by the length of time required to transport a given animal and have proved successful up to 12 hours, for example animals transported to Mote from the Florida Panhandle. It was suggested that planned transports of longer than 6-8 hours would benefit from overnight breaks at facilities en route and, if possible to arrange, transports of 3 hours or more should be carried out in water.

Use of air transport

All facilities agreed that air transport was a very useful option with the transport of stranded cetaceans. Cabin pressure needs to be maintained at or near that of sea level (1067metres/ 3520 feet or less), as cetaceans appear to be susceptible to high-altitude sickness. Jim McBain also pointed out that keeping cabin air temperature the same as the water temperature in the transport unit will avoid any unwanted temperature loss or gain.

Most facilities were comfortable with flights of up to 3-4 hours, although again times have been dictated by the distances over which stranded animals needed to be moved. Jim McBain believed that with proper equipment and planning, and carrying out assessment and initial treatment both prior to loading and in flight, flight time should not be a deterrent to a rehabilitation attempt. However, inexperienced staff and inappropriate equipment would be a big deterrent. Baltimore even simulated the effects of air transport beforehand by driving a pigmy sperm whale around Baltimore in an animal ambulance for a number of hours. This seemed to help the animal deal with the stress of the flight.

Mote and Baltimore have received a lot of help from the coastguard with the transport by air of stranded cetaceans.

Animal condition and other factors affecting transport times

All facilities agreed that the condition of an animal is the primary factor affecting its ability to cope with transport, and stabilisation of an animal's condition prior to transport is very important. Transport is a particular risk with seriously ill animals. Here, it may be advisable to place the animal in a temporary holding facility, for initial evaluation and supportive care until it is stable enough for transport to long-term rehabilitation facilities. If such facilities are not available, then the animal may need to be euthanased, rather than putting it through a stressful journey.

Robin Friday stated that the way an animal is handled on the beach also could affect its ability to cope with transport. If it has been dragged across the beach, or if it has been bouncing around in rough surf, then transport often will be difficult. If an animal is properly handled and cared for at the time of stranding, and is able to associate this to the caregivers, then transport should go more smoothly.

Rehabilitation procedures

Handling procedures

On arrival at the facility, all facilities dealing with larger dolphin and whale species have, or can easily borrow hoists for lowering animals into (and lifting animals out of) pools. At Baltimore, where the animal has to be moved into the main aquarium building, smaller cetaceans are brought to the rehabilitation pool via the main freight lifts. Larger animals are hoisted up, with an outside crane, to the level of the surgery room windows, on the floor above the pool. These are opened up to receive the animal, which is lowered into the pool using a surgery hoist through a large 'trapdoor' in the surgery floor. At most facilities, removable ladders are used for staff access to pools.

Animals are supported in the water on first arriving, by people, mats and floatation devices. Varying types of floatation device have been used by facilities such as Mote, Baltimore, Mystic and the Marine Mammal Center, usually rigged up from available materials, e.g. foam pads, PVC pipes and floats. Charlie Manire prefers to use floatation devices with animals where release is thought to be likely, as they help to minimise human contact. However, they have limited use in whales, which don't hold their pectoral flippers out and tend to roll out of the supports. As animals will shift around in floatation devices, people generally still need to be in the water to right the animals if necessary and to watch for signs of rubbing. Floatation devices are rarely used at Sea World, as Jim McBain believes they stress the animal and resist the animal's own attempts to swim. The exceptions he has found are harbour porpoises, which fare better in floatation devices. When animals are walked by hand, mats with handles (Clearwater) or stretchers (Baltimore, Mystic, New England) may be used to help support the animal.

Mote's handling guidelines in the volunteers' training manual lay out some basic principles of handling. Adequate control over the pectoral flippers and dorsal fin is needed, and additional support under the dorsal fin and peduncle may be required. Pectoral flippers are treated like handles, with one strong person at the front holding both of them: they are the key to the control and restraint of the cetacean. People are taught to reach over and hold both sides of the animal and handlers can link their hands under the animal's body for greater restraint. The eyes, genital slit, open wounds and flukes are avoided and handlers are not allowed to touch the animal in front of the blowhole and pectorals. Animals are walked at a leisurely pace in large circles, whilst ensuring the flukes do not rub on the sides or bottom of the pool, and taking care over the animal's orientation and position of the blowhole relative to the water surface. Animals are walked equally clockwise and anticlockwise. The dolphin's skin is kept wet at all times, without splashing and timing scoops of water over the blowhole between breaths. The temperature of exposed skin is monitored by feel, and the animal is walked in shade. People handling animals are rotated on a regular basis and the changing of handlers is carried out slowly and quietly, one at a time, with new handlers approaching from, and old handlers leaving towards the back of the animal. The overriding aim is to provide a secure, quiet environment for the animal.

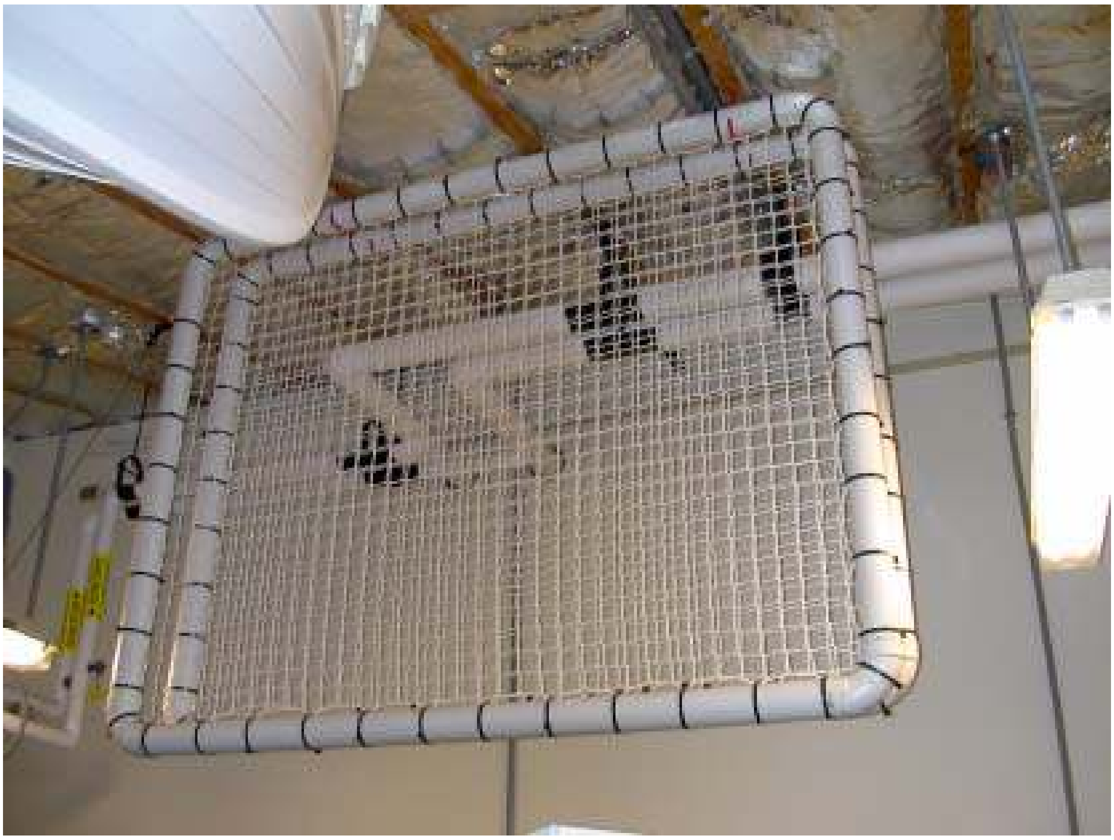
At the Marine Mammal Center, volunteers are taught that the principles of cetacean restraint are as for other marine mammals, i.e. to be quiet, firm and responsive to the animal. If an animal is constantly fighting due to a loose restraint, then it uses up too much energy, whereas an animal that knows it can't escape tends to give up and relax. Depending on the condition of the animal, various protective equipment and clothing is used at the facilities to minimise the risk of zoonotic disease spread, including masks and, in some cases, goggles and latex gloves. Restrictions also are imposed in at least some facilities on volunteers and staff, who are pregnant, sick or immunosuppressed, handling animals.

Periodically an animal's buoyancy is tested by gently releasing and monitoring it, all the time people remaining available to support the animal. Before releasing animals to free swim, some facilities will introduce them to the sides (and bottom) of the pool, to ensure they know the confines of the pool. This reduces the risk of trauma on release. At Sea World, particularly pelagic dolphins are first allowed to swim in shallow water in a soft sided pool, until they are aware of the sides. As Jim McBain pointed out, pelagic animals frighten readily and there is a risk of serious injury, e.g. broken mandibles, when they are first released to free swim in a concrete pool. Some facilities will line the pool sides with people, splashing to keep the animal away, but care has to be taken to avoid people getting pinned between the animal and the wall.

The number of people in the pool is reduced after the first few days of rehabilitation and people tend to only go in for medical procedures and feeding. The exception is with neonates. Here, people remain in the water a lot more with these youngsters than with an animal intended for eventual release.

When necessary, free-swimming dolphins are caught up in a number of ways. At Mote, animals are corralled by people walking slowly through the water in a line with their legs apart and arms and hands kept underwater. Net panels may be used at Mote and Mystic, held adjacent to each other and firmly against the bottom of the pool. At Baltimore and Mystic, when animals are free swimming in pools at full depth, nets are dragged under the animal along the bottom of the pool and then brought up tight with the animal on top. Someone then walks out on to the net to catch the animal up. At Sea World, pools are drained for catch up and nets are rarely used, as problems have been experienced with pilot whales and some dolphins spinning when they hit nets.

At Mote, netting is also present over the pool, as a previous pigmy sperm whale undergoing rehabilitation breached so high that she threatened to jump out of the pool. Baltimore also holds compass nets and 'Huki Lau' to facilitate capture of 'out of habitat' dolphins in Chesapeake Bay. These are weighted lines providing a visual and/or acoustic barrier to aid crowding and capture without risk of entanglement.



Nets used to corral free-swimming cetaceans at Mystic

Indoor facilities (Baltimore, small pool at New England), and those within a tent (the Marine Mammal Center, large pool at New England, small pool at Harbor Branch) are able to provide complete shelter and shade for animals undergoing rehabilitation. Other facilities provide partial shading and shelter with partial roofs (Mystic), neighbouring buildings (large pool at Harbor Branch) and material over the pool (Mote, Clearwater, Sea World).

Assessment protocols

A full initial clinical examination generally is carried out on the day an animal arrives, although some procedures, such as ultrasonography, gastroscopy and radiography, may be left until the animal is more stable, particularly if the procedure involves removing the animal from the water (see section on 'Beaching, diagnostic aids and surgery facilities.') Most clinical examinations are carried out in the water, but at Mystic, initial examination of large animals on arrival, e.g. pilot whales, tends to be in the truck in which they arrive.

Further clinical examinations by a vet are often tied in with blood sampling (see below) or treatments, although when an animal is being supported in the early stages of stabilisation, examinations can be relatively easily carried out at any time. Once free swimming, some cursory examinations also can be made from the side of the pool, by having the animal come alongside and remain more or less motionless, once it has habituated to the captive situation. At Sea World, the policy is a little different and is set up to try and minimise the handling of rehabilitated cetaceans by vets and thus reduce the risk of carrying disease to captive animals. After an initial clinical examination, a programme of diagnostics, treatment and nutrition is worked up for rehabilitation staff to implement. The vets become less involved, only examining the animal if there is an obvious change in its condition or blood parameters.

All facilities mount 24-hour poolside watches during the first few weeks of rehabilitation. The pools at Clearwater, Baltimore and Mystic have underwater viewing windows, which are useful for assessing how the animal is feeding and swimming. Neighbouring buildings provide amenities for observers, who often observe with only rudimentary shelter from the elements. New England has closed circuit television, allowing monitoring from an office in a nearby building. Jim McBain believes observers should keep away from the edge of the pool in order to minimise stress and effects on the animal's swimming patterns, and once an animal is stable, monitoring should stop.

Lighting to facilitate night-time observations can be provided in all facilities, but Robin Friday is of the opinion that, unless the animal is truly compromised, animals should be allowed undisturbed down-time, and even the shadows of staff walking around the pool will make most patients very excited and reactive. Harbor Branch uses green and red lighting over the small pool, allowing night observations without disturbing the animal, and the big pool has only limited perimeter deck lighting. At Mote, much of the work by necessity has to be done after dark and thus adequate lighting is essential.

Observations recorded include respiratory rates, behaviour, disposition, appetite and passing of faeces. Robin Friday believes these observations should be used to help evaluate the need to catch an animal up for a closer examination once it is free swimming. If improvements in these parameters can be seen, then it is sensible to reduce the number of catch-ups for examination. Obviously, if a particular animal appears to accept restraint with minimal stress, and the examination can be well planned and timed, then regular examinations can be implemented. When considering, planning and executing an examination procedure, the animal's response to the examination is very important. Every effort should be made to complete the procedure before the animal starts exhibiting signs that he's had enough, e.g. where the animal begins avoiding being handled, restrained or out of his environment. Whenever the animal can be handled quickly, safely and most importantly, reinforced with primary or any secondary reinforcement, the quicker the animal may begin to associate the positive side of the procedure allowing more thorough examinations in the future.

Clinical pathology protocols

All facilities take blood samples for haematology and biochemistry on arrival but, as Jim McBain pointed out, a second sample taken after the animal is rehydrated, 1-3 days after arrival, tends to give more realistic haematology and biochemistry parameters. The central tail veins are most commonly used for blood sampling, although the caudal peduncle, in smaller animals, and the dorsal fin, in larger cetaceans, also may be used. ¾" butterfly catheters are useful for sampling from the flukes and, if longer needles are required, then an extension set can be used, with a 2" needle being the maximum length needed for most species rehabilitated.

Some published reference ranges for haematology and biochemistry are available in the literature for a number of species, e.g. Bossart *et al.* (2001). Most facilities also have either constructed their own reference ranges from animals in the later stages of rehabilitation, or have generated an impression of what is the norm for a given species, taking into account the laboratory method used. However, as Rene Varela pointed out, it is also important to establish the baseline for each individual and observe trends in this baseline, due to the amount of individual variation in blood parameters.

Parameters considered useful in assessment include packed cell volumes, to assess hydration. Charlie Manire finds electrolytes are useful, as cetaceans often drink seawater if they are sick and plasma sodium and potassium levels are affected. Jim McBain considers fibrinogen, reticulocyte counts, serum iron and albumin yield the most useful information on an animal's state of health. Nonregenerative anaemias are seen with pneumonia and regenerative anaemias with ulcers. In his experience, white blood cell counts do not tend to be that high in cases of pneumonia, as cetaceans are poor at eliminating infection from their lungs.

Vet Charlie Manire taking gastric juice for cytology from a pigmy sperm whale calf at Mote

Blood samples in most facilities tend be collected daily or on alternate days for the first few days (possibly up to 2 weeks), then every 2-7 days until the animal is completely stabilised and then weekly, monthly or as seen to be needed after that.

Other routine sampling carried out by facilities when an animal first arrives is listed in Table 2. These vary between facilities but nearly all take bloods for morbillivirus serology and blowhole swabs and/or plates for culture, and at least half take faeces for cytology/ parasitology and culture, and gastric juice for cytology/parasitology. Other samples taken are dictated by the condition of the animal or findings from initial routine samples, e.g. culture if cytological examination reveals the presence of many leucocytes. Urine, and more commonly faeces may be picked up opportunistically for examination, particularly if they appear abnormal. Bronchoscopy and lavage is used to culture aetiological agents in cases of pneumonia. Culture of many samples is complicated by water contamination. Samples tend to be repeated depending on whether initial samples are abnormal.

On site laboratories capable of running haematology and biochemistry profiles are available at Harbor Branch, Baltimore, Mystic, Sea World, the Marine Mammal Center and New England. Automated haematology and dry chemistry are used in the last two. Mote and Clearwater send their samples away to local laboratories. Mystic has on site serum chemistry analysis capability but sends out most non time-sensitive samples for biochemistry; automated and manual cell counts are carried out on site. Some facilities are able to carry out microbiology, parasitology, urinalysis and cytology on site and Sea World also has a histopathologist. All facilities use external laboratories for serology.

Table 2 – Clinical pathology samples routinely taken on arrival of cetaceans for rehabilitation

	Harbor Branch	Mote	Clearwater	Baltimore	Mystic	Sea World	Marine Mammal Center	New England
Blood (haematology, biochemistry)	✓	✓	✓	✓	✓	✓	✓	✓
Blood (venous blood gases)							✓	
Blood (morbillivirus serology)	✓	✓	✓	✓	✓	✓		✓
Blood (Brucella serology)					✓	✓		
Faeces (culture)	✓		✓	✓*	✓			
Faeces (cytology/ parasitology)	✓	✓	✓	✓*			✓	
Gastric juice (cytology/ parasitology)	✓	✓	✓	✓*				
Gastric juice (culture)	✓	✓	✓	✓*				
Stomach contents (parasitology)								
Blowhole swab and/or plate (culture)	✓		✓	✓	✓		✓	✓
Blowhole swab (cytology/ (parasitology)		✓	✓	✓				
Genital slit (culture)								✓
Oral cavity (culture)								✓

* samples only taken if the animal is strong enough to cope

Beaching, diagnostic aids and surgery facilities

Animals tend to be beached on the side of the pool for procedures such as ultrasound, radiography, endoscopy and electrocardiography. Animals out of the water are placed on open or closed cell foam, 4 to 15cm thick, and are kept moist. Most facilities have their own equipment for these procedures, although in some cases, e.g. Harbor Branch, these are brought in. Ultrasound and radiography are important in the diagnosis of pneumonia. Auscultation is less useful due to normal respiratory noise being so loud.

At Baltimore**,** a ledge, approximately 4 feet (1.2 metres) wide and 4 feet above the pool floor, runs along one side of the pool, where animals can be beached, or supported with just their tails on the ledge for blood sampling (see picture on page 11). Animals requiring radiography, endoscopy and ultrasound are hoisted up in a stretcher to the operating theatre through a 'trapdoor' in the roof. Some facilities (Mystic, Sea World and the Marine Mammal Center) may move animals to nearby buildings for some of these procedures to be carried out. Clearwater tends to take animals off site to a local hospital for radiography, although these facilities can be brought poolside for larger animals.

Surgery tends to be limited to the occasional repair of fractured mandibles and insertion of chest drains. Such procedures are carried out poolside in many facilities, although again at Baltimore, animals can be hoisted into the operating theatre above the pool.

Treatment protocols

Some of the drugs used in the treatment of cetaceans undergoing rehabilitation are listed in Table 3.

Antibiotics are usually administered to incoming cetaceans as, if they are not already suffering from an infection, stress and malnutrition leave them prone to secondary infections, particularly pneumonia. Broad spectrum antibiotics used include third generation cephalosporins, aminoglycosides, fluoroquinolones and potentiated semisynthetic penicillins. Jim McBain minimises the use of new, efficacious broad-spectrum antibiotics and restricts the range of antibiotics used, to reduce the risk of precipitating antibiotic resistance in the animals' normal bacterial flora. Fluoroquinolones are avoided and cephalosporins are rarely used. Charlie Manire has found that pigmy and dwarf sperm whales are very sensitive to many antibiotics and uses enrofloxacin as the antibiotic of choice in these species. Marty Haulena has found oral gentamycin useful in cases of suspected gastrointestinal bleeding, as it remains in the gut.

Some vets voiced concerns over the use of non-steroidal anti-inflammatory drugs, due to the risk of gastric ulceration, particularly with flunixin and acetylsalicylic acid. Jim McBain indicated that care needs to be taken over combining flunixin with fluoroquinolones, due to the neurological side effects that can occur with the combination, and with aminoglycosides, due to the risk of renal damage. Lawrence Dunn has found early administration of methylprednisolone particularly useful in harbour porpoises, which tend to be rather nervous. A number of other vets were not keen on using steroids, due to the associated side effects.

Anthelminthics tend only to be given if deemed essential to improve the clinical condition of the animal. Although praziquantel is generally the anthelminthic of choice for trematode infestations, the preferred anthelminthic for nematode burdens varies. Rene Varela prefers pyrantel to gently remove nematodes in older animals with high parasite loads. He will occasionally use ivermectin or fenbendazole, but the latter is used at low doses given over a longer period of time, due to concerns over possible adverse reactions associated with the sudden die-off of the whole parasite load. Charlie Manire also uses very low doses of fenbendazole over 3 days to gently reduce the nematode burden in debilitated animals, but rarely uses ivermectin, due to inconsistent results. Lawrence Dunn and Robin Moore routinely use ivermectin to lighten, rather than eliminate the parasitic load. Particularly in debilitated animals with high parasite burdens, antibiotics and anti-inflammatories will be used prior to and during anthelminthic treatment.

In the treatment of pneumonia, diuretics such as frusemide tend to be more widely used than mucolytics and bronchodilators, as inflammation and pulmonary oedema are the primary problem. Steroids also are used by some vets.

At Mystic, gastrointestinal medications are not routinely used as few problems have been encountered. Conversely, Rene Varela has seen a high incidence of gastric ulceration in rehabilitated cetaceans. In the treatment of gastric ulceration, sulcrafate and, to a lesser extent, H_2 receptor antagonists (gastric acid blockers) are used The latter tend to be avoided in pigmy and dwarf sperm whales as they may cause gastric stasis in these species.

Sedatives may be used to calm animals during transport (sometimes along with intravenous fluids, propanolol (a beta blocker) and dexamethasone) and during the early stages of rehabilitation, particularly with Stenella species. Diazepam also may be used to sedate for bronchoscopy. Midazolam in combination with meperidine (pethidine) is used in some facilities to lightly anaesthetise for minimally invasive procedures (for longer procedures, isoflurane can be used).

At one time, many facilities vaccinated against erysipelas, but this is no longer routinely carried out as the old killed erysipelas vaccine was unsafe, often causing anaphylaxis. Attempts were made to import a cleaner, European vaccine, but Pfizer has just brought out a clean vaccine in the States and Sea World has completed initial trials with no adverse reactions.

Table 3 - Drugs used in the treatment of cetaceans undergoing rehabilitation.

Antibiotics	***Anti-inflammatories***
enrofloxacin ciprofloxacin ceftriaxone ceftioxine ceftazidime ceftiofur gentamycin amikacin clindamycin potentiated amoxycillin	methylprednisolone prednisolone dexamethasone carprofen flunixin acetylsalicylic acid acetaminophen paracetomol
Anthelminthics	***Antifungals***
fenbendazole ivermectin praziquantel pyrantel	nystatin (intravenous) itraconazole
Drugs acting on the respiratory tract	***Drugs acting on the gastro-intestinal tract***
diuretics, e.g. frusemide *mucolytics* *bronchodilators*, e.g. aminophylline	cimetidine ranitidine sulcrafate
Sedatives and analgesics	
diazepam midazolam meperidine (pethidine) codeine-type opiate	

The preferred route of administration of drugs initially is by intramuscular injection, to ensure Mean Inhibitory Concentrations of drugs are rapidly reached. Once the animal is fit and the gastrointestinal tract is functioning normally (stomach washes can be used to determine if the animal is digesting and absorbing food), then treatments are given orally, where possible. Oral treatments may be instigated earlier if an animal is very stressed by catch ups for injections. It needs to be remembered that oral antibiotic administration can upset the normal bowel flora.

Rene Varela pointed out that intravenous drug injections are contraindicated, as, due to the vascular anatomy of cetaceans, you cannot guarantee a purely venous portal. Thus, any injections given (particularly in the fluke vessels) are likely to have at least some arterial component. This will tend to result in thrombosis of the distal portion of the vessels, infarction of the associated tissue, and eventual necrosis, which may lead to a partial slough of the fluke or, at worst, a disseminated infection.

Wounds are treated with topical iodine solutions and debridement and are allowed to heal by secondary intention. Skin lotions, e.g. zinc oxide cream, are applied to dry skin if there is a risk of sunburn.

Feeding protocols

Feeding of adults:

All facilities will start animals on fluid feeds by stomach tube, but the number of such feeds varies not only with the animals' condition, including its level of hydration, but also with the protocols of the facility. A number of facilities will start animals on water, to which dextrose is later added, before the transition to oral rehydration fluids is made. Rene Varela explained the reasoning behind this approach, which is to ensure that renal function and gastrointestinal mucosal function is adequate and animals are urinating and defaecating normally before oral rehydration fluids are introduced. He went on to say that many animals have gut stasis problems on arrival and ensuring suitable nutrition helps to restore gut motility. Subcutaneous fluids also may be administered in some facilities. Within a few days, a fish 'soup' or 'mash' (fish blended with water) starts to be given by stomach tube, or liquid formulae developed for neonates. Tube feeding generally is carried out in the water as, on land, compression of the stomach may lead to refluxing and the larynx popping out and if this happens, aspiration of fluids may occur.

Mystic, Sea World and the Marine Mammal Center may use varying amounts of freshwater in the pool over the first few days of stabilisation if the animal is dehydrated. The freshwater sits on top of the saltwater and animals may be observed actually drinking from this layer.

Stomach tubing of emaciated animals at Harbor Branch may persist for as long as two weeks, due to concerns over giving solids before gastrointestinal function has been fully restored. Less malnourished animals are weaned on more quickly. At Mystic, depending on its condition, an animal may be weaned on to solids as early as the second feed. Lawrence Dunn explained that this protocol is adopted to minimise human contact and the risk of habituation and to allow the animal to be moved on to a high energy diet quickly. Mystic has seen few digestive upsets associated with using this approach, even in young animals. At other facilities, animals tend to be moved on to solids from one to a few days after arrival, depending on condition. Force feeding may be necessary in some animals, particularly younger ones, achieved by pushing a fish to the back of the throat after giving a fluid feed. Eventually, the animal will start to swallow the fish and then will progress to taking it him or herself. Some animals may have to be hand fed for a while. Feeding rates tend to be based on calorie content, but Lawrence Dunn said the aim, in the absence of proximate analyses of feed fish, is to get dolphins on to 5-10% of bodyweight in solids daily (depending on age and species). Regular weighing is important and this can be tied in with other procedures.

Fish species fed are primarily herring and capelin, and squid is also given. Other fish species used include mackerel, herring and Columbia River Smelt. Caloric content varies with the species and with the season. Typically the caloric content for herring is around 500 kcal/lb (1100 kcal/kg), but during summer it increases to approximately 900 kcal/lb (2000 kcal/kg); capelin tends to be between 300 and 500 kcal/lb (650 and 1100 kcal/kg) and Columbia River Smelt averages nearly 700 kcal/lb (1550 kcal/kg). Robin Friday prefers to use the latter in debilitated animals because of its high caloric content, as it is more readily digested than herring and because most animals accept the texture of this fish better than other species. Charlie Manire prefers to feed initially fish with a lower fat content, e.g. capelin rather than herring, having seen liver conditions occurring with high fat diets. Capelin is also the fish of choice initially at Baltimore. At New England, which specialises in the rehabilitation of harbour porpoises, small 3-4" herring are the feed of choice, bigger fish tending to cause constipation. Fish diets are supplemented with vitamins and minerals.

Mote has found that pigmy and dwarf sperm whales need additional fluids by stomach tube over and above the normal fluid and fish feeds. Charlie Manire suspects that the deep water squid on which they normally feed are higher in water content than normal squid.

At Sea World, if an animal is tending to feed off the floor of the pool, then it will be hand fed to try and stop the animal associating dead fish with the bottom of the pool, and therefore the sea bed. The problem with this is the desensitisation of the animals to humans but this can be limited by only having one or two people feeding the animal whilst they are wearing definite gear and clothing. Thus, the animal will not go to anybody in the ocean for food. As Jim McBain points out, it is important to minimise the chances of having a nuisance animal back in the wild and to maximise its chances of survival.

Feeding of neonates:

The facilities most experienced with the feeding of neonates are Harbor Branch, Mote, Clearwater and Sea World. At Sea World, formulas were developed primarily on beached cetaceans and subsequently used and refined on several captive born calves who had lost, or been rejected by their dams (see Table 4). Protocols have been developed for the use of such formulae in a number of species, including bottlenose dolphins, Risso's dolphins, common dolphins, Commerson's dolphins, killer whales, gray whales and pilot whales. Mote, recognised as specialists in the rearing of pigmy sperm whale calves, produced a suitable diet for these and dwarf sperm whales following a 6 week trial on a calf that lived for 18 months, using analyses of milk samples from albeit sick adult females and a Sea World bottlenose dolphin formula as starting points (see Table 4). As stated earlier, however, these species do need supplementary fluids in addition to formula.

Neonates are started on water initially, then water with dextrose to maintain gut mucosa vitality, for at least the first 24 hours. At Mote, however, if the animals' sodium and potassium are not too high, they are started on oral rehydration solution, initially at half strength. Animals then are weaned gradually on to formulae. Ideally, this is fed by bottle, which may take a while to be accepted by the calf, but syringe feeding via a stomach tube is also possible. When bottle-feeding, someone has to feed the calf in the water initially until it becomes conditioned to going to hand at the side of the pool. It is important to watch the consistency of the formula, so as not to put calves off suckling. The teat aperture can be widened to help with this. If a neonate has a strong suckling response, feeding is a lot easier.

Mark Simmonds bottle feeding a bottlenose dolphin calf at Harbor Branch

Sea World has estimated that the initial caloric requirements in neonatal dolphins are 100 kcal/kg/day, and 200 kcal/kg/day in neonatal porpoises. Adjustments to each individual's actual needs are made as rapidly as possible from these starting points. Requirements for older animals also can be calculated. The daily caloric requirements for a particular individual are then covered in a number of daily feeds. At Sea World, feeds are given every 45-60 minutes, depending on species size, for several days. Once the dolphin's weight is stable and weight gain becomes predictable, the process of decreasing feeding frequency and increasing individual feed volumes starts in earnest. At Mote, pigmy sperm whales are fed initially every 3 hours, then every 4 hours. Later on in rehabilitation, at Harbor Branch at least, daily caloric requirements are achieved by feeding differing amounts at irregular intervals.

An animal's weight trend is important in determining whether a feeding regime is adequate and neonates need to be weighed frequently, at least initially. At Sea World, weighing is daily for at least the first month. Jim McBain explained that the initial target is to stabilise the animal's weight and then, after a few days, to get the animal putting weight on. Target weight gains are derived from data on captive animals; with bottlenose and Risso's dolphin neonates, this is 0.22 – 0.35 kg/day. Once the animal is gaining weight, feed volumes are increased and frequencies decreased, with a view to getting rid of night feeds. The speed with which this transition occurs is dictated by the animal's progress.

Most dolphin calves at Sea World are weaned gradually on to fish and squid from 3 to 4 months of age. Sea World (Jim McBain) has found that weaning to solid food is probably safe at a much earlier age than might be expected. A Commerson's dolphin calf was completely weaned by 10 weeks of age without difficulty. The pigmy sperm whale calf on which Mote's formula was developed was on formula for over 9 months.

Table 4 - Ingredients in neonatal diets

Sea World neonatal dolphin formulae
Milk replacers: Zoologic 33/40 (low lactose) and Zoologic 30/55 (lactose free) - these use a mix of animal and vegetable fat sources; if just 30/55 is used, the final formula has too much animal fat in it, i.e. is too high in cholesterols. Dextrose - added to increase dextrose content to 2%. Aiming for maximum 2-3% carbohydrate content in the formulae, as dolphin milk contains no more than this. Herring (minus head, fins and tail). Bottled water. Salmon or other fish oil (NOT fish liver oil) - to increase energy density of diet. If the oil contains a very high level of cholesterol, e.g. salmon oil, this is removed to keep the cholesterol level of the diet down to acceptable levels. Heavy whipping cream - to increase energy density of diet. Lecithin. Dicalcium phosphate. Taurine. Mazuri marine mammal multivitamins. (SeaWorld formulation) Salt –as the high volume of formulae given diureses the animals and they become hyponatraemic.
Mote neonatal pigmy sperm whale formula
Milk replacers: Zoologic 33/40 (low lactose) and Zoologic 30/55 (lactose free). Bottled water. Safflower oil (calves cannot digest some fats, e.g. flax oil, cod liver oil). Lecithin. Osteoform (many ingredients including dicalcium phosphate, calcium carbonate, bone meal, magnesium stearate). Taurine. Arginine. Mazuri multivitamins. Additional vitamin C. Salt.

Feed storage and preparation:

Dedicated fish storage and feed preparation facilities are available for the rehabilitation facilities at Harbor Branch, Mote, Baltimore and New England. Stainless steel is the material of choice for feed preparation surfaces. At Mote, separate sinks and drainers are available for different animals. At Clearwater, Mystic, Sea World and the Marine Mammal Center, feed preparation and storage facilities in the main facility are used. Fish and squid purchased is fit for human consumption and is stored frozen (maximum –20^{o}C), usually for no more than 6 months, although capelin has to be stored for longer, being only seasonally available. Fish is fed within 24 hours of thawing, and kept on ice or refrigerated until a reasonable time before feeding. Formulae are fed within 24 hours of being made up and again are refrigerated until a reasonable time before feeding.

Water quality management

Both semi-open and closed systems are employed. Semi-open systems, such as Mote, Clearwater and Harbor Branch pump water directly from a body of seawater nearby, generally though a weldscreen. The closed systems at Baltimore, Mystic and the Marine Mammal Center use made up seawater. As Jim McBain pointed out, filtration and disinfection are absolutely critical to the success of rehabilitation as cetaceans are breathing at the air-water interface and will pick up bacteria and other pathogens from this interface. Poor water quality therefore can seriously worsen the condition of the animal. Filtration and disinfection systems widely used include mechanical filtration (sand/gravel), chlorine and/or ozone. Some facilities also use bromine, ultraviolet filtration, or protein skimmers. Most, but not all facilities have surface skimmers at both the lower and higher levels at which the pool tends to be maintained. Initial holding pools also tend to have surface skimmers and most pools have bottom drains. Pool turnover times when full vary from less than 2 hours (Marine Mammal Center, Sea World, Mote and Mystic) to 8 hours (Harbor Branch and Clearwater).

Nearly all facilities are able to heat the pool water and most are able to chill it, according to the needs of the animal and the ambient temperature. Maintaining water at 75-80^{o}F (24 – 27^{o}C) is considered important for the stabilisation of very young or thin animals, as this minimises energy loss, and the animals tolerate the heat well when they have no blubber layer. Small, active species in particular will chill easily when they are sick and inactive. Whether the animal is a cold or warm water species also needs to be considered. Some facilities such as Mote maintain water temperature at 80 ^{o}F (27 ^{o}C) for all animals. Others such as Mystic, situated that much further north, are only able to maintain pool water temperature at a minimum of 60 ^{o}F (16^{o}C) in the coldest months.

Water tests tend to be carried out a minimum of once daily, although some facilities monitor far more frequently than this (every 3 to 4 hours at Mote and Sea World). Depending on the facility, the parameters checked include free and total chlorine, bromine, pH, redox potentials, temperature, salinity, nitrates, nitrites and ammonia. Coliform counts tend to be carried out weekly and levels are kept within APHIS standards, i.e. below 1000 CFU/100 ml. (total coliforms).

Protocols to minimise disease spread within the facility

Here, the primary concern is the possibility of bringing morbillivirus into the facility. Most dolphinaria presently will not rehabilitate cetaceans for this reason.

Facilities with captive cetaceans prevent water from rehabilitation pools entering the captive cetacean pools, but Baltimore will allow water go in the reverse direction. Here, the captive dolphins are health screened frequently to minimise the risk of disease transfer. At Harbor Branch, Mote and Mystic, the different rehabilitation pools are also on different water systems. At Sea World, the two pools have a shared water system, but water is passed through ozone between the two. Furthermore, if one animal does present a major disease risk, it is euthanased, as effective isolation cannot be guaranteed.

Strict disease control measures are also in place for staff, particularly in facilities housing captive marine mammals. Here, different crews are used for animals undergoing rehabilitation and captive animals, and crews working with the former are often not allowed to enter areas containing the latter. For example, at Clearwater, staff working with a cetacean undergoing rehabilitation are not allowed to come in contact with the captive dolphins for 1 week after contact with a stranded animal and for 48 hours for other animals in the collection. They are also prohibited from using the same shower and toilet facilities as the dolphin trainers and from coming into face-to-face contact with them for 48 hours after working with the stranded animal. Although the same feed preparation room is used to thaw fish for captive and display animals, rehabilitation personnel are not allowed to enter it, separate equipment is used for captive animals and those undergoing rehabilitation, and the fish for animals undergoing rehabilitation are taken out for feed preparation by the pool.

At Baltimore, a system of differently coded levels is set, according to the level of perceived risk. When an animal first arrives, the level is ‘red’ and staff working with the admitted animal have to wait 24 hours to work with another animal. When the animal is healthier, the level is dropped to ‘white’ and the waiting time is reduced to 12 hours. A strict directional flow of people through captive and rehabilitation areas is maintained, and rehabilitation personnel and dolphin trainers cannot work in the same area. At facilities where more than one animal may be undergoing rehabilitation at a time, different crews may be used, or personnel are sprayed and scrubbed down between pools. Furthermore, at Mote where possible, 8 hours is allowed to elapse before people are allowed to work another shift with the same animal, in order to allow any pathogens carried on clothing or the body to die. At the Marine Mammal Center, different crews are used for pinnipeds and cetaceans undergoing rehabilitation.

Disinfection procedures are also important. These include washing hands with antibacterial soap before beginning a shift with an animal, disinfecting or showering before and after being in the water with an animal (separate showers may be maintained for different animals), and using footmats soaked in disinfectant at the entrance to each pool area. Chlorine, other viricidal disinfectants and chlorhexidine are used. Vets are a particular risk and, in facilities with captive cetaceans, they usually have to shower and change clothes before being allowed to work with other animals and often then only after a 24 hour decontamination period has elapsed. At Sea World, every effort is made by the vet to avoid handling the animal after its initial assessment on arrival. At the Marine Mammal Center, vets have to disinfect themselves between cetaceans and pinnipeds.

Protocols for euthanasia and necropsy

Pentobarbitone is invariably used for the euthanasia of cetaceans, but the route of administration does vary. The intravenous route is most frequently used, either via the central tail veins or the dorsal fin sinuses. Charlie Manire will run the calculated dose of pentobarbitone through two different intravenous lines, in case one line is lost part way through the procedure. Lawrence Dunn pointed out that in an emergency, as long as an adequate volume is given to induce respiratory failure, the animal would die, even if it is not killed outright and he believes there is no size limit to the use of intravenous pentobarbitone. This technique has only been employed when the number of animals in a mass stranding was too great for the amount of barbiturate available on scene. Most vets will sedate or anaesthetise an animal before administering pentobarbitone, to facilitate maintenance of the intravenous infusion and to reduce violent movements during the procedure, particularly in large cetaceans. Drugs used include diazepam, midazolam, xylazine, diazepam/meperidine combination or medetomidine/ketamine combination. Some vets have found that sedation is not always necessary to ensure a smooth euthanasia.

Rene Varela gives pentobarbitone initially intraperitoneally, via a long, wide-bore rigid catheter (a small volume only if the animal is quite stressed), before giving the majority of the drug via the intracardiac route. In his opinion, this is the most humane method with the most peaceful results for the patient, vet, staff, and public on the scene. Ian Walker and Brent Whittaker also have used the intracardiac route in large cetaceans, where peripheral venous access can be very difficult, particularly if the animal goes into a 'dive response'. Brake line tubing, with a fine ground tip, can be very useful for administering intracardiac injections in such large cetaceans.

Once pentobarbitone has been administered, it is important to ensure that the animal is disposed of properly, i.e. buried on site or hauled offsite to be incinerated, in order to avoid the death of wildlife that may scavenge on the carcass.

Most facilities have on site necropsy facilities that can be used for the post mortem examination of animals that die during rehabilitation. Baltimore uses facilities at the local university and New England either brings animals to the aquarium in Boston or to Woods Hole Oceanographic Institute for necropsy. Harbor Branch has a fully equipped necropsy trailer that can be taken out for the post mortem examination of larger cetaceans on the beach.

Necropsy trailer at Harbor Branch

Final pre-release facilities.

No facility has access to a sea pen for the final stages of rehabilitation.

Mote is the only facility with a pool specifically designed for animals in the final stages of rehabilitation, the 40 metre long ‘lagoon’ pool. This has sloping slides, to minimise echolocation reflections. It is very quiet acoustically and is designed to create a feeling of being in a bigger area. Animals can be placed in the pool when they are no longer being caught up for medication during the final 3 to 4 weeks before release (a NMFS requirement). The other facilities release animals from their rehabilitation pools, with the exception of the Marine Mammal Center, which moves animals on to larger facilities for the final stages.

Of those expressing an opinion on final release facilities, all agreed that some form of pen in a natural setting would be a useful addition to their rehabilitation pools.

Mark Trimm and Robin Friday wish to have a final release pen near the rehabilitation facility at Harbor Branch, to help with deconditioning prior to release, and to facilitate live feeding. For Jim McBain, the value of such a pen would be the ability to put an animal back into its native environment and observe it for a couple of days before release, the pen providing an added level of complexity in the animal’s environment. The need for such a final release facility would be greater if the rehabilitation pool was shallow. Frances Gulland and Marty Haulena felt that with such a pen, it would be possible to determine how fit the animal is and whether it is temperature adjusted before release. Jim Rice stated that such a facility actually would build up the animal’s strength before release, by getting it to swim against the tide.

Lagoon pool at Mote

It was suggested that a netted lagoon for coastal species and a floating sea pen, a few miles offshore, for pelagic species could be used as final release facilities. At Harbor Branch, the installation of a final release facility for coastal animals is presently under consideration, in a small inlet of the creek off the Indian River Lagoon that runs through the middle of the site. Here, animals could be netted, or swept in to a smaller area with a sloping beach for catch up for release. Alternatively, releases could be carried out straight from the pen. Presently, a permit cannot be obtained for a pen in the lagoon itself and the creek inlet pen will require significant funding.

Dave Schofield stated that such a pen would need to be far removed from the aquarium at Baltimore because of the polluted water in Chesapeake Bay. With floating pens, cost also would be an issue. Possibly herring or salmon weirs could be used to finish harbour porpoises.

Desired and proposed improvements to existing facilities, other than final pre-release pens

The improvements desired by those working in each facility are listed in Table 5. The most common themes amongst the suggestions were increasing the size of the pools, improving or installing holding facilities and improving or installing beaching facilities for examination.

Three sites had plans proposed for new cetacean rehabilitation facilities. At Harbor Branch, desires to modify existing facilities are hampered by the fact that the large pool is still in use as a swimming pool. Furthermore, the pool cannot always be used, if the owners are in residence. Funding is being sourced to build a new facility, which will consist of a 60 feet diameter pool and a satellite medical pool next to it, surrounded by a building housing radiography equipment, operating theatre, etc.. Hopefully, this will be ready in 2004.

At Baltimore, a new facility is planned in a new building, which will have two 100,000 gallon indoor pools and two 50,000 gallon outdoor pools, interconnecting. They will be oval, as this is considered better than a round shape as it gives animals more room to glide, and there will be some shallow areas to make the pools more interesting and a medical pool off to the side. The plan is to break ground in 2004-6, and it will take probably 6 years to complete. The new facilities will be much more amenable to disease control, and turtles will be kept away from cetaceans (often in the same air space now, as the turtle pools are in same room as the cetacean pool).

At the Marine Mammal Center, a new 40 feet (12 metre) diameter, 12 feet (3.6 metre) deep pool is planned.

In addition, at Mystic, a storage area is being converted into a laboratory so that all stranded animal diagnostics can be performed in isolation from the area of the institution containing non-stranded animals.

Table 5 - Improvements desired by facilities

FACILITY	IMPROVEMENT
Harbor Branch Oceanographic Institution	increase the diameter of the initial holding pool to 30 feet (9 metres) and the depth to 6 feet (1.8 metres)
	increase the depth of the main pool to 12 feet (3.6 metres)
	install a central drain in the main pool
Mote Marine Laboratory	increase the tank size from 30 (9 metres) to 40 feet (12 metres) diameter
	further separate the rehabilitation facilities away from the captive animal facilities with different accommodation, etc., for captive and rehabilitation animal staff
	put in five rather than three skimmer levels, starting at 1 metre and then every 0.5 metres after that
Clearwater Marine Aquarium	increase the number of underwater viewing windows from one to two, either using one way glass or with the ability to close off from the public when necessary
	renovate the tank, as the walls are rough and in need of repair
	install a medical pool, into which animals could be moved for beaching and examination
	install skimmers
National Aquarium in Baltimore	totally isolate the rehabilitation facility from the aquarium and dolphinarium to minimise disease spread, with an alternative entrance for rehabilitation animals so the common freight elevators would not have to be used, and removal of some common piping and reservoir systems
	increase the size of the pool, to give pelagic species in particular room to glide
	install hydraulics to move the ‘trapdoor’ between the pool room and the operating theatre
	round off the sharp edges of the ledge in the bottom of the pool and make it wider

Table 5 (continued) - Improvements desired by facilities

FACILITY	IMPROVEMENT
Mystic Aquarium	redesign the middle examination pool, which presently is too small, and lighten the doors separating it from the two pools - a properly set up small pool would be very useful, removing the need to drain the larger pools for catch up, etc.
	install a bigger crane, as the present one can only just cope with 400kg pilot whales (presently a mobile crane is used) - grant for this is expected to be approved
	install a valve on the bottom drains in the two big pools, as there is little control over the flow through the skimmers, which is not optimal as they are not drawing enough of the surface water off
	install a ledge around the pools, creating a beaching area
	create more room to move around the pools
Sea World	install an oval rather than a round pool, as this provides a longer glide distance for pelagic animals
	install a floor that can be raised in at least one part of the pool - this is less stressful for stranded animals and is very quick, which would minimise further stress in animals already usually suffering from adrenal exhaustion
	install small medical examination pools off the main pool
The Marine Mammal Center	install a larger pool - the present pool is not adequate as the final pre-release facility
New England Aquarium	install additional pools with separate life support systems to care for multiple animals within the quarantine space
	install underwater viewing in, and improved staff access to the bottom of the large pool
	install a beach area to allow work on the animal in the pool
	install a dedicated equipment room, treatment room and pharmacy, although this would create problems as the facility is often unmanned (everything has to be brought in from Boston presently)
	install a hoist for the pool

Opinions on the use of temporary facilities for the rehabilitation of stranded cetaceans

Those interviewed were asked as to whether the following option was realistic or acceptable for accommodating stranded cetaceans for rehabilitation: inflatable, or other easily erected pools sited at key centres around the coastline, possibly covered by a tent or awning, utilising on site facilities for water supply and maintenance, feed and treatment storage and preparation, carer accommodation, etc., e.g. at wildlife hospitals, zoos, aquaria or seal rehabilitation facilities.

The general consensus from virtually all those asked this question was that such facilities would only work if a final, permanent facility was available for animals to be moved on to. Thus, a temporary facility should be used only to hold an animal for a few weeks while initial triage is carried out to determine if the animal is likely to be a long term rehabilitation candidate, at which point it should be moved on to a final facility.

The main reason for this opinion was the size of pools required to complete all stages of rehabilitation. Jim McBain believed a deep pool of 12 feet (3.6 metres) is needed for many species, although it may be possible to satisfactorily rehabilitate common dolphins in 8 feet (2.4 metres) of water. From the experience of New England, 8 feet is also adequate for harbour porpoises. Robin Friday believes a rehabilitation pool needs to be at least 30 feet (9 metres) in diameter, but in the experience of Jim McBain, an oval pool would be preferable for the rehabilitation of pelagic dolphins and ideally it should be at least 40 feet (12 metres) x 20 feet (6 metres), in order to allow animals to swim straight and give them adequate surface area before release. These dimensions are likely to be difficult to achieve in a temporary facility.

Robin Moore added that most animals undergoing rehabilitation require several months of care before they are ready for release and cramped facilities are not conducive to survivability. Robin Friday did agree, however, that it may be possible to turn animals around in a few weeks if they have stranded purely though navigational error, as is believed to be the case with a number of pelagic dolphins in the United Kingdom. If the intention is to have the animals in just for a 4 week period, then protocols must be in place to euthanase them if they are not suitable for release at the end of this period, as any secondary conditions arising after arrival may not be reversible in this period of time

An additional problem associated with the use of temporary facilities even as satellite facilities is provision of experienced staff. Charlie Manire would not advocate this approach, as it would mean that no one veterinary surgeon would gain a decent amount of experience. Unlike the situation in a single permanent facility, you would end up with a number of vets in satellite facilities gaining only a small amount of experience. Frances Gulland highlighted the logistical problems of arranging suitable staffing in any form of temporary facility. Additional issues would be achieving good water quality in a temporary facility and ensuring adequate security for the site.

If a temporary holding or satellite facility is established, a pool design similar to the initial holding pools at Harbor Branch, Clearwater, Sea World and the Marine Mammal Center would be suitable. These are mass produced, round domestic swimming pools, with flexible sides of rubber coated nylon on a steel frame, designed for rapid erection in a matter of hours. Alternatively, a fibreglass pool with multiple skim levels could be set up.

Incidence of stress, stereotypic behaviour and other captivity-related conditions during rehabilitation, and their mitigation

Stress related changes in animals during transport and rehabilitation and their mitigation

Signs of stress observed in transit and rehabilitation include increased heart rates, respiratory rates and arching of the trunk, sputtering of the blowhole and flatulence. Cardiomyopathy may be a contributory factor to stress-related changes and deaths in transit and the early stages of rehabilitation. The condition, associated with contraction band necrosis, is thought to follow catecholamine release. It has been a frequent finding in stranded cetaceans in the United States (Turnbull and Cowan, 1998) and was found in 100% of all stranded cetaceans necropsied by the Marine Mammal Center. Marty Haulena has observed brief spikes in catecholamines in five animals following transport. He also has observed deaths in the first couple of days of rehabilitation that were thought to be stress related. At least one large dolphin lost during rehabilitation at Baltimore is thought to have been due to cardiomyopathy precipitated by stress, the animal dying after breaching excessively around the pool. Attempts to alleviate such stress related changes have included the use of propanolol, a beta blocker, to reduce heart rates, and sedatives, e.g. diazepam or midazolam, although these cannot be used in very sick animals.

Jim McBain believes fright may be responsible for many of the stress-related changes and deaths observed in transport. In his experience, animals undergoing rehabilitation generally adapt very fast to their surroundings, but there are a number of potential problems that need to be mitigated against. Social animals in rehabilitation may feel vulnerable, stressed or frightened and consequently cannot rest. This slows up their clinical progress and some may even 'lose the will to live'. Their behaviour does tend to improve with time, but invariably they will remain stressed to some extent, through the insecurity of being on their own. These species fare better in groups, an opinion shared by Charlie Manire, who believes this is also true for more 'highly strung' species such as Stenella species (spotted, spinner and striped dolphins). The Marine Mammal Center had a rough toothed dolphin, a social species that craved attention and was always curious and interactive with people. As the animal was considered unlikely to be a suitable candidate for release, the Center put people in the water with it, as the animal otherwise floated on the pool surface.

The restriction of cetaceans undergoing rehabilitation in a confined space is another stress factor in Jim McBain's opinion. Adequate pool depth, in particular, is important once an animal's condition has stabilised. If depth is inadequate, cetaceans, particularly pelagic species, will tend to float on the surface and, if this is observed, a move to a larger pool is required. Other factors associated with the captive environment also may cause stress. At the Marine Mammal Center, noise and vibration in the water generated by the plumbing for the filtration system, sited close to the pool, caused a harbour porpoise to stop diving, become inappetant and list and float at the surface.

Gastric ulceration was the most frequently observed clinical condition thought to be associated with stress. In the opinion of Rene Varela, this is seen in nearly all cetaceans undergoing rehabilitation. Charlie Manire suggests that inappropriate diet as well as stress of confinement is likely to be a contributory factor. In some cases, gastric worm burdens also may be implicated. Rene Varela believes that dolphin pox may develop following a stressor, e.g. when an animal is bled, and the infection may persist if the animal is chronically stressed.

Little blood work has been carried out to assess stress effects in animals undergoing transport and rehabilitation. Alkaline phosphatase tends to decrease rapidly in a sick animal, over 1-2 days, and also there appears to be a direct relationship between food intake, activity and levels of this enzyme. Normal levels tend to be much higher in cetaceans than in other species: it appears to be all bone in origin and it is possible that bone metabolism is shut down when cetaceans are sick. One observation has shown that if captive cetaceans are put in small pools, their alkaline phosphatase levels will decrease. The same experiment has not been conducted on animals undergoing rehabilitation, but it is possible that such restriction is affecting cetaceans' immune systems. A panel of blood parameters to assess stress levels in captive killer whales has been developed at Sea World and the intention is to apply these to cetaceans undergoing rehabilitation.

Peaks of stress associated with particular interventions and their mitigation

Handling for clinical examination and blood sampling was believed to be an important stressor in all facilities and in the opinion of Jim McBain, this is very much part of the fear-fright response. The concern of Robin Friday over the detrimental effects of frequent catch ups is mentioned in the sections on assessment and clinical pathology. At Harbor Branch, catch ups are minimised, and the effects of these interactions reduced through reinforcing positively following the procedure, typically with a feeding session. With animals unsuitable for release, this is usually paired with a play orientated training session, which focuses on the relationship between caregiver and animal.

Charlie Manire believes the stress of interactions also can be minimised by carrying out as many procedures as possible in the water. Certainly, research carried out at Mystic by its staff showed significant elevations in the stress-related hormones, ACTH, cortisol and aldosterone in captive beluga during out of water physical examinations and he suspects the same is likely to occur in rehabilitated animals. Jim Rice concluded that it is very important with out of water examinations to minimise time involved in capture, time out of water, and associated noise and activity.

Development of stereotypic behaviour patterns during rehabilitation and their mitigation

A frequently observed behaviour in cetaceans undergoing rehabilitation is swimming in the same direction in a circular pool and there was some debate among those interviewed as to whether this is stereotypic behaviour. Charlie Manire believed that this was not necessarily the case as, if the animal could swim in a straight line, it probably would. Furthermore, he had never seen this swimming pattern associated with obvious signs of stress. Robin Friday, however, believed that if such swimming is coupled with unresponsiveness to people, this is a sign of boredom. In the experience of Jim McBain, the behaviour is not a stereotypy unless it proves impossible to break the animal out of it, with interaction and play. The latter is an infrequent occurrence, but is a serious problem when it does occur. Some of these intractable cases are associated with brain damage, seen in many cetaceans stranding on the Pacific coast of southern California, and animals have to be euthanased if they fail to respond to treatment. Circular swimming patterns can lead to bending of the dorsal fin because, as Jim McBain explained, when the fin is out of the water, it warms up and softens and, when the animal is swimming in a circular pattern, it stretches on one side and contracts on the other, thus bending.

A behaviour generally believed to be a stereotypy and seen in a number of facilities is rubbing against the pool sides or bottom, sometimes at one particular spot. Flukes, flippers or heads may be rubbed, occasionally down to the bone. In one example, a harbour porpoise at New England's Duxbury facility repeatedly somersaulted in the water column to rub itself on the pool bottom. One postulation for the cause of such behaviour is that it is a way of coping with the extreme monotony of living alone in a small, artificial environment, where no conspecifics are available to interact with and rub against. Another example of probable stereotypic behaviour at Baltimore was a calf that latched on to the ridges of the soles of boots.

Means of mitigating against stereotypic behaviour centre on enrichment and training. Breaking an animal out of such behaviour has been achieved successfully with the introduction of toys and, in some cases, people, with operant conditioning, and through altering feeding patterns, combining neonates and moving animals into bigger pools.

Other captivity-related conditions arising during rehabilitation

Apart from gastric ulceration and rubbing, captivity related problems are rare and most conditions seen during rehabilitation are related to the animal's condition on arrival. Some husbandry-related conditions have arisen, however.

A small number of injuries have followed violent reactions to sudden changes in lighting. At Mystic, two animals sustained fractured mandibles in the old indoor facility when the lights were suddenly turned on. Sea World lost a northern right whale dolphin that hit the walls when the power failed and the lights suddenly came back on again; the animal died outright from concussion and a fractured jaw. Fractured mandibles have been observed in other animals undergoing rehabilitation in the same circumstances and it is important that back up generators and fail safe night lights are available to avoid this problem.

At Mystic, candidiasis had once been a problem but improved water quality and treatment regimes have made this condition a ‘thing of the past’. A sub adult male pigmy sperm whale also succumbed to pulmonary abscessation after inspiring a pine needle. Ingestion of foreign bodies in pools also can be a serious problem and care needs to be taken to avoid this happening. A rough toothed dolphin at the Marine Mammal Center went into suspected renal failure due to an error in pool water salinity, illustrating the potential for problems with systems using made up seawater. In some rehabilitation facilities not visited, it is reported that scoliosis had occurred in animals kept in cold water in too small a pool. This is reversible, if the environment is corrected very early in the process. However if it is not corrected early on, the scoliosis will involve bony changes that are not reversible.

Policy on enrichment and training during rehabilitation and its justification

Methods of enrichment and training used and reasoning behind their use

Enrichment

All facilities provide some level of environmental enrichment for animals undergoing rehabilitation. Usually, this is in the form of introduction of novel objects (‘toys’), but water sprays and currents, ropes slung across the pool, acoustic enrichment, varying the position of feeding and the type of feed (including live feeding) and human and other cetacean presence in the pool also may be used. Indeed, some environmental phenomena, e.g. rain and wind, also act as enrichment for animals undergoing rehabilitation. The techniques used vary greatly between facilities and also with the species of animal, its likelihood of being released and, in some facilities, its likelihood of encountering humans once released (see next section).

Toys used include water filled and air filled or other floating toys (i.e. bottom toys and surface toys). Care is taken to avoid toys that may be swallowed, or in which animals may become entangled or otherwise injured. Animals may not latch on to new toys immediately and also will blow hot and cold with different toys, so they have to be varied. At Harbor Branch, trainers also will haul out a toy when an animal is playing with it, so reinforcing this behaviour.

At Sea World, enrichment with toys is often restricted to animals that are non-releasable and showing signs of aberrant behaviour, particularly rubbing. Jim McBain pointed out that newborn or very young cetaceans undergoing rehabilitation are very tactile animals that need to be able to rub on something and, if rubbing starts and a rubbing object is not provided, they may rub down to the bone on the sides of the pool.

The justification for enrichment is to try and make up for the sterile environment in which animals are housed and thus keep the animals stimulated and free from boredom. Furthermore, as Jim Rice pointed out, through enrichment exercise can be promoted, ensuring attainment of good muscle tone and fitness.

Training

All facilities accepting neonates regularly use medical and husbandry training to facilitate clinical examination, blood sampling, stomach tubing and bottle feeding, and stretcher restraint with these non-releasable animals. Older animals deemed unsuitable for release also are often trained, although here human contact tends not to be as important as it is for calves.

Floating toys used at Mote

At Baltimore, a pigmy sperm whale and harbour porpoise, destined for release, also were trained. Training included human presence in the pool, with tactile stimulation during and following medical procedures, and primary reinforcement with food afterwards in order to desensitise the animal to physical restraint for examination. Deconditioning was carried out before release (see next section). A harbour porpoise that went into a state of learned helplessness when caught up with a net also had this behaviour positively reinforced with fish. The same animal was desensitised to transport before release (see next section). At Clearwater and Mote, a small amount of training occasionally has been carried out on releasable animals, for example to facilitate catch up.

Some species differences in response to training have been observed. Bottlenose dolphins tend to respond well, whereas striped and common dolphins tend to respond less positively.

Similar to enrichment, training alleviates boredom. It also facilitates completion of husbandry and medical procedures with the minimum of stress. It was emphasised by a number of those interviewed that an animal undergoing rehabilitation is learning whether formal training is taking place or not. As Robin Friday explained, everything that is done before and after an invasive procedure will dictate how the animal will respond to this in the future.

Minimising the risks of habituation and conditioning during enrichment, handling and training

In order to avoid habituation to any particular toy, staff at Baltimore and Mote, at least, rotate toys regularly. If an animal does become habituated, the particular toy is not given to the animal again for an extended period of time. With releasable animals, facilities tend to avoid toys bearing any resemblance to objects they may encounter in the wild that could be detrimental to the animals' health and well being. At Baltimore, unnatural objects are avoided altogether for animals intended for release, and live fish and crabs are used. In some facilities, toys are totally removed in the final stages of rehabilitation, prior to release.

Robin Friday training a non-releasable bottlenose dolphin calf at Harbor Branch

Facilities adopt quite different strategies in their attempts to minimise the conditioning of releasable animals to humans.

At one end of the spectrum is Baltimore, where a pelagic species, a pigmy sperm whale, and a coastal species, a harbour porpoises, intended for release have been trained during the course of rehabilitation. Here, deconditioning prior to release was achieved by the removal of people from the water and removal of any positive reinforcement associated with human contact.

At Harbor Branch, once it is determined that an animal is to be released, deconditioning of animals is achieved by avoiding any training that encourages an animal to become dependent. A schedule is adopted that prevents such conditioning behaviour, by avoiding regular feed times, handling times, etc, and thus discouraging solicitation by the animal. Efforts are taken to ensure the animal has a positive experience, e.g. food, after it exhibits behaviour that is appropriate for a released animal and not after an inappropriate behaviour. A bad experience, e.g. a catch up, is put in after inappropriate behaviour. Steps are taken to ensure that the animal has plenty to interact with so it doesn't continually look for people and people are withdrawn as much as possible in the last few months of rehabilitation.

At Mote, the degree to which human contact is avoided with releasable cetaceans during rehabilitation is determined by the species. Human contact with coastal species is minimised, the connection between humans and feeding is broken as soon as practical through remote and randomised feeding, and no training is carried out. Pelagic animals are considered unlikely to encounter humans, so staff are less concerned over the risk of conditioning. Some training may be carried out with these species, but every effort is still made to try and minimise bonding with humans.

At Sea World, the philosophy is one of minimal interaction throughout rehabilitation for every species, but Jim McBain admits that, as all procedures are potentially negative or positive reinforcements, this is difficult to achieve. He believes becoming desensitised to, and dependant on humans is a major cause of failure to survive in rehabilitated animals, so there is a need to minimise human contact and any opportunities for humans to become reinforcing contacts. A similar philosophy is adopted at Mystic, due to concerns over habituation and the inability to effectively decondition animals prior to release. People are only allowed into the pool for the first couple of days of a rehabilitation attempt, remote feeding is started early on and no training, including operant conditioning, is carried out with animals undergoing rehabilitation. This is also the case at the Marine Mammal Center.

Criteria used to determine when an animal is fit for release and policy for those considered unsuitable for release

Criteria used to determine when an animal is fit for release and the reasoning behind the use of these criteria

The criteria for release of a stranded cetacean from any rehabilitation facility in the United States are determined by NMFS. The criteria are laid out in a set of guidelines that have been in draft format for about 10 years.

These are:

- *The animal is in appropriate body condition for the species, age, sex and time of year* –
  This requires provision of information on its length, weight and axial girth at the time of stranding, during rehabilitation and prior to release, and its species, sex and estimated age.

- *The animal is free from a diagnosable disease* -
  Results of diagnostic tests, including serology, must be provided to substantiate this, plus an account of the diseases, illnesses or injuries the animals was treated for. Two negative morbillivirus serology tests are required, the animal must have a normal blood screen (haematology, biochemistry) a maximum of 10 days prior to release and, at the time the last blood sample was taken, the animal must be examined physically by a veterinarian, certified healthy, and a statement provided that, to the best of the vet's knowledge, the animal is not a threat to wild populations.

- *The animal is independent of medication* –
  Details of medications given have to be disclosed and it has to be off all treatment for 3-4 weeks before it can be released.

- *The animal is illustrating normal behaviour, including the ability to catch live prey* -
  A description of the animal's captive behaviour must be provided, including locomotion, feeding, vocalisations, etc., and also information on the frequency and success of live prey consumption, including details of prey items.

- *The animal is not a neonate and is not still dependent on its mother* -
  Neonates are not released due to concerns over their ability to survive in the wild, with little pre-existing knowledge of the wild environment or ability to develop appropriate social behaviour. Bottlenose dolphins need to be into the second year of life and harbour porpoises more than 10 months old on arrival for them to be considered for release. The exception is where animals are released with their mothers.

- *The animal is suitably tagged* -
  It must be marked for identification prior to release with a freeze brand or rototag and a monitoring or tracking technique selected on the basis of the expected ranging pattern of the animal, i.e. photoidentification, VHF or satellite telemetry. Full details of satellite tags must be supplied, including expected tracking duration, and confirmation provided that the attachment mechanism is degradable and the person attaching the tag is experienced.

- *An appropriate release plan is in place* -
  Information required includes anticipated release date, duration and method of transport and details and rationale for the proposed release site. Cetaceans must be released in known habitats (geographically and temporally) for that species in the wild, as indicated by information gleaned from sightings, strandings and bycatch. Where known, the individual should be returned to its home range. If this is not known, and the stranding site is in an appropriate habitat, the animal is released close to the stranding site. If the stranding site is not suitable, then the animal is released in the nearest appropriate habitat to the stranding site. With bottlenose dolphins, it is possible, through use of haemoglobin electrophoresis, to determine if the animal is an inshore or offshore type and an appropriate release site is chosen accordingly. Other information required on the appropriateness of the release site includes sea temperature, and fishing effort and shipping traffic in the area as projected for the time of release. NMFS will help with the provision of at least some of this information.

If a facility has an animal they consider suitable for release, the attending vet must notify NMFS that the animal fits all the above criteria. When deciding if the criteria have indeed been met for the animal, NMFS will often consult other authorities on cetacean rehabilitation, although these will tend to go with the judgement of the rehabilitation facility and the vet caring for the animal. Ultimately, however, NMFS make the final decision, and they may block a release.

There can be some flexibility over the application of the release criteria. If an animal meets all the main criteria, and only one or two minor criteria aren't satisfied, occasionally NMFS will allow an "Experimental Release", after consulting with a number of marine mammal veterinarians, particularly if the facility can demonstrate an ability to catch the animal up again. Jim McBain stated that the policy of Sea World is to try and release animals considered to have as low as a 50% chance of survival post release. In their experience, usually it has been possible to persuade NMFS to allow such a release to occur, as long as it can be shown that the animal is no threat to wild populations.

Where strict adherence to the NMFS release criteria has been applied, this has resulted in some rehabilitations being greatly prolonged. For example, the release of a harbour porpoise from Baltimore was delayed while waiting for a leucopenia to correct, which extended the rehabilitation period to a total of 13 months (Westgate *et al.*, 1998). A harbour porpoise present at Mystic at the time of my visit has had its release delayed by at least 14 months primarily due to concerns over the intended release site.

Some of the NMFS release criteria are rather subjective, for example assessment of the appropriateness of captive behaviour exhibited by a social animal in what is essentially an antisocial environment. However, animals that obviously have become habituated during rehabilitation would not be candidates for release.

The interpretation of serology results for morbillivirus has been a contentious issue. A positive titre indicates that an animal has been able to mount an immune response following exposure to morbillivirus and thus it could be immune rather than having an active infection. Sea World have managed to release an animal with a positive morbillivirus titre despite NMFS initial reluctance, by illustrating that the animal was indeed immune and not a source of contagion. As a result, NMFS will now allow the release of animals with repeatedly high but stable titres to morbillivirus and no signs of infection.

The NMFS criterion covering the earliest age at which a young cetacean can be released tends to be evaluated on a case by case basis. Robin Friday is of the opinion that this age should be the point at which a calf is no longer 'living' with its mother, as the calf needs to learn all its social and feeding skills from her. This may be at a few years old, for example, in bottlenose dolphins. Animals have been released where it is questionable as to whether they were fully weaned. For example Baltimore was allowed to release a harbour porpoise whose length at the time of stranding suggested it was, at best, barely weaned, after illustrating that it could take live fish At least one definitely unweaned neonate has been released, of a species that was probably too large to keep in captivity. This was JJ, a grey whale that was less than one week old at the time of rescue. In order to optimise her chances of survival on release, she was weaned at the same time grey whale calves are weaned in the wild and released on the normal migration route after 14 months' rehabilitation. Her chances of survival were still accepted as slim, but it was felt that a lot could be learnt from the release of a baleen whale and permanent captivity was not an option. It is possible that other successfully rehabilitated neonates of large whales would also be considered for release by NMFS. Marty Haulena also believes that it may be appropriate to allow experimental releases of solitary species that are unweaned on arrival, e.g. harbour porpoises, as social development may not be as critical for their survival as it is likely to be in more social species. The animal would still need to be weaned and able to forage for live fish in its pool at the time of release. Here comparisons were drawn with the numerous releases of unweaned harbour seals with apparent success.

In defending the release criterion of feeding live prey, Charlie Manire explained succinctly that he would not want to put several months' effort into rehabilitating an animal, then release it and have it starve to death because it could not catch prey. Although this is unlikely to be a problem for older, more experienced animals that have not been in rehabilitation for long, it could be a problem for younger animals. He agreed that catching live prey in a pool cannot be equated with catching them in the wild and consequently, it is required that each animal demonstrate only once that it will seek and capture live prey. However, with some species, demonstrating an ability to feed on live prey is not possible, as the normal prey for the species cannot be obtained. This is the case with pigmy and dwarf sperm whales, which feed on deep-water squid.

Every effort is made to minimise transport time to the release site, and thus minimise the risk to the animal's ability to survive transport and function properly after release. Where possible, members of social species are released into groups of conspecifics, found beforehand by spotter plane. However, if finding such animals unreasonably lengthens the duration of transport, this is not adhered to. Releases tend to be from boats although, in facilities such as Baltimore, far removed from the home range of many of the animals they receive for rehabilitation, animals first may have to be flown some distance to get them back to their home range. Preparations also have to be made to potentially recover the animal if it fails to thrive: stranding network members are notified of the release and rehabilitation facilities are made available to receive and care for the animal if the need should arise. Realistically, though, such recovery would be very difficult to achieve in most circumstances.

A comprehensive review of the release guidelines has been underway for a number of years, and the final document arising from this will provide more comprehensive criteria and guidance. The delay in the completion of this document has been due to its high level of detail and its constantly changing scope and content, as fields of study and methodologies continually develop. A number of vets and scientists attached to the facilities visited have been helping NMFS with the development of these new guidelines.

Other factors allowed to affect the timing of a release

Most facilities will allow the arrival of a satellite or VHF tag to delay the timing of release by a few days as long as this is not compromising the animal's health.

Most facilities will allow the release date to be postponed for a short period of time to facilitate two animals housed together to be released together.

A small number of facilities may allow release to be delayed by a few days for NMFS sanctioned research to be completed. Sea World will ask for the animal to be transferred by the research team to another facility for this to be carried out, if they are not in agreement with the delay or the nature of the research.

Disposition of animals unfit for release

Apart from unweaned animals, animals that are non-releasable include older animals which fail to meet the major release criteria, including those with epilepsy, disabling trauma, for example severe injuries to the head and tailstock, or disability, such as blindness or impaired echolocation, rendering the animal unable to catch live fish.

Once an animal is declared non-releasable by NMFS, it will become a permanent captive and will fall under the control of the Animal and Plant Health and Inspection Service (APHIS) of the United States Department of Agriculture (USDA), which permits, inspects, and regulates facilities with permanent animals. If the rehabilitation facility cannot house the animal itself, NMFS will determine where it is placed, although the rehabilitation facility can make recommendations.

Although bottlenose dolphins are not difficult to home, other species are more difficult. The Dolphin Research Centre in Florida Keys and Sea World will take some pelagic dolphins, but few other facilities will take such animals. This difficulty in placing rehabilitated non-releasable animals has been exacerbated by the significant advances made recently in the rearing of stranded neonates of not only bottlenose dolphins but also other species. As, Robin Friday pointed out, it is important to try and home these neonates with others of their own species, so that hopefully they will learn the skills they have missed out on.

Due to the shortage of appropriate accommodation available for non-releasable animals, Mystic and Sea World only attempt to rehabilitate unweaned calves if it is known in advance that they can be accommodated afterwards. Apart from bottlenose dolphins, therefore, they are very selective about what they will take on and larger species are usually euthanased as these will be impossible to place. The release of the neonatal grey whale from Sea World was an exception to this rule. At Mote, where the ability to bring on neonate pigmy and dwarf sperm whales continues to improve, the intention is to build a permanent facility for surviving unweaned animals, housing them in the lagoon pool in the short term. Clearwater and Baltimore have provided a home for non-releasable animals rehabilitated in the past. Harbor Branch and the Marine Mammal Center will rehabilitate non-releasable animals but would need to relocate them to a permanent home. At New England, every effort is made to try and eliminate animals likely to be non-releasable through triage before rehabilitation is attempted and Jim Rice believes euthanasia may be the best option for these animals.

Justification for keeping non-releasable animals as permanent captives

Permanent captivity is justified by all facilities primarily on the grounds of public education about anthropogenic impacts on animals. Non-releasable animals are often termed 'ambassadors of ocean health'. They are also considered an educational resource for the scientific community, particularly species about which little is known, e.g. pigmy and dwarf sperm whale calves. Here they provide information not only about the species in general but also information specifically of value in the management of animals that come in for rehabilitation in the future. A further justification cited is their value in captive breeding programmes, by increasing genetic diversity and reducing the drain on wild populations. Lawrence Dunn also believes that providing a permanent captive home is the only option acceptable to the volunteers who rehabilitate a non-releasable animal; euthanasia would be very difficult to justify to them. "The time to euthanase an animal which will be non-releasable and for which a permanent home cannot be found, is early in the course of handling, not after a large number of people have invested countless hours in rehabilitation efforts".

Non-releasable bottlenose dolphin held in permanent captivity at Clearwater

Lawrence Dunn is of the opinion that most cetacean species rehabilitated can make the adjustment to becoming permanent captives. "Some of it is just a gut feeling, and all of it is predicated on a good captive environment, water chemistry, food quantity and quality, pool size, conspecific companionship, and excellent care. The animals engage in lots of play, seek out contact with animal care staff, have low resting cortisol levels and react very differently from the way cetaceans held in substandard facilities did many years ago".

Jim McBain also believes that rehabilitated cetaceans can have good lives in a captive environment, although admittedly different lives from those animals living in the wild, as long as those caring for the animal are committed to what they are doing. In his opinion, space is not an insurmountable issue, as all other needs are provided for and the animal benefits from the social contact they have in the captive facility. Even if a lot of space is available, frequently it is challenging to make the whole facility reinforcing so that the animals will use all the habitat available to them. He illustrated this with an example from Kolmarden Zoo in Sweden, where the harbour seal exhibit was huge, but the seals were swimming around in one small corner of the facility, choosing to stay near the area where the keepers were and where they were fed. The issue of space nonetheless is always foremost in the minds of the vets at Sea World and most of those working with captive cetaceans would prefer facilities bigger than those presently available. Furthermore, although Jim McBain believes that the USDA's APHIS space and housing standards defined in the Animal Welfare Act have proved to be adequate for animal health, he feels they are not from the point of view of public perception. Larry Dunn pointed out, however, that a number of surveys have documented satisfaction on the part of the public with the facilities in numerous institutions.

The relative importance of the nature of the facility versus the engagement of staff with the animal was discussed with Robin Friday. His belief was that if there was a choice between a standard concrete captive facility with experienced staff who have ability to take care of the development of a young calf and are able to provide operant conditioning, and a natural lagoon without such staff, the former would be preferable as the animal's needs would be met and it would be more likely to survive.

Survival of stranded animals during refloatation, transport, rehabilitation, captivity and following release

Survival of refloated animals

Most facilities have not used this option and therefore have not had the opportunity to determine the survival of animals after refloatation.

Mystic have refloated a number of animals from mass strandings; 2 Atlantic white-sided dolphins in 1986 and 20 pilot whales from a mass stranding of 40 animals in the same year. The Atlantic white-sided dolphins were not monitored post release. Three of the 20 pilot whales were tagged on the dorsal fins and did not restrand, but no other information was obtained about their survival. Sea World have used this option, but no monitoring apart from checking for restranding was carried out, and a 'reasonable percentage' tended not to restrand. The Marine Mammal Center have refloated on two occasions; both times the animal was a bottlenose dolphin stranded behind a sandbar on mudflats in the same bay. The first was refloated nearly immediately. The second was relocated to an ocean beach a couple miles away, then refloated. No tracking was performed on either animal.

The option has been used quite often by New England. A significant number of refloated animals have restranded and died. A number also have not reappeared, but no effective monitoring of these animals has been carried out to date. As Jim Rice pointed out, the survival rates for these animals will not be known until animals are monitored for long periods (6-8 weeks minimum) post release. New England submitted an application for Prescott grant funding (see section on 'Funding rehabilitation') for the tagging of mass stranded animals on Cape Cod in 2002. This failed, but they are trying again in 2003.

Release rates for stranded animals taken in for rehabilitation

Full access to data on release rates for animals where rehabilitation was considered an option was not achieved in all facilities. In one facility, no data was readily available for perusal.

The data given in this section needs to be considered in the context of the small numbers of animals involved and the large variation in the nature and location of strandings that influences the outcome of attempted rehabilitations before an animal is admitted to a facility. These variables include the species, age and condition of animals stranding, substrates on which animals stranded, environmental conditions at the time of strandings, response times to strandings and distances transported.

Harbor Branch:

a) Data for the years 1999 to 2001: 20 live strandings attended, 2 died on the beach, 1 died during transport, 12 died during rehabilitation, 1 released, 4 died after transfer to other facilities. The animal released was an adult male bottlenose dolphin that had been attacked by bull sharks (after approximately 160 days).

- *Death rate in transit: 1/18 = 5.5%*
- *Release rate of those transported: 1/18 = 5.5%.*
- *Release rate of those admitted for rehabilitation: 1/17 = 6%*
- *Release rate of those admitted that were potentially releasable (i.e. weaned animals): 1/14 = 7%.*
- *Non-releasable animals admitted: 3/17 =18%*

b) Comment: animals are usually terminally ill on arrival and animals will often die in the first few days of rehabilitation.

Mote

a) Data for the years 1992 to 2002: 34 live strandings admitted for rehabilitation, 9 died during the first 10 days, 8 died after 11-50 days, 3 died after 51-100 days, 5 died after 100-200 days, 1 died after 631 days, 1 is still alive after 307 days (as of 17/5/03) and 7 were released. Of these, 6 animals were non-releasable as they were neonates. Animals released included 5 bottlenose dolphins (released after 37, 69, 92, 107 and 111 days) and 2 rough toothed dolphins (2 of 4 animals admitted from a mass stranding of 62 animals – both released after 101 days).

- *Death rate in first 50 days of those admitted: 17/34 = 50%.*
- *Release rate of those admitted: 7/34 = 21%.*
- *Release rate of those admitted that were potentially releasable (i.e. weaned animals): 7/27 = 26%.*
- *Non-releasable animals admitted: 6/34 = 18%*

b) Comment: occasionally individuals have died during transport, but these invariably were extremely emaciated animals that had obviously been very sick for a long time.

Clearwater:

a) Data for the years 1993 to Jan 2001: 29 live strandings admitted for rehabilitation, 19 died during rehabilitation and 10 were released. Of these, 1 animal was non-releasable, as it was unweaned and probably not admitted with its mother after a mass stranding. Animals released included 4 Clymene dolphins (4 of 6 admitted from a mass stranding of 18 animals – all released after only 4 days), 4 bottlenose dolphins (released after 80 and 85 days and a mother-calf pair after 181 days) and 2 pantropical spotted dolphins (2 of 3 admitted from a mass stranding of 3 animals – both released after 73 days).

- *Release rate of those admitted: 10/29 = 34%*
- *Release rate of those admitted that were potentially releasable (i.e. weaned animals): 10/28 = 36%*
- *Non-releasable animals admitted: 1/29 = 3%*

It could be argued that those animals admitted from the mass stranding of Clymene dolphins were not strictly rehabilitated, as they were only in the facility for 4 days. If this mass stranding is not included in the data set:

- *Release rate of those admitted: 6/23 = 26%*

b) Comment: no animals were released in the twenty years prior to 1993 that Clearwater was taking in cetaceans for rehabilitation, although one non-releasable animal, stranded in 1984, became a permanent captive. Since January 2001, a number of animals have been admitted, but only one animal has been released (after 62 days), a young female bottlenose dolphin that stranded near the aquarium after suffering from suspected intraspecific aggression. Most mortalities tend to occur in the first couple of days of rehabilitation, although occasionally an animal may respond initially and then crash several days into rehabilitation. Two animals have been lost in transit in the last 5 years, one immediately after loading and one an hour into transport.

Baltimore:

a) Data for the years 1990 to 2002: of 24 animals elected for attempted rehabilitation at Baltimore, 19 died during transport or rehabilitation, 2 were non-releasable and placed into collections and 3 were released. Animals released included 2 harbour porpoises (after approximately 180 days and 400 days), and 1 pigmy sperm whale (after approximately 150 days).

- *Release rate of those transported: 3/24 = 12.5%.*
- *Release rate of those transported that were potentially releasable (i.e. weaned animals): 3/22 = 14%.*
- *Non-releasable animals transported: 2/24 = 8%*

b) Comment: most animals died in transport, and most of those dying in rehabilitation died in the first 1 to 2 weeks. If animals live beyond 30 days, they tend to have a good chance of survival; if they live beyond 90 days, they have a really good chance of survival. However, animals may crash any time up to 90 days after arrival.

Mystic:

a) Data for the years 1976 to 2002: 33 animals elected for attempted rehabilitation, 3 died in transit, 11 died during the first 10 days, 7 died after 11-50 days, 0 died after 50-100 days, 5 died after 101-200 days, 1 died after approximately 240 days, 1 died after approximately 450 days, 1 died after 646 days, 1 is still alive and awaiting release after approximately 545 days (as of 23/7/03) and 4 were released. 2 animals were non-releasable. Animals released included 2 Atlantic white-sided dolphins (after 116 and 253 days), and 2 pilot whales, which stranded together (both released after 115 days).

- *Death rate in transit: 3/33 = 9%.*
- *Death rate in first 50 days of those admitted: 18/30 = 60%*
- *Release rate of those transported: 4/33=12%*
- *Release rate of those admitted: 4/30 = 13%*
- *Release rate of those admitted that were potentially releasable (i.e. weaned animals): 4/28 = 14%*
- *Non-releasable animals admitted: 2/30 = 7%*

b) Comment: another animal attended, a pilot whale involved in a mass stranding, was released after approximately 190 days at New England Aquarium (two other animals from the same stranding taken to New England died). Animal awaiting release is not included in above calculations.

Sea World:

a) Data: not readily available.

b) Comment: probably 20% of animals attended will die before they are recovered from the beach, in transit or within a few hours of arriving at the rehabilitation facility. The longer the transport, the higher portion of that 20% that will die during the transport phase. This means that 20% are probably going to die, regardless of any action that is taken. If animals are not going to survive after admittance, it is usually apparent within the first 2 to 3 days. If they make three days and stabilise, then there is some chance of success. The survival rate overall during rehabilitation may vary from 0 to 80% on an annual basis. An important annual variable is whether there has been an El Nino. During El Nino years, a lot of animals strand purely through malnutrition and hypothermia and survival rates are very good, for example 5 out of 7 animals were released one year. A crude estimate of the overall survival rate is 25%. Prior to 1994, no animals survived to the point of release.

Marine Mammal Center:

a) Data for the years 1980 to 2002: information was received from 58 of the live strandings attended (approximately two thirds of the data). Of these, 36 were transported to rehabilitation facilities, 5 died during transport, 8 survived 0-24 hours, 4 survived 24-48 hours, 1 survived 48-72 hours, 6 survived 72 hours - 1 week, 4 survived 1-3 weeks, 1 survived 3-4 weeks, 4 survived more than 4 weeks, 1 was transferred (and subsequently died a few days after transfer) and 2 were released. It is unknown as to how many of these animals were non-releasable. Animals released included 1 harbour porpoise (which spent approximately the last 30 days of 101 days' rehabilitation in Marine World Africa USA) and 1 common dolphin (transported to Sea World soon after arrival and released from there).

- *Death rate of those transported: 5/36 = 14%*
- *Death rate in first 28 days of those admitted: 24/31 = 77%*
- *Release rate of those transported: 2/36 = 5.5%*
- *Release rate of those admitted: 2/31 = 6.5%*

b) Comment: two other common dolphins picked up by the Marine Mammal Center and transported straight to Sea World were released and also another common dolphin taken to Marine World Africa USA and then on to Sea World. Nearly two thirds of animals admitted died in the first week of rehabilitation. Factors contributing to poor survival include prolonged transport times, too small a pool and the fact that most animals are very sick on arrival.

New England:

a) Data for the years 1968 to 2002: of approximately 28 cetaceans admitted for rehabilitation, New England or a secondary facility managed to release about 12 animals.

- *Release rate of those admitted: approximately 12/28 = 43%.*

b) Comment: Jim Rice feels this doesn't necessarily provide a meaningful number, as the decision to euthanase may be taken only after an animal deteriorates during transport to the facility or within the first day or so of rehabilitation. Few animals have been lost during transport.

Survival times for animals deemed unfit for release and kept in captivity

Harbor Branch:
1999 – 2001 data: survival times for non-releasable animals are unknown.
2002: 1 unweaned bottlenose dolphin went to the Keys after 6 weeks at Harbor Branch and died after 4 weeks, i.e. total survival time of approximately *70 days*. 1 unweaned bottlenose dolphin is still alive after approximately *390 days* (as of July 2003).

Mote:
1992-2002 data: 5 pigmy whale calves had survival times of *91-631 days*; 1 dwarf sperm whale calf is still alive after *353 days* (as of 2/7/03).
Comment: if the nutrition is right, stress is minimised and human contact for calves is maintained, then there is a good chance of bringing them through.

Clearwater:
1993 – Jan 2001 data: 1 Clymene dolphin calf was brought in as part of a mass stranding and died after *86 days.*
Before 1993: 1 bottlenose dolphin lived for *17 years*.
Since 2001: 1 bottlenose dolphin is still living at the aquarium approximately *21 months* after stranding (as of July 2003).

Baltimore:
1990-2002 data: 1 unweaned bottlenose dolphin survived approximately *180 days*. 1 unweaned common dolphin, held first at the Marine Mammal Stranding Center, New Jersey, and then at Sea World, survived approximately *180 days*.

Mystic:
1976 – 2002 data: 1 harbour porpoise survived *646 days*, 1 common dolphin survived for approximately *450 days* in total, dying at Sea World, San Diego after an initial 8 months at Mystic.
In addition: 1 unweaned bottlenose dolphin transferred after 6 months from Texas Marine Mammal Stranding Network, survived another 10 months, i.e. a total of approximately *480 days.*

Sea World:
Longest lived cases:
1 common dolphin that stranded as a neonate died after *5 years.*
1 common dolphin that stranded as a mature animal died after *18 years.*
1 killer whale that stranded as a juvenile died after *7-8 years*.

Marine Mammal Center
1980 – 2002 data: all non-releasable animals were transferred to Sea World - the survival times of these animals are unknown. One animal recently transferred lasted only a few days, but some animals have lived longer.

New England:
No animals have become permanent captives, at least recently.

Variation in survival times and release rates between different age classes and different species

The only facilities for which this could be tentatively evaluated were Mote and Mystic. Again, the observations made here have to be considered in light of the small sample sizes and large numbers of variables associated with strandings.

Mote:
Age: 63% (17/27) of adult and juvenile animals died in the first 50 days, whereas only 17% (1/6) calves died during this period. Thus, a higher proportion of unweaned animals appeared to survive beyond the early stages of rehabilitation than weaned animals.
Species: bottlenose dolphins made up the majority of animals released (5/7, i.e. 71%) and this was half of all that came in of this species. Half of the rough toothed dolphins (2/4) also were released. Although none of the 10 pigmy sperm whales that came in were released, half of these were calves, of which 0/5 died in the first 50 days and one lived for 631 days. 2/2 dwarf sperm whales died in the first 50 days, although an additional animal in at the time of the visit is still alive after 353 days (as of 2/7/03). All false killer whales (3), Gervais beaked whales (1) and common dolphins (1) died in the first 50 days. The best release results therefore appear to have been with bottlenose dolphins and rough toothed dolphins, but significant progress is being made in keeping pigmy (and more recently dwarf) sperm whale calves alive.

Mystic:
Age: only one calf has been admitted and this died within 10 days of arrival. Juveniles: 8/14 (57%) animals died in the first 50 days and 2/14 (14%) were released. Adults: 8/10 (80%) animals died in the first 50 days and 2/10 (20%) were released. Thus, although similar numbers of both age groups were released, a higher proportion of juveniles appeared to survive beyond the early stages of rehabilitation than adults.
Species: the most common species brought in were Atlantic white-sided dolphins (2/7, i.e. 29% released), harbour porpoises (0/6 released, although a 7th animal is awaiting release), long-finned pilot whales (2/6, i.e. 33% released), white beaked dolphins (0/6 released) and common dolphins (0/4 released). Single animals of dwarf sperm whale, pigmy sperm whale, bottlenose dolphin, striped dolphin and an unknown Stenella species were also seen; none were released. The best release rates therefore appear to have been with pilot whales and Atlantic white-sided dolphins.

Supporting the data above, Robin Friday and Mark Trimm also found that neonates and adolescents survive longer during rehabilitation. However, they also felt that if adult animals do survive, their release is more appropriate as, even if they are in captivity for a year, they will not lose the skills they learnt in the wild. With adolescents, it is less clear that this is the case. Jim Rice believed younger (and therefore smaller) animals might tend to show higher survivability due to a lower incidence of stranding-related complications. Interestingly, at Baltimore, the best release results have been seen with just weaned harbour porpoises: these accounted for two of the three animals released, which was a third of the total number of this species transported to the facility. At Sea World, old animals and grey whale neonates have tended to have poor survival rates. Only one of the latter survived to release and this was probably because it was the only one found suffering purely from emaciation, with no other underlying condition. Jim Rice thought that pelagic species probably had a lower survival rate in rehabilitation due to a reduced ability to acclimate to a captive environment.

Changes in survival times and release rates with time

The only facility where access was possible to a complete data set spanning a number of decades was Mystic. Splitting the data into three 8-year periods, the number of deaths occurring in the first 50 days of rehabilitation was as follows:
1976-1984: 7/12 (58%)
1985-1993: 5/9 (56%)
1994-2002: 4/9 (44%)
The release rates of those transported were as follows:
1976-1984: 1/13 (8%)
1985-1993: 1/9 (11%)
1994-2002: 2/11 (18%)
This suggests possibly that there has been an improvement in survival times and release rates with time. However, this observation again has to be considered in light of the small sample sizes and large numbers of variables associated with strandings.

Post release monitoring techniques employed to determine the survivability of released cetaceans

As discussed in the section considering criteria for release, a variety of post release monitoring methods have been used. Historically, techniques have included photoidentfication, rototags inserted in the dorsal fin and freeze branding. Today, remote tracking techniques also are frequently employed.

Randy Wells detailed the post release monitoring protocols at Mote. If the animal is expected to stay in sheltered coastal waters following release, then photoidentification with follow up observations is used. For coastal animals likely to range so far that photoidentification becomes impractical, but are still likely to remain within range of a shore, boat or aircraft, VHF tags are used. Satellite tags are reserved for animals where it is not known how far they will range, or where they are expected to range offshore. Location only satellite tags are adequate for the monitoring of released animals, in Randy Wells' opinion, as it is possible to interpret tag movement in relation to known currents, and thus determine if the movement is passive or active. Because tags can be unreliable, however, when a signal fails, it can be difficult to determine if the tag has failed or the animal has died. Here, combining a satellite tag with a VHF tag allows follow up observations, and provides an alternative source of information if one tag should fall off or otherwise fail. Apart from the tags, other logistics also need to be arranged, e.g. vessels for VHF tracking and observations, aircraft for more distant VHF tracking, and Argos for satellite tracking.

The other facilities visited also use these methods of post release monitoring. Clearwater follows a similar protocol to Mote, for coastal and pelagic animals. Baltimore has used satellite tags and freeze branding and Mystic has used these techniques plus rototags and, on one occasion, a spaghetti tag. Sea World and the Marine Mammal Center have used satellite and VHF tags and New England ideally will attach satellite tags.

Before attaching satellite tags, a cast of the fin is taken to ensure a good fit. Tags are then fitted either a few days before release (to allow assessment of infection, stress, etc.) or at the time of release. There is some debate as to whether side-mounted or wrap around attachments should be used. Randy Wells is happy that the attachment mechanism for side-mounted tags (delrin pins with plastic coated zinc nuts) allows the tag to come away quickly and cleanly. However, he believes wrap around tags may be more likely to fail incompletely, as they are more rigidly held against the dorsal fin. He also believes wrap around tags act as a foil on the front of the dorsal fin and thus are less hydrodynamic. Hubbs-Sea World Research Institute, however, created the wrap around satellite tag as they found it created the least drag in tests carried out on captive animals. Lawrence Dunn also has found skin irritation to be a problem with side-mounted tags.

Jim Rice put it succinctly that only with effective post release monitoring, will the successes and failures of rehabilitation and refloatation be known. At New England, it has been agreed that monitoring needs to be maintained for a period of 60 days, generally accepted as the time needed to give a reasonable assessment of the animal's likely survival after release (Greg Early, personal communication). As Jim McBain pointed out, it may take an animal at least two months to die if they are not feeding successfully. In addition to determining an animal's ability to readapt to the wild, Robin Friday stated that information could be obtained from post release monitoring on social structures, habitat utilization and grand scale movement patterns. Randy Wells added that the biological information gleaned from a tracked animal becomes important beyond the point where you have satisfied yourself that the animal has survived. Greg Bossart believes tracking will probably become a NMFS requirement.

Attaching a side mounted satellite tag to a harbour porpoise at New England (photograph courtesy of Jim Rice)

Information obtained from post release monitoring

Only in 6 facilities was data available on post release monitoring.

Harbor Branch:

- 2001: 24 year old male Atlantic bottlenose dolphin, which survived a shark attack and was rehabilitated for approximately 160 days. A 2oz VHF transmitter was attached to the trailing edge of the dorsal fin with one plastic pin before he was released into the Indian River Lagoon. The aim was to track him for 60-90 days and the tag had a 30 mile range under ideal conditions. Over the first month of his release, he was tracked and sighted on many occasions in the lagoon, he maintained his body condition, exhibited normal behaviour and respiratory rates, and reunited with a lifelong partner and other dolphins. After 99 days, he was found dead, and appeared to have died in a freak incident, after chasing and asphyxiating on a species of wrasse that was not normal prey. It was believed that he was exhibiting aberrant behaviour, trying to catch any food he could, because he was at the end of his life cycle.

Tracking results: 1/1 tracked for 60 or more days.

Mote:

- 1992: adult male bottlenose dolphin, stranded following entanglement, rehabilitated for 37 days. Freeze branded. Known from photo-ID work in the area of release and observed several times following release over a 2.5 year period
- 1993: adult male bottlenose dolphin, stranded following shark attack, rehabilitated for 107 days. Freeze-branded and roto-tagged. Known from photo-ID work in the area of release and observed several times following release over a 6 month period.
- 1997: adult male bottlenose dolphin, stranded with bloat, rehabilitated for 69 days. VHF tag. Tracked for less than 1 day: it headed straight out into the Gulf and was probably an offshore species.
- 1997: adult male bottlenose dolphin, stranded for unknown reasons, rehabilitated for 111 days. Freeze branded, location only satellite tag and VHF tag. Tracked for 47 days. He was tracked and observed for an hour and a half post release and immediately began diving for over 3 minutes at a time. His movements over the first week suggested some initial disorientation, but then he travelled offshore and ended up covering 4200 km in the period of tracking, from Florida to the Caribbean, swimming at times against known currents and avoiding colder water, but ending up in deeper water off the continental shelf. (Wells *et al.*, 1999).
- 1998: two adult male rough toothed dolphins, part of a mass stranding of 62 animals, rehabilitated for 101 days. Satellite and VHF tags. Tracked for 112 days throughout the northeastern Gulf of Mexico. The animals were observed with the tags on 4 months after release and with the tags off 5 months after the release – there was no discernible damage to the dorsal fin and the animals were in good body condition (observed by a fisherman).
- 1999: juvenile male bottlenose dolphin, stranded with malnutrition, pneumonia, heavy parasitism and gastrointestinal infection, rehabilitated for 92 days. Satellite tag and VHF tag. The satellite tag failed immediately, but he was tracked by VHF for approx. 8 hours on the day of release and was picked up again the following day. He was found dead within 1 week of release, but the body was too decomposed for post mortem examination. Death may have been due to rough seas associated with a hurricane.

Tracking results: 4/7 tracked for 60 or more days, 1/7 tracked for 40 -59 days, 1/7 unknown and 1/7 dead in less than 10 days.

Clearwater:

- 1993: adult male bottlenose dolphin, stranded with malnutrition and trauma, rehabilitated for 80 days. Not tracked or observed.
- 1995: four adult Clymene dolphins, stranded as part of a mass stranding of 25 animals, rehabilitated for 4 days. One animal roto-tagged. Restranded in the same area after 24 hours.
- 1997: adult male bottlenose dolphin, stranded in bad weather with pneumonia, rehabilitated for 85 days. Freeze branded and location only satellite tag. Tracked for 43 days. Only 4 reliable signals were received and these were not of sufficient quality for precise location estimates. He appeared to have travelled 2,050 km around the south tip of Florida and up the Atlantic coast of the southern United States, the movements corresponding to known currents, but the surface-time counter data was consistent with other cetaceans, suggesting he was spending similar times at the surface to healthy dolphins. (Wells *et al.*, 1999).
- 1997: bottlenose dolphin mother and calf, mother stranding with post parturient complications, rehabilitated for 181 days. Freeze brands on both animals, satellite tag on the mother. Mother tracked for 152 days off the central Gulf coast of Florida.
- 1999: two young adult male pantropical spotted dolphins, found dehydrated and traumatised in a mass stranding of 3 animals (the other died during rehabilitation with bronchopneumonia and was also morbillivirus positive), rehabilitated for 73 days. Satellite tags. Tracked for 21 and 42 days. They were joined by a school of pantropical spotted dolphins within 3 minutes of release on the Atlantic coast of Florida (stranded on that coast). Initially moved east and then north. Stayed together for the 21 days of the signal from one animal, the other then heading south into the Caribbean.
- 2002: young adult female bottlenose dolphin, stranded with trauma following suspected intraspecific aggression, rehabilitated for 62 days. Freeze branded and VHF tag. Tracked for 2 days by plane. She initially remained in the vicinity of the release site for a few hours, then moved NNW, and was swimming strongly and surfacing at regular intervals.

Tracking results: 1/11 were tracked for 60 or more days, 2/11 were tracked for 40 – 59 days, 1/11 was tracked for 20 - 39 days, 5/11 were tracked for less than 10 days (of which 4/11 known to have died within 24 hours), 2/11 were not tracked.

Baltimore:

- 1993: juvenile female pigmy sperm whale, stranded with gastric impaction and pneumonia, rehabilitated for approximately 150 days. VHF tag (as it was felt that the satellite tags available at the time were too large). Tracked for 4 days. The tag was thought to have fallen off, as a visual sighting was obtained during these 4 days and she appeared to be behaving normally. However, it is possible that she was killed.
- 1996: juvenile female harbour porpoise, stranded emaciated and with parasitic and bacterial dermatitis, rehabilitated for 13 months. Freeze branded and location only satellite tag. Tracked for 50 days. An initial 16 day period of rapid offshore movements, possibly associated with orientation, was followed by nearly 4 weeks of slow movement close to the coasts of New Jersey and New York, presumably associated with foraging. For the last 8 days of the track, she swam steadily north east along Long Island. Speed and surface times were similar to those recorded in tracks from wild members of the same species, and had not altered at the time the signal was lost, suggesting this was due to tag failure. (Westgate *et al.*, 1998).
- 1999: juvenile (just weaned) male harbour porpoise, stranded emaciated and with a deep wound on his tailstock, was transferred from New England and rehabilitated for approximately 180 days. Location only satellite tag. Tracked for 60 days. Moved

into an area off Cape Cod where harbour porpoises are not normally found, but was swimming and diving normally.

Tracking results: 1/3 tracked for 60 or more days, 1/3 tracked for 40 - 59 days, 1/3 tracked for less than 10 days.

Mystic:

- 1983: young adult male Atlantic white-sided dolphin, stranded in adverse weather conditions, rehabilitated for 116 days. Spaghetti tag in the dorsal fin. No information on post release survival.
- 1991: adult male Atlantic white-sided dolphin, stranded as part of a mass stranding, rehabilitated for 243 days. Satellite tag with Time Depth Recorder. Tracked for 5 days before the tag stopped transmitting during a severe offshore storm. It was suspected that the pins broke in rough seas and that tag failure rather than death of the animal was the cause of cessation of transmissions, as the animal's dive patterns were essentially unchanged over the 5 day period. The animal spent an average of 89% of its time submerged, with a maximum dive duration of 4 minutes. Its respiratory rate dropped significantly following release (from around 3 breaths/min. in the later stages of rehabilitation to 1.5 breaths/min. after release). He travelled just over 300km during the 5 day period, a comparable swim speed to wild dolphins, heading north into known feeding grounds for the species on the edge of the Gulf of Maine. (Mate and Stafford, 1994).
- 1999: two juvenile male pilot whales, stranded after suspected separation from the main pod, rehabilitated for 115 days. Satellite tag with Time Depth Recorders. Tracked for a period of 127 and 132 days, during which period they travelled more than 3700 km, circumstantial evidence also suggesting that they stayed together. The animals moved to fertile fishing grounds around Georges Bank in the first 10 days after release and, within 4 weeks, were regularly diving to depths greater than 200 metres. A number of dives exceeding 26 minutes (and 300 metres) were logged, the longest yet recorded in this species. This tended to indicate that the animals were not only surviving, but were diving and foraging normally. (Nawojchik *et al.*, 2003).

Tracking results: 2/4 tracked for 60 or more days, 1/4 tracked for less than 10 days and 1/4 not tracked.

Sea World:

A complete data set was not available for perusal. There have been a variety (perhaps 8-10 species) of rehabilitated cetaceans tracked by satellite tag after release, mostly for only very short periods of time either due to attachment problems (which is still probably the primary obstacle to success), animal mortality, or instrument failure, although the causes for only limited tracking aren't known with confidence. The longest track on a rehabilitated animal was approximately 90 days on a common dolphin, which travelled out to the Channel Islands and then down to San Diego before the signal was lost. In 1994, five common dolphins (out of 10 that came in that year) were successfully rehabilitated and released with satellite tags and monitored by Hubbs-Sea World Research Institute. Not many VHF tags have been deployed on their own, as no opportunities exist to track animals from regular flyovers by planes. A combination of satellite and VHF tags is used, however. This was the case with the baby grey whale, JJ, released after rehabilitation, but the tags came away in 3 days.

Marine Mammal Center:

- Year unknown: common dolphin rehabilitated initially at the Marine Mammal Center, but mostly at Sea World, released and subsequently restranded.
- 2001: juvenile male harbour porpoise, stranded malnourished and with parasitic pneumonia, rehabilitated for 101 days (last month at Marine World Africa USA).

VHF and satellite tag. Tracked with the VHF tag for half an hour after release, during which time he swam and dived normally, and was tracked with the satellite tag for over 120 days, moving up and down the coast fairly close inshore, at least for the first 60 days. He was tracked as far away as Mexico.

Tracking results: 1/2 tracked for 60 or more days, 1/2 restranded in less than 10 days.

New England:

Most post-release monitoring of cetaceans has been with VHF tags, which illustrated that animals survived for at least a few days after release, and had left the immediate area quickly. There has not yet been the opportunity to satellite tag many cetaceans. A porpoise released from the Duxbury facility was fitted with a satellite tag and the track only lasted 6 days. The swimming pattern was normal, but the transmissions abruptly stopped. As the tag had been functioning fine and the battery still had plenty of life left in it, this rather suggested that the animal had died. He had moved north from the release site in Massachusetts Bay to an area of gillnetting in the Gulf of Maine and may have been caught.

Causes of death in those that do not survive rehabilitation

Significant necropsy findings in animals undergoing rehabilitation

Significant necropsy findings in rehabilitated animals include:

- (broncho)pneumonia, including granulomatous bacterial pneumonias, parasitic pneumonias
- cardiac failure, including cardiomyopathy and some cases of viral origin
- thromboembolism
- liver disease, including cirrhosis
- renal failure
- gastrointestinal disease, including gastric ulceration, inflammatory bowel disease, parasitism
- (meningio)encephalitis, including Nasitrema infestation, mycotic encephalitis
- morbillivirus
- trauma, including shark bites
- septicaemia
- peritonitis
- abscessation
- dermatitis
- domoic acid toxicity

Conditions regularly encountered and associated with a poor chance of survival include chronic diseases, particularly granulomatous bacterial pneumonias, cardiomyopathy in pigmy sperm whales, and meningioencephalitis associated with Nasitrema infestation.

Deaths possibly associated with conditions developing during captivity

Few deaths appear to occur as a consequence of conditions picked up during rehabilitation, rather than conditions arising before or during stranding. Cases include:

- Mycotic infections have caused a small number of deaths in cetaceans on antibiotics for extended periods of time during rehabilitation.
- Intestinal torsions have been seen in two pigmy sperm whale calves at Mote, one of which may have been associated with excessive breaching, but it is difficult to say conclusively that these occurred as a direct consequence of the animals being in captivity.
- A bottlenose dolphin calf died at Clearwater after suspected aspiration of formula during a feed.
- A case of necrotic enteritis in an unweaned bottlenose dolphin developed after the animal had been rehabilitated and introduced to the captive group at Baltimore.
- A white-beaked dolphin died from peracute erysipelas at Mystic, thought to have been picked up from food fish.
- A sub adult male pigmy sperm whale died at Mystic after inspiring a pine needle and developing pulmonary abscessation.
- Sea World lost a northern right whale dolphin with concussion and a broken jaw after it hit the walls following a power failure, during which the lights went off and then came on again.
- A rough toothed dolphin died from suspected renal failure after the salinity became too high at the Marine Mammal Center.

There was also concern among some of those interviewed that the capture myopathy like syndrome associated with cardiac and skeletal muscle damage, seen in many stranded cetaceans and probably caused by the release of catecholamines (Turnbull and Cowan, 1998), was exacerbated by the stress of transport and the early stages of rehabilitation and could be causing stress related deaths at this time.

Licensing and financial survival of rehabilitation facilities

Key elements to the NMFS licensing of rehabilitation facilities

Rehabilitation facilities wishing to rescue and rehabilitate marine mammals, including cetaceans, in the United States have to be licensed to do so under the Marine Mammal Protection Act (1972), via a Letter of Authorisation from NMFS. The 'letter holder' has to bear the costs of collection, maintenance, and release of the rescued animal. Letter holders can designate other organisations or institutions to implement their activities under the Letter of Authorisation through sub letter designation, as long as they have the agreement of NMFS. If the sub letter holder breaches the Marine Mammal Protection Act, the letter holder is held responsible.

NMFS imposes a number of regulations on letter holders. Animals undergoing rehabilitation must be isolated from display animals, other wild animals and domestic animals. Any zoonotic pathogens isolated from rescued animals must be reported to NMFS, as must pathogens liable to affect marine mammal populations. Appropriate records have to be kept of all animals admitted to the facility for rehabilitation and NMFS needs to be informed of any new arrival within 30 days of rescue, including date of admittance, location of rescue, species, size, condition, any related scientific information and disposition of the animal. NMFS must be allowed access to inspect the facility and its records, and an annual report must be submitted to NMFS, summarising the facility's activities and findings with rehabilitated marine mammals.

The agreement of NMFS is needed to release or move an animal to another facility, and released animals must be tagged in an appropriate manner (see section on criteria for release). The veterinarian responsible for the care of rehabilitated animals in the facility must be experienced with marine mammals, and euthanasia of any animal has to be carried out by a person acting under the supervision and training of a vet. Furthermore, NMFS needs to be notified verbally before endangered species are euthanased. Animals or parts of animals cannot be sold and necropsy reports must be available to NMFS on request.

Although minimum standards are set by APHIS for captive marine mammal facilities, under the Animal Welfare Act, facilities for cetaceans undergoing rehabilitation do not have to meet these standards. However, animals deemed non-releasable do need to be housed in facilities meeting the minimum standards, once rehabilitation is considered to have been completed. The minimum APHIS standards relate to construction, drainage, environmental control in indoor and outdoor facilities, perimeter fencing and security, space (including minimum horizontal dimension, depth and volume for one or more individuals of the given species), feeding, water quality, sanitation, separation of animals, staffing, veterinary care and transportation.

Jim McBain stated that many letter holders would like to see more stringent standards applied to rehabilitation facilities. Presently, standards are set by the facilities themselves rather than by government, and Letters of Authorization from NMFS seem to be issued more according to the recipient's willingness to provide the service and previous experience, than on the quality of the facility and the service that can be provided. However, as rehabilitation is volunteer based, the government has been reluctant to impose tighter regulation and Letters of Authorisation are rarely cancelled. Many hope that the long awaited arrival of the completed rehabilitation facility guidelines from NMFS, after several years of review, should improve the situation.

NMFS is divided into five regions - Northeastern, Southeastern, Southwestern, Northwestern and Alaskan – and the regional offices operate in a fairly autonomous manner. Thus, the policies of one region are not necessarily the policies of another. Examples include:

- until very recently the Northwestern region did not allow intervention of any kind with beached pinnipeds but did allow intervention with stranded cetaceans.
- the Southwestern region does allow intervention with beached or stranded pinnipeds and cetaceans, except on the offshore islands where no intervention is allowed for either pinnipeds or cetaceans.
- the Southwestern region requires that an attempt be made to allow a stranded animal to swim back out to sea if it will.

Funding rehabilitation

Rehabilitating cetaceans is expensive. Taking into account all the costs involved, including transport costs, food and medical costs, labour costs, pool and water quality maintenance, energy costs, depreciation, etc., the cost of rehabilitating a cetacean is likely to fall between $40,000 and $250,000, variables including species, condition and length of stay. Some more exceptional rehabilitations may exceed this, e.g. that of JJ, the grey whale calf, which cost approximately $950,000.

Non profit making facilities such as the Marine Mammal Center, Mote and Clearwater rely primarily on private donations of money, time, equipment and medical supplies to cover the costs of rehabilitation. Membership and educational programmes also bring in revenue at the

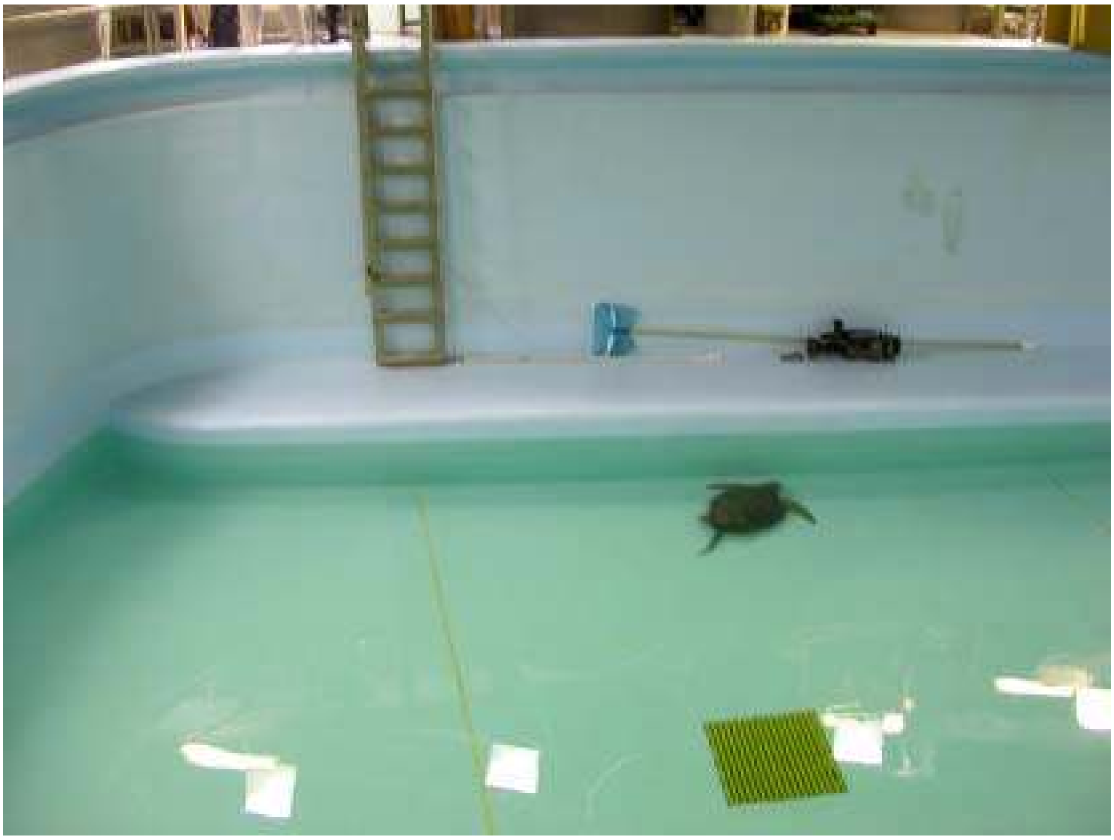
Marine Mammal Center, and the two aquaria can fall back on gate receipts if funds are short. Some grants are applied for and funds also are raised via the media and website. Other non profit making aquaria, such as Baltimore and Mystic, receive the majority of their funding from gate receipts, as well as seeking donations and grants, and running fundraisers. This is also true for commercial facilities such as Sea World and New England.

Harbor Branch, primarily a research and educational organisation, receives greater than 70% of its funding from competitively awarded outside grants and contracts. The remainder comes from private donations, foundations and various other trust funds. Marketing of an innovative license plate, sporting a "protect our dolphins' logo, has raised well over $1million. This money is earmarked for dolphin research and rehabilitation work.

Recently, NMFS have brought in the Prescott grant scheme, for equipment and facility improvement and research projects, e.g. pathological investigation of stranded marine mammals. This is the first real funding from NMFS and it is only available to letter holders.

Alternative use for the facility when it is not being used for rehabilitation

Most facilities do have an alternative use for pools used for cetacean rehabilitation, primarily for housing other animals undergoing rehabilitation, e.g. turtles, otters and seals. Occasionally, captive animals will be accommodated for short periods in the pools, e.g. sharks at Clearwater and dolphin calves at Sea World. The pool at the Marine Mammal Center is used as a water reservoir when not in use for cetacean rehabilitation.



Housing a turtle in the cetacean rehabilitation pool at Baltimore

Policies for public and press interaction with animals being rehabilitated, and their use as an educational resource

Public viewing of animals undergoing rehabilitation

The Marine Mammal Center and New England Aquarium do not allow any public viewing of cetaceans undergoing rehabilitation. Mote does not allow viewing of the two main rehabilitation pools and viewing of the lagoon pool, the final release pool, can only be viewed through glass from some distance.

The other facilities, although not allowing free public access to the rehabilitation pools, will allow some viewing of animals undergoing rehabilitation by limited groups of the public or special guests taken on tours. These tours only start once the animal is stabilised and they finish when deconditioning prior to release commences. At Sea World, the number of people viewing an animal may reach 150 people a day. Care is taken to minimise the risk of disease spread by these groups, for example at Clearwater the public can only see a stranded animal as the last stop in their visit to the aquarium.

The tours are justified by the facilities as they generate money and raise public awareness on rehabilitation and other environmental and welfare issues.

Remote and delayed public 'viewing' of rehabilitation attempts

Mote and Clearwater provide detailed website coverage of rehabilitation attempts as they are proceeding. The other facilities provide irregular updates on rehabilitation attempts, write ups of completed rehabilitations, or some general information on cetacean rehabilitation on the website.

Remote cameras for public viewing of rehabilitation attempts are used at Mote, Clearwater and Mystic. A web cam is used at Mote during daylight hours, and this technique also is used occasionally at Sea World with particularly interesting cases, e.g. JJ the grey whale neonate.

Mystic and Baltimore make films of rehabilitation attempts for educational purposes. A good example was a video of the pigmy sperm whale, Inky, rehabilitated at Baltimore. She had swallowed plastic debris, including the remains of a balloon and a rubbish bag, which impacted in the cardiac (first) chamber of her stomach. The video was used to teach about the impact of marine debris. Both aquaria also work with programmes such as National Geographic, thus facilitating the broadcasting of information about rehabilitated marine mammals and the impact of man on the state of the oceans.

Media viewing of animals undergoing rehabilitation

All facilities have a PR person or department to liase with the media. If media are allowed access to rehabilitation areas, which is the case in most facilities, they are escorted. At Sea World, however, no media are allowed in the rehabilitation area, due to concerns over the spread of disease. At the Marine Mammal Center, press releases are not put out until an animal has survived a week and the vets are consulted over their content. Press generally will cover releases and, at Mystic, a team from the National Geographic channel also has come out on rescues. Press involvement is justified on the grounds of raising public awareness and education, and the generation of funds.

Educational use of animals undergoing rehabilitation

Some school visits to view rehabilitated animals are allowed at Harbor Branch and Clearwater. The education department also runs the limited guided tours of the rehabilitation facility at Sea World.

At Mystic and the Marine Mammal Center, a limited number of veterinary students, for example those on zoological medicine residencies, gain hands on experience with cetaceans undergoing rehabilitation when they are being handled for assessment and treatment. At New England, a visiting biologist or veterinarian may be invited to participate with a procedure in order to maximize the learning potential of the occasion.

Research policy and its justification

Type of research allowed on rehabilitated animals

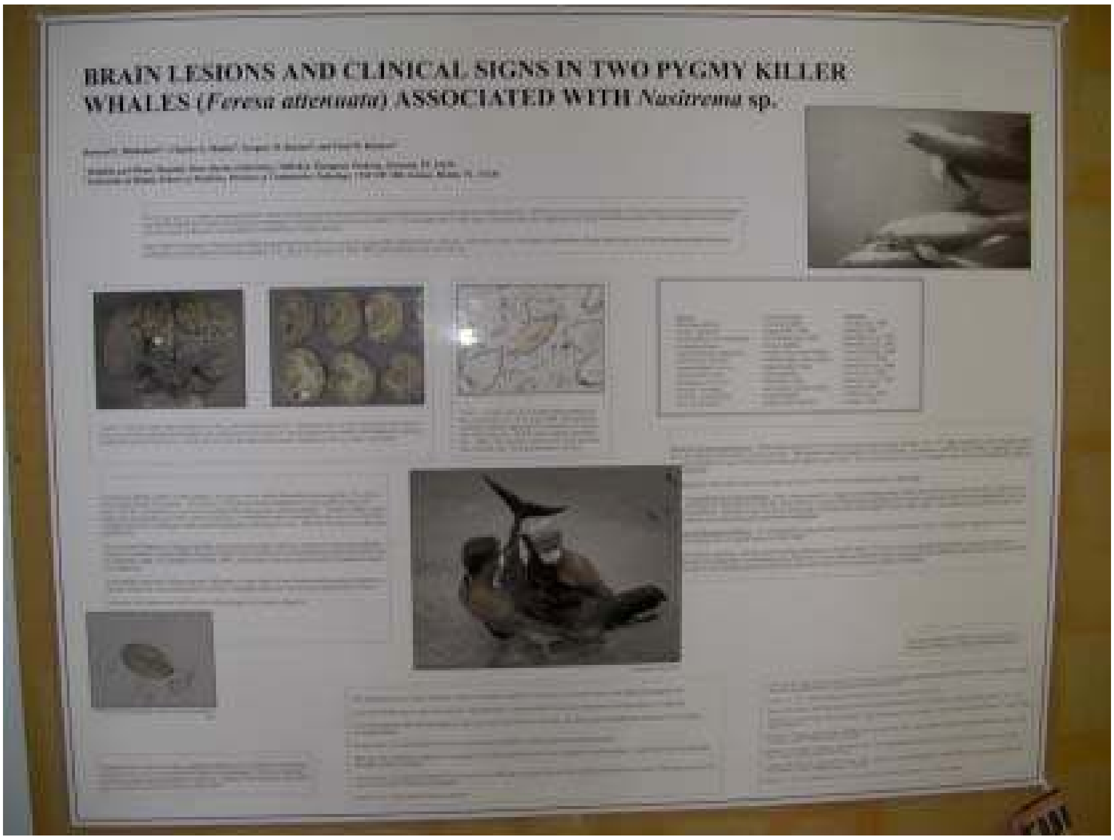
Research carried out at most facilities includes the recording and evaluation of clinical, clinicopathological and pathological information. Live stranded animals that die are particularly useful for pathological investigation as the carcasses are fresh. Serum banks held by facilities such as Mystic and the Marine Mammal Center have proved useful, for example, in tracking the spread of morbillivirus through marine mammal populations. As Jim McBain pointed out, live stranded animals can be considered as sentinels, providing a valuable insight into the health of the seas, and this is a driving force for rehabilitation efforts.

Another key area of research is nutrition. Much information has been generated on the nutritional requirements of neonates of different species, including species not normally kept in captivity, such as pigmy and dwarf sperm whales and grey whales.

Behavioural research on animals undergoing rehabilitation has been more limited in its application to the understanding of wild populations, as animals are not in their normal social environment. Some useful information may be gleaned on social structure if more than one member of the same species is accommodated together. Behavioural research however can provide useful information on the value of different enrichment and training techniques for captive animals.

Some acoustic research has been carried out on animals undergoing rehabilitation by a team led by Dr Sam Ridgway, at facilities such as Baltimore, as it was deemed more appropriate to carry this out on live stranded animals than wild animals caught at sea. This research did require some physical restraint of animals and the application of auditory stimuli directly to the lower jaw (Calder *et al.*, 1995).

As mentioned in the section on post release monitoring, this has yielded useful information not only on survivability after rehabilitation but also, with longer tracks, on dive behaviour, social structures, habitat utilization and grand scale movement patterns.



An example of clinical and pathological research on cetaceans undergoing rehabilitation at Mote

Regulation of research

For all species, NMFS must approve the research and adequate funding must be in place. Invasive research generally is not allowed, although NMFS occasionally may make an exception. Jim McBain believes that research involving a lot of handling obviously should be avoided, although with unusual cases this may be superseded by the desire to gain knowledge. This was the case with the grey whale neonate, JJ, where a lot of close contact research was carried out on acoustics and metabolism in baleen whales, which was not ideal as far as her survival chances were concerned. As he pointed out, any research is a fine line between balancing the desire to help science against the possible effects of such research on rehabilitation success. If NMFS do sanction invasive research, Sea World generally require the animal to be moved by the researcher to another facility.

The Marine Mammal Center has an Internal Animal Care and Use Committee, based on the Animal Welfare Act, to consider research that falls outside normal diagnostic procedures. The two vets are on the committee, as are some of the volunteers and a science advisor. The Committee decides on the appropriateness of any research and invasive procedures are not condoned.

Staffing

Use of salaried staff and volunteers

All facilities except Sea World run rehabilitation attempts with a mix of salaried staff and volunteers. The approximate numbers involved are shown in Table 6. Volunteers have become indispensable in most facilities, and facilities such as Mote, Clearwater, the Marine Mammal Center and New England have particularly large, well-established volunteer programmes.

At Mote, volunteers have to be 18 or over and sign a claim waver before they are allowed to work with animals undergoing rehabilitation. They are covered by personal and third party liability insurance. People suffering from specific conditions, or who are pregnant or on immunosuppressive drugs are not allowed contact with the animals. There is a part time, salaried volunteer coordinator and volunteers work 4 hour shifts run by shift leaders, who are volunteers with the most experience and training. The number of volunteers per shift varies with the condition of the animal but usually ranges between 4 and 6 people. Volunteers assist with strandings response, medical examinations, including ultrasound, radiography and endoscopy, sampling, treatments, continuous observations, record keeping, water quality testing, post release monitoring and a wide range of other tasks, including necropsies. The more experienced volunteers are able to tube feed, and can be left monitoring an animal on their own at night. Volunteers receive recognition and an award for each 100 hours of service.

Clearwater works a similar system, with an ‘elite’ team of 60 more experienced volunteers who respond, with staff, to strandings and supervise shifts. The number of salaried staff is considered just adequate by vet, Robin Moore and the team is heavily reliant on the volunteers, who are required to cover at least one shift per week during a rehabilitation attempt.

At the Marine Mammal Center, when a cetacean first comes in, the more ‘hands on’ activities are carried out by staff, who also cover the first overnight feeds. Volunteers then take over tube feeding within a few days. A number of volunteers committed to the day teams working with pinnipeds will put in overtime to cover cetacean rehabilitation attempts, taking on extra pool duty shifts.

Volunteers at New England make up the bulk of personnel attending strandings in Massachusetts and they come from all over the state. These can be very quickly tapped into, to help with shifts during rehabilitation attempts. Senior staff work with volunteers on critical shifts in the first few days and a senior person is always on site until the animal is left overnight.

Baltimore and Mystic have slightly smaller, but still very useful volunteer forces, assisting with observations, feeding, medical procedures and cleaning. At Baltimore, being 2.5 hours from the coast, volunteers are particularly important for attending strandings, along with other, ‘satellite’ rehabilitation facilities. Lifeguards and Park Services also have basic training in strandings management. Volunteer team leaders at the aquarium have 5 or more years’ experience and are able to carry out catch ups, tube feeding and basic treatments, and monitor new volunteers.

The dozen volunteers assisting Harbor Branch help with cleaning and routine observations, record keeping, fetching supplies, etc.. They also assist with the feeding of neonates, but not with feed preparation, as this has to be very carefully managed.

Sea World does not use volunteers in rehabilitation attempts, this being a rule of the parent corporation. Generally, full time staff are used to oversee animal rehabilitation, but other, even non animal staff with an interest in animals are used part-time on rehabilitation attempts.

Table 6 - Staff and volunteers available for rehabilitation attempts

FACILITY	SALARIED STAFF	VOLUNTEERS
Harbor Branch Oceanographic Institution	2 full time vets 2 full time health care providers with experience 2 health care providers with experience on contract work	10-12 (mainly retired)
Mote Marine Laboratory	1 full time vet 1 part time volunteer coordinator 1 full time animal care coordinator 2 full time vet technicians 1 full time feed prep/maintenance person	250, of which 85 specially trained for rehabilitation attempts and 15-20 are shift leaders
Clearwater Marine Aquarium	1 full time vet 3-4 full time staff	Stranding team of 35, 20 of which are specially trained supervisors. Support team of 100.
National Aquarium in Baltimore	2 full time vets 1 vet intern 2 vet technicians 2 full time staff on Marine Animal Rescue Programme 1 part time staff on Marine Animal Rescue Programme	70, 50 of which are based in Baltimore and remaining 20 in Ocean City for rescues
Mystic Aquarium	1 near full time vet 1 vet intern 1curator 1 researcher 1 strandings coordinator 1 vice president of aquarium	40
Sea World, California	3 full time vets vet technicians several full and part time staff	0
Marine Mammal Center	40, including: 2 full time vets 1 vet intern 3 vet technicians 2 strandings coordinators	800
New England	3 vets 2 vet technicians 1full time strandings coordinator 2 biologists	Many

Staff training programmes

Formal training programmes for volunteers are run at Mote, Clearwater, Baltimore, Mystic and the Marine Mammal Center, usually over one or more days. Courses are run by vets and other staff and topics covered tend to include:

- anatomy and physiology
- species identification
- the law
- stranding response
- transport
- husbandry and nutrition
- safe handling of marine mammals
- hygiene
- medical procedures
- data recording
- post release tracking
- use of facilities and equipment.

Shift leaders/supervisors at Mote and Clearwater are more experienced and receive additional training. Continuing education is provided at Mote by quarterly newsletters and regular meetings. At Baltimore, volunteers have a monthly revision exercise after their initial training programme.

At Harbor Branch, staff provide volunteers with written protocols for cleaning, how to behave around animals, taking of respiration rates and water testing. At New England, training programs for mass stranding beach response are run regularly for large groups of staff and volunteers, but most basic husbandry training for rehabilitation is hands on. Staff training at many facilities tends to be hands on and through mentorship.

Minimum number of staff required to manage a rehabilitation attempt

All facilities agreed that it is essential to have a number of full time staff to run a rehabilitation attempt. The number suggested varied from 2 to 6 and included a vet, vet technician(s), volunteer coordinator(s), feed prep person and, if not on an open system, a person managing water quality. A good team of 15 to 20 committed volunteers also would be needed. Observation shifts need to be covered ideally by two or more people and the number required for handling animals may vary from 2 to 8, depending on the size of the animal.

As Jim McBain pointed out, if volunteers are to be used, training and infrastructure are vital and it is important that it is laid down at the beginning exactly what the volunteers are allowed and not allowed to do. The vet also is crucial and there needs to be a willingness to put in the time, not to give up, and to focus on the animal.

Summary of Information obtained from US cetacean rehabilitation facilities

Seven rehabilitation facilities in the United States were visited over a 4 week period in 2002. An eighth was discussed in detail without visiting the actual facility.

- Harbor Branch Oceanographic Institution, Fort Pierce, Florida
- Mote Marine Laboratory, Sarasota, Florida
- Clearwater Marine Aquarium, Clearwater, Florida
- National Aquarium in Baltimore, Maryland
- Mystic Aquarium, Mystic, Connecticut
- Sea World of California, San Diego
- The Marine Mammal Center, Sausalito, California
- New England Aquarium, Boston, Massachusetts (*not visited*)

Facilities with a species complement closest to that seen in the UK are those on the north east of the Atlantic seaboard of the United States, i.e. Mystic and New England. The bottlenose dolphin is encountered by all facilities visited. Some seasonal variations do occur in the incidence of strandings and mass strandings are seen particularly by New England, who cover Cape Cod, a peninsula in Massachusetts on which mass strandings frequently occur.

Options taken with stranded cetaceans

Refloatation, i.e. beach release, usually is considered only in the management of mass strandings. It is rarely used in single strandings, as evidence from post mortem examinations suggests that very few animals stranding singly strand in healthy condition. Exceptions include cetaceans stranding on the topographical anomaly of Cape Cod through suspected navigational error and animals caught in the strong surf of southern California. Even when healthy animals strand in single or mass strandings, many interviewees believe that complications arising from the stranding itself soon preclude the use of refloatation. The experiences of those who have refloated animals on Cape Cod is that many of these restrand.

Rehabilitation is used commonly and with both single and mass strandings, due to the widely held belief that it is usually the only option giving a stranded animal any chance of survival. Another justification put forward is the considerable amount of information gained from rehabilitated animals. However, concern over the use of this option was expressed by some, due to the terminally ill nature of many single stranded animals and the lack of social cohesion when only some animals are taken in from mass strandings.

Euthanasia is used in the management of stranded cetaceans. However, half the facilities visited will remove an animal to the facility to euthanase it due to concerns over public reaction and, in some cases, concerns over inadequate triage on the beach.

Criteria used to assess options taken

Clinical condition is an important consideration when determining the option for an animal on the beach. Signs of chronic ill health, serious trauma, excessive skin loss, unresponsiveness and blindness will lead to euthanasia. Other animals are brought in for rehabilitation, unless they strand through navigational error on Cape Cod or in California and are in good clinical condition on assessment. Portable blood analysers frequently are taken on the beach and major abnormalities in haematology and biochemistry parameters are considered in the triage. Rectal temperatures also are recorded and influence the option taken; thermistor probes are a vital part of assessment equipment.

The decision to rehabilitate an animal is not affected by whether a species is coastal or pelagic in nature. This does affect the decision to refloat on Cape Cod, where coastal species stranding through navigational error can be more easily released into their normal habitat. Species size is considered in the triage; only Sea World is able to accommodate animals larger than juvenile pilot whales and some facilities are only able to take animals up to 2.5 metres in length. Although nervous species, such as Stenellas, may not so readily acclimate to captivity, this does not affect the decision to attempt rehabilitation. Neonates generally are taken in for rehabilitation, although some facilities may euthanase neonates if permanent placement is likely to be difficult; only bottlenose dolphins are easy to place. In most facilities, the risk of introducing disease to a facility is not considered in the triage.

All three options may be used with animals in a mass stranding. The ability to rehabilitate compromised animals is limited by the space available. Refloatation of animals determined to be in good physical condition can be logistically very difficult in locations such as Cape Cod, where animals may strand several miles from the open sea.

Transport

Animals are usually transported from the beach on foam, or in stretchers suspended in bladder bags, containing some water, and cushioned with foam. Animals generally are transported to the release site or between facilities in full water transport, suspended in stretchers partly or completely floating in water. Although a maximum transport time of 3-4 hours is considered sensible, times largely have been governed by that required to transport a given animal and have proved successful up to 12 hours. Overnight breaks and full water transport should be considered with long transports. Air transport is a useful option, but cabin pressure needs to be maintained at or near that of sea level. The condition of an animal is the primary factor affecting its ability to cope with transport, and stabilisation of an animal's condition prior to transport is very important.

Rehabilitation procedures

All pools in which rehabilitation to the point of release is attempted are at least 9 metres in diameter and the majority are at least 2.4 metres deep. Most are held at a depth of 1 - 1.2 metres to support an animal in the early stages of rehabilitation. Half the facilities also have smaller holding pools for housing animals on first arrival and most of these are domestic portable swimming pools of 6 - 7.2 metres diameter and 1.2 metres depth. The majority of pools are outdoors.

Hoists are used to manoeuvre larger animals into pools and animals are supported and walked initially in the water by people, sometimes using mats or floatation devices. Some facilities deliberately 'introduce' animals to the sides of the pool, to minimise the risk of trauma when they start to swim unaided. Human presence in the pool is reduced after the first few days, unless the animal is already deemed non-releasable. Free swimming animals are caught up by corralling with people in partly drained pools or, in some facilities, with nets.

Handling in the water for clinical assessment and blood sampling is carried out at regular intervals in all facilities, particularly in the early stages of rehabilitation. Haematology and biochemistry parameters are measured. Many facilities have developed their own reference ranges for different species, but observing individual trends in parameters is also considered important. Other samples commonly taken on arrival include bloods for morbillivirus serology, blowhole swabs/plates for culture, faeces for cytology/parasitology and culture, and gastric juice for cytology/parasitology. Most facilities have on site laboratories capable of running haematology and biochemistry profiles and some also are able to carry out microbiology, parasitology, urinalysis and cytology.

24-hour poolside watches are mounted during the first few weeks of rehabilitation, with records kept of respiratory rates, behaviour, disposition, appetite and passing of faeces. For ultrasound, radiography, endoscopy and electrocardiography, animals usually are beached on the side of the pool.

Antibiotics are administered to new arrivals, due to concerns over primary infections or the risk of secondary infections in stressed or malnourished animals. Vets were split over the use of non-steroidal anti-inflammatory drugs versus steroids, due to concerns over their respective side effects. Anthelminthics tend only to be given if deemed essential to improve the clinical condition of the animal. In the treatment of pneumonia, diuretics tend to be used more than mucolytics and bronchodilators, to counter inflammation and pulmonary oedema, and sulcrafate, particularly, is used in the treatment of gastric ulceration. Drugs are given preferably by intramuscular injection until the gastrointestinal tract is functioning normally; treatments then are given orally where possible. Wounds are allowed to heal by secondary intention and only limited surgical procedures are carried out.

All animals are started on either water or rehydration solution on arrival. Freshwater also may be added to the pools of dehydrated animals. Adults graduate on to fish soup before receiving solids, the speed of transition depending on the animal and also the policy of the facility. Squid, herring and capelin, fit for human consumption, are most frequently fed. Neonates are weaned on to formulae developed initially on beached cetaceans and refined on captive born calves at Sea World. Mote, recognised as specialists in the rearing of pigmy sperm whale calves, developed a suitable formula after analysing milk samples from adult females and adapting a bottlenose dolphin formula accordingly. Neonates in particular are weighed frequently to ensure they are receiving sufficient calories, and are weaned on to solids when a few months old.

Good quality water is recognized as being critical to the success of rehabilitation. Both semi open and closed water systems are used, facilities either drawing from a local body of water or making up their own seawater. Mechanical filtration (sand/gravel), chlorine and/or ozone are usually employed, most facilities having surface skimmers at the lower and higher levels at which the pool is held. Pool turnover times when full vary from less than 2 hours to 8 hours. Nearly all facilities are able to heat the pool water and most are able to chill it, according to the needs of the animal and the ambient temperature. Maintaining water at 75 - 80^{o}F (24 - 27^{o}C) is important for the stabilisation of very young or thin animals.

Strict controls are put on the movement and disinfection of staff, equipment and water to minimise the risk of disease spread through a rehabilitation facility, particularly between animals undergoing rehabilitation and captive animals.

Pentobarbitone is most frequently used for euthanasia, usually given intravenously, but intraperitoneal and intracardiac routes also may be used. Most vets sedate or anaesthetise an animal first, to facilitate maintenance of an intravenous infusion and to reduce violent movements, particularly in large cetaceans. Most facilities have necropsy facilities that can be used for the post mortem examination of animals that die during rehabilitation.

No facilities had final release sea pens, although Mote has a near 40 metre long pool specifically designed for animals in the final stages of rehabilitation, with sloping slides to minimise echolocation reflections. Of those expressing an opinion, all agreed that some form of pen in a natural setting would be a useful addition, to observe an animal in its native environment before release and to build up its fitness. A netted lagoon for coastal species and a floating sea pen for pelagic species could be used. Other commonly desired improvements to existing facilities included increasing the size of the pools, improving or installing initial holding facilities and improving or installing beaching facilities for examination. Three sites had proposals drawn up for new cetacean rehabilitation facilities.

Opinions on the use of temporary facilities for the rehabilitation of stranded cetaceans

Nearly all those asked believed that temporary facilities would only work if a permanent facility was available for animals to be moved on to. A temporary facility should be used only to hold an animal for a few weeks while initial triage is carried out. Temporary pools are considered likely to be too small, particularly too shallow for full rehabilitation of most species encountered, the minimum dimensions required being 9 metres diameter and 2.4 metres depth. An additional concern raised was equipping a temporary facility with experienced staff, particularly vets.

If a temporary holding or satellite facility is established, a pool design similar to the portable, round, flexible sided swimming pools used as holding pools at a number of facilities would be most appropriate.

Incidence of stress, stereotypic behaviour and other captivity-related conditions during rehabilitation, and their mitigation

Signs of stress have been observed in transit and early rehabilitation, particularly increased heart rates, respiratory rates and arching of the trunk. Cardiomyopathy, associated with catecholamine release, may be contributing to stress-related deaths at this stage. Alleviation of stress has been attempted with beta blockers and sedatives.

Social and nervous species in rehabilitation may feel vulnerable, unable to rest, and their clinical progress subsequently slowed. Such animals tend to fare better in groups. Pelagic species, particularly, will tend to float on the surface if held in pools of inadequate depth once stabilised. Here, mitigation requires moving the animal to a larger pool.

Handling for clinical examination and blood sampling is an important stressor in rehabilitation and the value of the procedure needs to be weighed against the potentially detrimental effect on the animal's progress. Carrying out procedures in the water where possible, and positive reinforcement following handling both help to minimise adverse effects.

There is some debate as to whether swimming in the same direction in a circular pool is stereotypic behaviour. Some believe the pattern is just a reponse to the shape of the pool. However, although rare, sometimes it can prove impossible to break an animal out of this swimming pattern with interaction and play, and this behaviour should be considered detrimental. Rubbing is a more obvious stereotypy observed. Flukes, flippers or heads may be rubbed, occasionally down to the bone. Mitigation is achieved through enrichment and training.

Gastric ulceration is the most frequently observed clinical condition thought to be associated with stress. Inappropriate diet and parasite burdens also may be contributory factors. A small number of head injuries, primarily fractured mandibles, have followed violent reactions to sudden changes in lighting, often associated with power failures. Back up generators and fail safe night lights therefore need to be in place.

Policy on enrichment and training during rehabilitation

All facilities provide some level of environmental enrichment for animals undergoing rehabilitation, to keep animals stimulated and free from boredom. This is often achieved through introduction of novel objects, i.e. 'toys', but techniques used vary with the facility, species, and likelihood of release. In some facilities, toys are only given to non-releasable animals, or those exhibiting stereotypic behaviour. Where toys are used, they are rotated to avoid habituation. With releasable animals, toys resembling potentially detrimental objects in the wild are avoided and all toys may be removed in the final stages of rehabilitation.

Training to facilitate medical and husbandry procedures is regularly used with neonates, and human contact appears to be important for these animals. Older animals unsuitable for release also may be trained. As with enrichment, training helps alleviate boredom.

Half of the facilities visited will train potentially releasable animals, although some only do this occasionally to facilitate handling. Those that train regularly decondition animals before release by reducing exposure to humans, removing any positive reinforcement associated with human contact and avoiding any training that encourages an animal to become dependent. Facilities not training releasable animals are concerned about the risks associated with habituation and ineffective deconditioning. Most facilities recognise that animals are learning whether formal training is taking place or not, but some consider desensitisation to humans may be a major cause of failure to survive in rehabilitated and released animals.

In all facilities, whether training releasable animals or not, human contact and exposure is reduced in the final stages of rehabilitation.

Criteria used to determine when an animal is fit for release and policy for those considered unsuitable for release

The criteria for release of a stranded cetacean from any rehabilitation facility in the United States are determined by the National Marine Fisheries Service (NMFS). These are:

- The animal is in appropriate body condition for the species, age, sex and time of year.
- The animal is free from a diagnosable disease.
- The animal is independent of medication.
- The animal is illustrating normal behaviour, including the ability to catch live prey.
- The animal is not a neonate and is not still dependent on its mother.
- The animal is suitably tagged, according to the expected ranging pattern of the animal.
- An appropriate release plan is in place, which includes releasing animals into known home ranges, geographically and temporally, preferably among conspecifics.

Ultimately, NMFS make the final decision as to whether an animal can be released. Some flexibility over the release criteria does exist and experimental releases may be allowed if only minor criteria are not met, particularly if the facility can demonstrate an ability to catch the animal up again and as long as the animal is no threat to wild populations. In other cases, strict application of NMFS criteria has resulted in releases being delayed by several months. Some release criteria are considered rather subjective, e.g. illustrating normal behaviour and the setting of the minimum age for release, and others have been contentious, e.g. the need for negative titres to morbillivirus. A comprehensive review of the release guidelines has been underway for a number of years.

Most facilities will allow the release date to be postponed for a few days to allow arrival of a satellite or VHF tag, or to facilitate two animals housed together to be released together. Some also may allow release to be delayed briefly for NMFS sanctioned research to be completed.

Animals considered non-releasable include unweaned animals, and older animals which fail to meet the major release criteria, including those with epilepsy, disabling trauma, or disability, such as blindness or impaired echolocation. Once declared non-releasable by NMFS, animals become permanent captives, either at the rehabilitation facility itself or at a facility of NMFS' choosing. Species other than bottlenose dolphins can be difficult to place, a problem exacerbated by the significant advances made in the rearing of stranded neonates. This potential inability to home non-releasable animals may influence some facilities' decisions to bring animals in for rehabilitation.

Permanent captivity for stranded, non-releasable cetaceans is justified by all facilities primarily because of their value for public education about anthropogenic impacts on animals and also as an educational resource for the scientific community. Vets expressing an opinion believe that most cetacean species rehabilitated can make the adjustment to becoming permanent captives with good standards of husbandry and care and adequate social contact. Space is not considered an insurmountable issue if all other needs are provided for and the space issue is believed to be primarily one of public perception.

Survival of stranded animals during refloatation, transport, rehabilitation, captivity and following release

The data given in this section needs to be considered in the context of the small numbers of animals involved and the large variation in the nature and location of strandings that influences the outcome of attempted rehabilitations before an animal is admitted to a facility.

Survival of animals refloated: no information was available from facilities using this option.

Death rates in transit: only in two facilities could this be determined from the data provided. At Harbour Branch, 5.5% of animals transported died in transit, and at Mystic, the figure was 9%. From the incomplete data set obtained from the Marine Mammal Center, 14% of animals transported died in transit.

Survivorship of animals in the early stages of rehabilitation: only in two facilities could this be determined from a complete set of data available for a given period of time. At Mote, 50% of animals admitted died in the first 50 days of rehabilitation, with a higher proportion of unweaned animals surviving beyond this stage than weaned animals. At Mystic the figure was 60%, with a higher proportion of juveniles surviving beyond this stage than adults. From the incomplete data set obtained from the Marine Mammal Center, 77% of animals died in the first 28 days.

Release rates: full access to data for potentially releasable animals was not achieved in all facilities. For three facilities, release rates for those transported and admitted could be determined, although in one case the data set was not complete for the period under consideration. For two facilities, release rates could only be determined for those admitted, although one was an approximation. In one case, release rates could only be determined for those transported. In one facility, no data was readily available for perusal.

Release rates of animals transported ranged from 5.5 to 12%. Release rates of animals admitted ranged from 7 to 26%, where definite figures were available.

The higher release rates for animals admitted were seen in facilities where numbers of deaths in transit could not be accurately determined, but was were believed to be relatively low. Therefore, the upper limit of release rates for animals transported is likely to be higher than that given above. An approximate release rate of 43% of animals admitted was determined in one facility. In another, if animals housed for only 4 days following a mass stranding are included, the figure for that facility rises to 34%.

Only at two facilities could species differences in release rates be determined. At Mote, the best results were seen with bottlenose dolphins and rough toothed dolphins, where 50% of animals of both species admitted were released. At Mystic, the best results were seen with long-finned pilot whales and Atlantic white-sided dolphins, where 33% and 27% of animals admitted respectively were released.

Only at Mystic was there a complete data set spanning a sufficient number of years to tentatively evaluate any changes in survival times and release rates with time. The number of deaths occurring in the first 50 days of rehabilitation fell from 58% in 1974-1984 to 44% in 1994-2002, and the release rates of those transported rose from 8% to 18%, suggesting an improvement in survival times and release rates with time.

Length of rehabilitation for released animals: if one discounts the 4 animals from a mass stranding brought in to one facility for 4 days, which could be construed as not constituting rehabilitation, of 24 animals released, 4% (1) were released in the first 50 days, 29% (7), in 51-100 days, 38% (9) in 101-150 days, 17% (4) in 151-200 days and 8% (2) after 201-400 days. 1 animal (4%) was released after an unknown period of time. A potentially releasable animal at one facility was still awaiting clearance for release after approximately 545 days, as of 23/7/03.

Number of non-releasable animals admitted and their survival times: where this could be determined, numbers admitted have ranged from 3% to 18% and, where data was available, survival times have ranged from approximately 70 days to 18 years.

Survivorship of animals post release: post release monitoring techniques include photoidentfication, rototags inserted in the dorsal fin, freeze branding and, more recently, VHF and satellite tracking. The combination used depends on the facility and the anticipated dispersal of the animal following release. Only with effective post release monitoring probably for at least 60 days can a reasonable assessment be made of an animal's likely survival after release.

Of 28 animals released from 6 of the facilities, 36% (10) were tracked for 60 or more days, 18% (5) for between 10 and 59 days, 32% (9) for less than 10 days and 14% (4) were not tracked.

If one discounts 4 animals from a mass stranding brought in to one facility for 4 days, which again could be construed as not constituting rehabilitation, the percentage of animals tracked for 60 or more days following rehabilitation rises to 42%. These 4 animals were found dead within 24 hours of release. Two other animals tracked for less than 10 days were also found dead. One animal tracked for 60 or more days was found dead after 99 days, but the cause of death could not be related to his condition during rehabilitation.

Only 15 of the 28 animals monitored post release definitely died or definitely survived beyond 60 days. Survival rates beyond 60 days for these 15 animals are 60% or 82%, depending on whether the 4 animals from the mass stranding discussed above are included. Due to the issue of tag failure, it is reasonable to assume that at least a proportion of the animals whose survival beyond 60 days is not known did actually survive beyond this time. Therefore, the survival rate of released animals beyond 60 days is likely to fall between 36% and 82%.

Causes of death in those that do not survive rehabilitation

A wide range of conditions were encountered in animals failing to survive rehabilitation. Granulomatous bacterial pneumonias, cardiomyopathy and meningioencephalitis associated with Nasitrema infestation in particular were associated with poor survivability.

Few deaths appear to occur as a consequence of conditions picked up during rehabilitation. Most cases reported by facilities only have been recorded in individual animals, but a small number of deaths have been observed with mycotic infections in animals on antibiotics for extended periods. Intestinal torsions also have been seen in two pigmy sperm whale calves at Mote, although it is unclear whether these were as a direct consequence of being in captivity.

As already discussed, cardiomyopathy associated with release of catecholamines also may have contributed to a number of stress related deaths in transit and the early stages of rehabilitation.

Licensing and financial survival of rehabilitation facilities

US rehabilitation facilities are licensed to rescue and rehabilitate marine mammals, including cetaceans, via a Letter of Authorisation from NMFS and have to bear all the costs involved. Records have to be kept of all animals admitted for rehabilitation, NMFS needs to be informed of any new arrivals and animals undergoing rehabilitation have to be isolated from other animals. NMFS also must be allowed access to inspect the facility and its agreement is needed before animals are released or moved. NMFS needs to be notified verbally before endangered species are euthanased and animals or their parts cannot be sold.

Rehabilitation facilities do not have to meet the minimum standards set by APHIS for captive marine mammal facilities and many letter holders would like to see more stringent standards applied. The government has been reluctant to impose tighter regulations as rehabilitation is volunteer based. Many hope that the completed rehabilitation facility guidelines due soon from NMFS will improve the situation.

The cost of rehabilitating a cetacean in the US is expensive and tends to average between $40,000 and $250,000, taking all discernible costs into account. In exceptional cases, it may be nearer $1 million. Non profit making facilities rely primarily on private donations to cover the costs of rehabilitation, although those attached to facilities open to the public for a fee also can rely to a greater or lesser extent on gate receipts. Membership, educational programmes, grants and fundraisers also bring in money. Commercial facilities rely primarily on gate receipts. Harbor Branch, a research and educational organisation, receives most its funding from competitively awarded outside grants and contracts. Recently, NMFS have brought in the Prescott grant scheme to fund equipment and facility improvement and research projects.

Most facilities have an alternative use for cetacean rehabilitation pools, primarily for housing other animals undergoing rehabilitation, and occasionally for short term housing of captive animals.

Policies for public and press interaction with animals being rehabilitated, and their use as an educational resource

Although not allowing free public access to rehabilitation pools, over half the facilities will allow some viewing of animals undergoing rehabilitation by limited numbers of the public, special guests taken on tours, or occasionally school children. These are justified on the grounds that they generate money and raise public awareness on rehabilitation and other environmental and welfare issues.

Facilities provide variable amounts of website coverage on rehabilitation attempts, ranging from detailed regular updates to more general information on cetacean rehabilitation. Three facilities have remote cameras for public viewing of rehabilitation attempts and one also regularly uses a webcam. Some facilities make films of rehabilitation attempts for educational purposes.

All facilities have a PR person or department to liase with the media and, in most facilities, media are allowed supervised access to rehabilitation areas. Press involvement is justified on the grounds of raising public awareness and education, and the generation of funds.

A limited number of veterinarians, veterinary students and biologists may be allowed to gain practical experience with cetaceans undergoing rehabilitation in some facilities.

Research policy and its justification

Research carried out at most facilities includes the recording and evaluation of clinical, clinicopathological and pathological information and live stranded animals can provide a valuable insight into the health of the seas. Much information also has been generated on the nutritional requirements of neonates of different species, but behavioural research has been more limited in its application to the understanding of wild populations. Post release monitoring has yielded useful information not only on survivability but also on dive behaviour, social structures, habitat utilization and grand scale movement patterns of cetaceans.

NMFS must approve any research and invasive research generally is not allowed or condoned, with some exceptions. Occasionally, in unusual cases, the desire to gain knowledge has superseded the need to avoid excessive handling of animals undergoing rehabilitation, and welfare and survivability may have been compromised. Any research is a balance between the desire to forward science and possible adverse effects on rehabilitation success.

Staffing

Nearly all facilities run rehabilitation attempts with a mix of salaried staff and volunteers, and volunteers have become indispensable in most facilities. Some facilities have particularly large, well-established volunteer programmes, run by full time, salaried volunteer coordinators. Here, volunteers are capable of carrying out rescues and many husbandry-related and clinical tasks, and providing round the clock cover for animals undergoing rehabilitation, often under the supervision of more experienced volunteers. Other facilities use volunteers less extensively but nonetheless rely on their support. Only one facility does not use volunteers in rehabilitation attempts, due to the employment rules of its parent corporation. Most facilities run formal training programmes for volunteers over one or more days. Staff training tends to be hands on and through mentorship.

All facilities agreed that it is essential to have between 2 and 6 full time staff to run a rehabilitation attempt, plus a team of 15 to 20 committed volunteers. If volunteers are to be used, suitable training and infrastructure are vital.

Conclusions with regard to setting up a cetacean rehabilitation facility in the United Kingdom

Should we carry on refloating cetaceans in the UK?

In the United States, cetaceans appear to rarely strand, at least singly, in good health. Even where animals do strand apparently through navigational error, there is considerable concern over the likely survival of these animals if refloated. This concern primarily is over the life-threatening sequelae that occur even in healthy animals when they strand. There is also an inability, with pelagic species at least, to readily refloat them into an appropriate habitat. The concern to some extent has been realised by the high incidence of restranding of refloated animals on, for example, Cape Cod.

This concern does further highlight the urgent need to determine the survival of refloated animals through effective post release monitoring in the UK. This needs to be a continued major focus of cetacean strandings management in this country in the immediate future.

It would be untimely to recommend the cessation of refloating animals in the UK before the results of post release monitoring are known, but these results may have a significant impact on any future recommendations.

In some situations in the UK, for example mass strandings, it is likely that refloatation will continue to remain the only realistic alternative to euthanasia.

Should rehabilitation be considered as an option for cetaceans presently refloated in the UK?

It was impossible to determine definitive survival rates for all rehabilitation facilities visited in the United States and any conclusions drawn from the data that was available have had to be considered particularly in the context of the small sample sizes and also in terms of the large numbers of variables associated with strandings. However, an impression of survivorship of cetaceans taken in for rehabilitation can be gained from the figures given in the section on ‘Survival of stranded animals during refloatation, transport, rehabilitation, captivity and following release’ in the Summary above.

Using the known death rates in transit that are available, survival in transit is probably at best around 95%. Even using the comparatively high approximate release rate obtained from one facility, release rates of cetaceans admitted for rehabilitation are probably no more than 45%. The most optimistic assessment of post release survival beyond 60 days is a little over 80%. Thus, the percentage of animals transported that are successfully released is likely to be at best around 35%. Using the lowest survival rates in the data from the same section (86% surviving transport, 7% admitted animals released and 36% animals surviving 60 days post release), the percentage of animals transported that are successfully released could be as low as 2%. It is likely therefore that the successful release rates for transported animals in the facilities visited for which some data was available fall somewhere between 2 and 35%.

Successful releases from rehabilitation in the United States have included species that live strand in the UK, e.g. pilot whales, Atlantic white-sided dolphins and harbour porpoises. However, even if the most optimistic figure given for release rates above could be achieved in the UK, whether this is an acceptable ‘return’ on the level of investment and infrastructure that would be needed for any cetacean rehabilitation facility requires careful consideration.

These survivorship estimates obviously are based on animals taken in for rehabilitation in the United States. Few of these are considered to be healthy at the time of admittance, or even at the time of stranding. It is possible that survival rates in rehabilitation would be greater for animals stranding purely through navigational error. Presently, a significant group of primarily pelagic animals do strand apparently for this reason in the UK and are the group for which refloatation is considered an option, if response is quick enough. No information, however, is available on the survival of animals managed in this manner. If survival proves to be poor, then rehabilitation for this group of animals may become a more attractive option.

Until the survival rates associated with refloating animals are known, however, it would be premature to recommend rehabilitation as a more suitable option for these animals.

Should rehabilitation be considered for animals not considered suitable for refloating in the UK?

Mayer (1996) in her review of live cetacean strandings management in the UK, determined that, with refloatation in place as an option for stranded cetaceans in the UK, there were perhaps only 5 animals a year that would be suitable candidates for rehabilitation throughout the UK. Justifying the creation of a cetacean rehabilitation facility for these animals alone, therefore, would need to be considered not only in light of likely survival rates but also bearing in mind the very small number of potential candidates.

Again, it would be more appropriate to defer the decision to rehabilitate these animals until the survival of refloated animals has been evaluated. This would then indicate whether a larger set of animals may be available for rehabilitation, which would make the option more viable.

What other factors will need to be considered in any future proposal to build a cetacean rehabilitation facility in the UK?

Effective rehabilitation appears to take several months. Where data was available from the US facilities visited, nearly two thirds of animals released were in rehabilitation for more than 100 days and a quarter for more than 150 days. Determining if and when to release an animal in the States is the responsibility of an external regulatory body using a fairly exacting set of criteria. These are designed to maximise the chances of an animal's survival after release and minimise its likely impact on the wild population. It would seem appropriate to adopt a similar set of guidelines in any facility built in the UK and thus similar rehabilitation periods should be considered likely, at least with animals in a comparable state of health. (One criterion used in the States that would prove difficult to implement is the feeding of live prey prior to release, due to existing UK legislation). Again, if it is decided that rehabilitation rather than refloatation is appropriate for animals stranding purely through navigational error, rehabilitation periods for such animals may prove to be shorter.

Rehabilitation is expensive. Costs of setting up a facility from scratch have not been considered in this report. However, even if running costs alone are considered, each rehabilitation attempt may costs tens of thousands of pounds. Obviously, again this could be less if animals stranding purely through navigational error are brought in for attempted rehabilitation. The capacity to ensure the necessary funding not only to build a facility but to suitably maintain it needs to be fully evaluated if it is decided to consider this option further. As with facilities visited in the United States, it would seem sensible to combine any UK rehabilitation facility with an existing facility, where fundraising expertise or gate receipts could be exploited and facilities shared. Rehabilitation pools ideally would be dual purpose and used to house other animals when not in use for cetacean rehabilitation. For such an arrangement, disease control measures would need to be strictly enforced, to avoid transfer of disease between cetaceans undergoing rehabilitation and other animals in the facility.

Rehabilitation needs space and a good quality environment. With minimum acceptable dimensions of 9 metres' diameter and 2.4 metres' depth, a substantial pool is required for the complete rehabilitation of even the smaller species encountered in the UK. This requirement, particularly depth, realistically rules out the use of temporary pools to carry out rehabilitation to the point of release. Water quality needs to be optimal and its temperature controlled, which again may be difficult to achieve in any temporary facility. Consideration also should be given to the use of final release sea pens, a concept raised by Mayer (1996) and fully endorsed by those interviewed.

Rehabilitation requires manpower. A minimum of two full time staff plus up to 20 committed volunteers are considered likely to be needed to cover handling procedures and 24 hour observations over at least the first few weeks of any rehabilitation attempt, plus other activities such as feed preparation and maintenance of the environment. Well conceived and implemented staff and volunteer training programmes and protocols would need to be in place.

Rehabilitation needs to be carried out by experienced personnel with access to good facilities. Providing appropriate stabilisation, triage, transport, handling, nutrition, assessment and care all come with experience and are vital to the success of any facility. Furthermore, a comprehensive understanding of the behaviour of cetaceans is essential to ensure that stress is minimised and boredom alleviated in captivity, and reinforcement of inappropriate behaviours, and habituation and desensitisation to people are avoided. Good facilities required to complement this experience include suitable transport vehicles, ready access to diagnostic equipment and clinical pathology laboratories, suitable feed preparation facilities and access to good quality feed. Developing and maintaining an experienced group of people to staff a rehabilitation facility will be difficult with the relatively small number of live cetacean strandings seen in the UK. This was estimated by Mayer (1996) to be 35 annually and, of these, a significant number are unlikely to be suitable for transport and rehabilitation. The only means by which it may be possible to maintain adequate experience would be by rehabilitating the majority of animals live stranding in the UK in one facility.

Whether one facility could service the whole of the UK coastline is debatable. Although over half of UK live strandings occur in Scotland, the east coast of England, southwest England and the coast of Wales also are important areas for live strandings (Mayer, 1996, Barnett *et al.*, 2001). Therefore, animals potentially suitable for rehabilitation are likely to strand at the most northerly and southerly extremes of mainland Britain. In the States, it has been possible to overcome such logistical problems. Florida, a state only slightly smaller than the UK, has two facilities in the middle of its west coast taking live strandings from all over the state. Baltimore takes animals from 1400 miles of intricate coastline over three states. Although transport times by road may be best limited to 3 to 4 hours in the view of many interviewed, it has proved possible to move animals over longer distances. This has been aided by the stabilisation of animals prior to transport in holding facilities and, where feasible, by the use of air transport. For one facility to take strandings from throughout the UK would require a similar protocol. A good working relationship with airlines would need to be in place and a second tier of infrastructure, of readily erectable temporary pools sited around the UK would need to be established, staffed by relatively experienced personnel. This could be difficult to achieve.

Rehabilitation generates non-releasable animals and the disposition of non-releasable animals, e.g. neonates, would need to be carefully considered if any facility is established. With the lack of captive cetacean facilities in the UK presently, and the unwillingness of most groups involved in marine mammal rescue and rehabilitation in this country to allow stranded animals to become permanent captives, then hard decisions will need to be made. Animals obviously non-releasable on initial triage, e.g. neonates, would need to be euthanased. Other animals would need to be euthanased as they were determined to be non-releasable during rehabilitation. Even with a set of release criteria in place, determining when an animal becomes non-releasable will be challenging, particularly when this is carried out in the eye of the media and public. A strong argument would need to be in place to counter any criticism of this policy.

Rehabilitation requires an undisturbed environment. Although it is recognised that generating public interest and awareness in animals undergoing rehabilitation helps with fundraising and educating the populace about man's effects on the marine environment, it needs to be carried out in a manner that minimises stress and avoids habituation. Animals undergoing rehabilitation also are wonderful opportunities for scientific research and veterinary education, but these activities again have to be carried out in a manner sympathetic to the needs of the animal. Strict policies on press, research and educational opportunities would need to be in place prior to any rehabilitation facility opening. Public access to animals should be avoided and compensated for with remote viewing, e.g. remote cameras and web cams.

Rehabilitation needs to be constantly reviewed. A high standard of record keeping would need to be maintained for animals undergoing rehabilitation and further financial investment needed to ensure animals are effectively monitored after their release into an appropriate habitat. In the absence of any external regulatory authority, a process of regular evaluation of the activities of any cetacean rehabilitation centre would need to be established, through consultation with, and examination by recognised experts in the field.

Final thoughts

In conclusion, even though it is untimely to support the setting up of a cetacean rehabilitation facility in the UK at the present time, it is hoped that the information contained in this fellowship report provides a useful insight into use of the option of rehabilitation with stranded cetaceans. Furthermore, if the survival of animals monitored following refloatation proves to be poor, it is hoped that it will be valuable in the subsequent deliberations over the setting up of one or more cetacean rehabilitation facilities in this country.

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Further information

Recommended reference texts for vets involved in cetacean rehabilitation

Dierauf, L.A. and Gulland, F.M.D. (Eds) (2001) CRC Handbook of Marine Mammal Medicine: Health, Disease and Rehabilitation. 2nd Ed.. CRC Press, Boca Raton, Florida.

Fowler, M.E. (Ed.) (1986). Zoo and Wild Animal Medicine. 2nd Ed. W.B. Saunders Co., Philadelphia, Pennsylvania.

Geraci, J.R. and Lounsbury, V.J. (1993). Marine Mammals Ashore. A field guide for strandings. Texas A&M Sea Grant Publication, Galveston, Texas.

Howard, E.B. (Ed.) (1983) Pathobiology of Marine Mammal Diseases. Volumes I and II. CRC Press, Boca Raton, Florida.

Ramirez, K. (1999) Training: Successful Animal Management Through Positive Reinforcement.. Shedd Aquarium. Chicago, Illinois.

Ridgway, S.H. (Ed.) (1972) Mammals of the Sea: Biology and Medicine. Charles C. Thomas, Springfield, Illinois.

Wallach, J.D. and Boever, W.J. (1983). Disease of Exotic Animals: Medical and Surgical Management. W.B. Saunders Co., Philadelphia, Pennsylvania.

Additional references cited

Barnett, J., Knight, A. and Stevens, M. (1998). British Divers Marine Life Rescue Marine Mammal Medic Handbook. The Printed Word, Horsham, U.K..

Bossart, G.D., Reidarson, T.H., Dierauf, L.A. and Duffield, D.A. (2001). Clinical Pathology. In: (2001) CRC Handbook of Marine Mammal Medicine: Health, Disease and Rehabilitation, 2nd Ed., pp. 383-448. Edited by L.A. Dierauf and F.M.D. Gulland. CRC Press, Boca Raton, Florida

Carder, D., Ridgway S, Whitaker BR, Geraci J (1995). Hearing and echolocation in a pygmy sperm whale Kogia. Proceedings of the Eleventh Biennial Conference on the Biology of Marine Mammals. Orlando, Florida.

Culik, B.M., Bannasch, R. and Wilson, R.P. (1994). External devices on penguins: how important is shape? Marine Biology 118: 353-357.

Mate, B.R. and Stafford, K.M. (1991). Movements and dive behavior of a satellite-monitored Atlantic white-sided dolphin (Lagenorhynchus acutus) in the Gulf of Maine. Marine Mammal Science 10, 116-121.

Mayer, S.J. (1996). The veterinary care of stranded cetaceans. A Report for the Whale and Dolphin Conservation Society, Bath, U.K..

Nawojchik, R., St Aubin, D.J., Johnson, A. (2003). Movements and dive behaviour of two stranded, rehabilitated long-finned pilot whales (Globicephala melas) in the northwest Atlantic. Marine Mammal Science 19, 232-239.

Needham, D.J. (1993). Cetacean strandings. In: Zoo and Wild Animal Medicine. 3rd Ed., pp. 415-425. Edited by M.E. Fowler. W.B. Saunders Co., Philadelphia, Pennsylvania.

St Aubin, D.J., Geraci, J.R. and Lounsbury, V.J. (1996) (Eds.). Rescue, Rehabilitation, and Release of Marine Mammals: An Analysis of Current Views and Practices. Proceedings of a Workshop held in Des Plaines, Illinois. NOAA Technical Memorandum.

Turnbull, B.S. and Cowan, D.F. (1998). Myocardial Contraction Band Necrosis in Stranded Cetaceans. Journal of Comparative Pathology 118: 317-327.

Walsh, M.T., Odell, D.K., Young, G., Asper, E.D. and Bossart, G. (1990). Mass strandings of cetaceans. In: CRC Handbook of Marine Mammal Medicine: Health Disease and Rehabilitation. pp. 673-683. Edited by L.A. Dierauf. CRC Press, Boca Raton, Florida.

Wells, R.S., Rhinehart, P., Cunningham, P., Whaley, J., Baran, M., Koberna, C. and Costa, D.P. (1999). Long distance offshore movements of bottlenose dolphins. Marine Mammal Science 15, 1098-1114.

Westgate, A.J., Read, A.J. and Cox, T.M. (1998). Monitoring a rehabilitated harbor porpoise using satellite telemetry. Marine Mammal Science 14, 599-604.

Wilkinson, D. and Worthy, G.A.J. (1999). Marine Mammal Strandings Networks. In: Conservation and management of marine mammals. Edited by J.R. Twiss and R.R. Reeves. Smithsonian Institution Press, Washington, pp. 396-411.

ADDENDUM

Page 58 - Release rates for stranded animals taken in for rehabilitation at Sea World

Since this report was produced Sea World has made the following data on release rates available:

Data for the years 1991-2003: 46 animals attended, 4 died before attempted rehabilitation (1 definitely during transit), 35 died during rehabilitation and 7 were released. Animals released included 6 common dolphins and 1 grey whale (after 14 months' rehabilitation).

- *Release rate of those admitted: 7/42 = 17%*

Comment: 34 of the 46 animals attended were common dolphins, 28 of which were adults. Of these, 31 were admitted, giving a release rate for this species of 19%.