Chapter 21
Assessing Welfare of Individual Sirenians in the Wild and in Captivity

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Abstract Assessing the welfare of wild populations of sirenians has required a "generalist" approach. The outcome has been a subjective decision as to whether what the observers are witnessing in an individual or group of animals is normal and whether that has positive or negative consequences. The understanding of sirenian welfare requirements, and a decision process for whether to support and maintain their natural habitats or to try to replicate it in a meaningful way in an artificial captive setting, is still in its early developmental stages and has dynamic qualities that are in need of urgent attention. In this chapter we use the knowledge and observations presented throughout the chapters on sirenians to outline a proposed standard approach for assessing welfare in individuals in wild populations, as well as guidelines for assessing captive groups of dugongs and manatees. In the wild, the suitability of the habitat and human impact on it, the limitations of carrying capacity, the dynamics of ecosystems, and the effects that the immediate environment will have on the known resident populations are examined. In captivity, we use the foundation of the *Five Freedoms*, based on experience derived from other captive species, and we combine this with experience from rehabilitating manatees in Europe and the United States and, more recently, dugongs in the Indo-Pacific, to identify requirements and to help us to assess the unique needs of these species when held in facilities. We present considerations and approaches to (1) holistically assess captive facilities and to assess the well-being of the individuals held in the facility, (2) derive a guideline for standard captive assessment, (3) determine if adequate welfare needs for the animals are being met, and (4) help to provide guidance on whether an animal is suitable for release after rehabilitation.

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21.1 Introduction

Most vertebrate species, and especially the primate species, have detailed accounts of natural behavior and habitat usage, which has enabled a comprehensive baseline of collective knowledge to be used to assess their well-being in any given situation (Goodall 1986). Unlike these well-studied wild species, assessing the welfare of wild populations of sirenians has required a more "generalist" approach. Biologists, mariners, ecologists, veterinarians, pathologists, and modelers have collaborated to bring together segregated data and anecdotal information and to consider multiple environmental, populational, and individual characteristics which may correlate with certain specific behavioral responses. The outcome has been a subjective decision as to whether what the observers are witnessing in an individual or group of animals is normal and has positive or negative consequences for their welfare. In some ways the understanding of sirenian welfare requirements, and a decision process for whether to support and maintain their natural habitats or to try to replicate it in a meaningful way in an artificial captive setting, is still in its early developmental stages and has dynamic qualities that are in need of urgent attention.

In this chapter we use the knowledge and observations presented in the preceding chapters on sirenians to outline a proposed standard approach for assessing welfare of individuals in wild populations, as well as guidelines for assessing captive groups of dugongs and manatees.

In the wild, the suitability of the habitat and human impact on it, the limitations of carrying capacity, the dynamics of ecosystems, and the effects that the immediate environment will have on the known resident populations are examined.

In captivity, we use the foundation of the Five Freedoms (Farm Animal Welfare Council 1979), based on experience derived from other captive species, and we combine this with experience from several decades of rehabilitating manatees in Europe and the United States and, more recently, dugongs in the Indo-Pacific, to identify factors, judge their relative importance, and so help us to assess the unique needs of these species when held in captive facilities.

We present considerations and approaches to (1) holistically assess captive facilities and to assess the well-being of individuals held in the facility, (2) derive a guideline for standard captive assessment, (3) determine if adequate welfare needs for the animals are being met, and (4) provide guidance as to whether the animal is suitable for release after rehabilitation.

21.2 Wild: Indirect Assessment of Individuals in a Population

Indirect assessment of an individual can be carried out by assessing the features of the environment and then by applying a decision-making process on the suitability of those conditions relative to the carrying capacity for a particular group of animals that use or live in that area. This is not a straightforward approach, and many

complex interactions, including those of competing species and humans, result in the need for best judgment as opposed to a set of rigid guidelines. However, it is quite possible to clearly determine the suitability of an environment to harbor dugongs and manatees, based on the assessment of known desirable characteristics.

High levels of human activity and occupation can deter use of a preferred area. Harmful algal blooms, such as red tide (*Karenia brevis*) exposure in Florida, can cause severe morbidity and mortality during blooms. A cyanobacterium (*Lyngbya majuscula*) can cause irritation, and its persistent presence in an area is not conducive with maintaining an ecosystem suitable for sirenians (Capper et al. 2013; Landsberg et al. 2009).

Global climate impacts are making site suitability a dynamic process. In Africa and South America, it cannot now be assumed that a body of water present during the rainy season will persist through the dry season and hence be perennially available. It is probable that this type of environmental unpredictability will become more prevalent as climate change impacts regions over the coming decades. Assessment of sites for long-term suitability should consider the possibility that some areas may become unsuitable habitats, and this should be considered alongside the human social implications of desertification discussed in the climate change chapter (Chap. 19).

Finally, increasing public awareness of the challenges faced by marine mammals over the last decade has resulted in a more informed public, and well-intentioned public now commonly directly alert authorities when they observe something which they perceive is amiss in the environment. This improved communication has allowed a greater capacity for those tasked with monitoring and assessing the well-being of sirenians, by enabling rapid collection of up-to-date information across huge geographical areas and through rapid reporting of "tip-offs" regarding potential issues or hotspots. This information directly assists efforts to manage imperiled sirenian stocks.

21.3 Wild Animals: Assessing Welfare at the Individual Level

Wild caught manatees and dugongs offer a rare direct insight into the health of members within the population (Figs. 21.1, 21.2, and 21.3). The assessment of the well-being of these individuals may allow decisions to be made based on welfare criteria which support responsible approaches to mitigation of problems.

The assessment of animals by radio tracking can offer useful information on the interaction of individuals within their environment (Flamm et al. 2005). The use of satellite telemetry and microchipping as part of a capture-mark-recapture program may yield vital data on (1) animal movement (distribution) and use of habitat or structures (seagrass beds, warm water refuges), (2) migratory patterns, (3) home range patterns, and (4) response to perturbations and anthropogenic activities (Fig. 21.4). Although considered to be of minimal risk to the animal and to present

Fig. 21.1 Manatee capture for health assessments. The animal is encircled by a net deployed from a boat (see behind manatee) and carefully captured by manually pulling the net to shore. *Image credit: Sirenia Project—United States Geological Survey*

Fig. 21.2 The animal is intensively monitored while medical and biological data is collected prior to release within approximately 30 min. *Image credit: Sirenia Project—United States Geological Survey*

Fig. 21.3 Dugong in a capture-mark-recapture study. These are usually performed by a "rodeo technique" where a jumper captures and secures the animal from a moving vessel. The animal is then supported either on or next to the vessel or by people in the water as shown in this image. *Image credit: Department of Environment and Heritage Protection StrandNet*

Fig. 21.4 Attaching a satellite telemetry tag to a dugong in southern Queensland, a region with a high urban population. This study determined the movements of dugong with respect to anthropogenic and climatic pressures. *Image credit: Department of Environment and Heritage Protection StrandNet*

only a short-term impediment, it is advised that any wild sirenian capture program includes documented welfare considerations or guidelines for reference during capture. Invasive methods are often used to collect samples from individuals for biological and health assessments, and this sampling is commonly incorporated into programs during tagging (Gerlach et al. 2015; Sulzner et al. 2012). This approach can yield detailed data on the functional health of the population, and allows determination of physiological parameters, and can guide responses to current environmental conditions or challenges. In addition to health (clinical pathology, body condition, abnormalities), other ancillary indicators of survivorship, such as nutritional state and reproductive status, can be determined during tagging procedures.

Guidelines could include assessment and minimization of the risk of death during handling and assessment of the ongoing effect of placement of any radio tag attachments or tissue or blood sampling used in research, which may have an adverse impact on the animal during the collection procedure or after release.

Live stranding of animals and the subsequent veterinary assessment and/or treatment of stranded individuals may help to identify that a part of the population is not performing well (Flint et al. 2010). These cohorts could be considered surrogates or proxies for assessing the health of the population. Furthermore, these individuals may highlight what the parameters of assessment should be for examining the health of the population. Frequently, the assessments carried out on stranded individuals include a baseline assessment of (1) body condition, body mass index, and/or nutritional status; (2) identification and diagnosis of disease; (3) behavioral response to capture and mentation or discussion of any indicators on the animal which may indicate a stress response and the current capacity of the animal to cope; and (4) the presence of injuries or external indicators of health status (e.g., parasites).

The collection of ancillary scientific data from these animals during rehabilitation has helped create physiological and anatomical baselines and expands our understanding of the requirements for the health and well-being of individuals. Combining this data with the environmental needs of the animal in a particular habitat, we can make better informed decisions on the requirements for maintaining a captive animal (if required) and what steps need to be taken prior to releasing an individual back into the wild.

21.4 Captive Animals: Assessing Welfare at the Facility Level

While many of the principles outlined for assessing individuals in the wild can be applied to assessing individuals at the facility level, there are additional considerations due to the potential for high stocking densities within facilities, resulting in low space/or water volume provided per animal when compared to the natural environment. In order to optimize an animal's artificial environment, assessment in captivity should take into consideration, as minimum, the *Five Freedoms*—standards derived for the holding of animals by the UK Farm Animal Welfare Council (1979).

The *Five Freedoms* simply outline that all animals held in captivity should have:

1. Freedom from hunger and thirst by ready access to freshwater and a diet to maintain full health and vigor
2. Freedom from discomfort by providing an appropriate environment including shelter and a comfortable resting area
3. Freedom from pain, injury, and disease by prevention or rapid diagnosis and treatment
4. Freedom to express normal behavior by providing sufficient space, proper facilities, and company of the animal's own kind
5. Freedom from fear and distress by ensuring conditions and treatment which avoid mental suffering

To achieve this, we strive to determine the necessary needs and wants of the species. Using our wild habitat knowledge for sirenians, we should provide:

1. Access to freshwater, appropriate seagrasses, and freshwater vegetation or substitutes located in a natural feeding location (i.e., on the floor for dugongs)
2. Protection from the sun, in the form of shade, replicate diurnal cycles when using indoor lighting, providing areas for isolation, and the ability to swim and turn unhindered
3. Available medical care and daily observation of health status
4. Tank design and size with adequate space per animal
5. Selection of structures, tools for enrichment development, and tank mates that allow social interaction in an environment safe from non-predatory hazards and one where areas are available for sanctuary from predators/competition/the public, while still achieving the general goals of the *Five Freedoms*

As is the case in many attempts to improve the welfare of facility inhabitants, the use of the Five Freedoms and creation of expected standards run the inherent risk of anthropomorphizing and the projection of personal human wants onto the animals. To avoid this wherever possible, reference to scientific data and analysis of the meaning of this data should form the basis of decision-making or as a reference. Robust data which can satisfy these needs can be derived from previous dugong and manatee captive experiences and our knowledge of their free-ranging behaviors and requirements.

There are additional considerations when artificially housing behaviorally complex species. The nature of the artificial housing may require adaptive behaviors that are otherwise not seen in the wild in order to maintain social structure and to support the well-being of individuals. For example, dominance structures exist in many hierarchical groups with a leader of each herd, flock, or group. This dominant position may be held by different members of the group for different activities, such as feeding, drinking, sleeping, or mating rights. With increased stocking densities and altered habitat, these activities may require the addition of complexities greater than observed in the wild or the creation of new dominance opportunities, like novel activities, to artificially develop and maintain social structure and help alleviate stress. This has been previously documented in other free-ranging species that become intensively managed (Flint and Murray 2001).

Conversely, natural dominance behaviors that exist in the wild may need to be curtailed in a captive environment. For example, for manatees, dominant (usually bigger) individuals may take more food than smaller individuals. This could lead to some smaller animals not getting the required minimal nutrition as a "behavioral expense" of being housed with larger individuals, if this is not monitored and controlled. Regarding the dugong, males can dominate other males, females, and juveniles by use of their tusks to rake (scar) herd mates into submission. If left unchecked in an enclosure, this could potentially lead to severe injury or morbidity and mortality.

For sirenians, natural and artificially induced behaviors are still an area of rapid learning for the animal keepers, with facility design requiring separate feeding areas and segregation of captive animals by size, sex, and breeding status as we progressively learn more about how to safely allow cohort interactions.

Building on the *Five Freedoms*, several principles have been proposed as being necessary to ensure animal welfare (Barnett and Hemsworth 2009):

1. Minimize stress.
2. Minimize negative emotions.
3. Maximize positive emotions.
4. Ensure adaptation.
5. Provide opportunity for normal or natural behaviors.
6. Provide natural environments.

One advantage afforded to manatees is that, as a Federally protected species, a consistency can be achieved through Federal standards being established for the care and management of sirenian undergoing rehabilitation in the United States. Unfortunately, this has not been achieved globally and would require many territories and countries to adopt the same guidelines or standards. The creation of US Federal standards effectively prescribes minimum standards against which all other needs may be assessed. In other parts of the world, outlined minimum requirements to optimize welfare tend to be based on each individual facility's best practices.

In the previous chapter (Chap. 20), Walsh and Blyde identified a range of health considerations and minimum standards which should be adopted in captive manatees and dugongs. Addressing Barnett and Hemsworth's (2009) principles, and common to all facilities, were space requirements, diet, and tank environmental factors. In some of the more resource-limited countries where standards are not as rigorously monitored, advocacy and assessment of the welfare of the dugongs or manatees may benefit from the input of special interest groups, and public reaction in these countries is starting to influence change and activity to support the safety, comfort, and health of these animals.

Finally, environmental enrichment has been a tool used in many aquatic and terrestrial species to combat negative behaviors and to provide a source of stimulation for the facility inhabitants (Anzolin et al. 2014). Sirenia are highly tactile animals, so the incorporation of novel objects in their enclosure such as flowing water or "toys" is believed to have beneficial effects on social development and cognitive abilities.

21.5 Captive Animals: Assessing Welfare at the Individual Level

When there is limited published data and all appropriate anecdotal knowledge has been employed, one mechanism to assess how effectively a captive enclosure is working is the behavioral response of the individuals within the facility. Two ways in which this can be achieved without the need to directly handle the animal are through the assessment of normal or stereotypical behaviors and through the public's response to the display and the animals in it.

Stereotypical behaviors have been reported in captive sirenians (Anzolin et al. 2014). One of the sirenians that the authors have dealt with had spent the majority of its 20-year life in captivity. While sirenians are usually docile animals in the wild, this individual was certainly not when people entered his tank to restrain him. He would quickly swim circles around the perimeter of the tank (the stereotypic part of the behavior) and repeatedly and rapidly head-butt anything in his path to avoid and prevent capture. This anticipation of an impending event posed a risk to any people in the pool but also illustrated the cognitive capacity of sirenians and their ability to respond to specific actions or perceived threats. Avoidance of these types of specific reaction, and steps to avoid the stimulus responsible or to prevent these types of behaviors, should be given consideration when dealing with individuals held in long-term captive situations.

With increased public awareness of the needs of captive animals, including sirenians, as well as the public demand for quality care in captivity, the comments made by guests about their experience of the animals are considered an important and rapid feedback mechanism to determine how well the animals are coping in captivity. This creates a two-way street for information, with facilities being an avenue to get the message out about conservation education and issues facing manatees and dugongs, but also producing a keen-eyed public that is informed and able to look for, and detect, signs of discontent. This public "eye," linked with the capacity for the public to be vocal (particularly through social media) about any anomalies or injustices they perceive, creates a situation in which public response to a situation is a very sensitive barometer for poor captive care. A case in point was a captive manatee in Venezuela that was being fed meat. The local zoo did not know that manatees were herbivores, but when this was observed and reported by a concerned citizen, the caretakers made amends and started feeding the malnourished manatee vegetation.

21.6 Guidelines for Use of Sirenians in Research

Research on both wild and captive sirenians follows the nationally adopted Institutional Animal Care and Use Committee (IACUC) standards based on the Animal Welfare Act in the United States, Animal Ethics Committee (AEC) standards based on the institute's state Animal Welfare Act in Australia, and systems

such as Animal Research: Reporting In Vivo Experiments (ARRIVE) as part of the United Kingdom's 3R's (Replacement, Refinement, Reduction) to create standards to help maintain the well-being of these animals. These guidelines may also be used to provide information for intensive management.

21.7 Release of Sirenians Back into Their Natural Environment

In the United States and Australia, it is not legal to hold sirenians for public display. They can only be held in captivity for the purposes of medical treatment and rehabilitation, with the final intent of release back into the wild. Exceptions to this are if a panel of experts agree formally that the animal is non-releasable; that is, if the animal were to be returned to the wild, it would not be likely to survive or pose an imminent threat to the wild population. This is, in part, based on a determination of the animal's inability to thrive in the wild, or it is a health threat to the wild population.

When releasing sirenians back into their natural environment at the end of rehabilitation, there are several important considerations. In addition to requiring that the individual is free from disease and confirmation that they are suitably recuperated to survive unassisted in the wild, we must consider the environment and the resident population. Any release of animals must consider the genetic benefits and consequences of crossbreeding. This can occur through placing an animal from a different genetic population into a new area. Benefits might include the potential of hybrid vigor, but consequences might result from introducing a maladapted individual into a novel set of environmental conditions. In a similar way, the release of animals into inappropriate habitats, regardless of genetic effects, may be detrimental. The animals require "basic local knowledge" to meet the challenges for survival in a given area, such as finding access to freshwater (manatees), to food, to cohorts, to shelter (the location of warm water during winter in some populations), and to protection (from predators, human interactions, and loss of habitat).

Captive breeding programs have often been used as a final effort by recovery teams for critically endangered species. However, by the time a captive breeding program is implemented, it may be too late as there is already a low reproductive rate on captive bred animals. Most regional wildlife managers would prefer to allow sirenian species to breed successfully in the wild, but with some local populations at risk of going extinct, there is discussion about species reintroduction back into some extirpated areas.

21.8 Captive Assessment Guidelines

A tabulated score sheet (Table 21.1) is presented as an example of a potential approach to assessing the parameters we have discussed above and in the preceding chapters. It is by no means definitive or accurate for every facility, and any assessor could create their facility-specific own score sheet using this table as a guide.

Table 21.1 Assessing captive sirenian habitat suitability by the use of a cumulative weighted welfare parameter score

Facility assessment					Total
Parameter	Subparameter	Factor 1	Factor 2	Factor 3	
Housing	Cohorts in tank (#)	2 (10)	0 (5)	5+ (5)	
	Other species in tank	No (5)	Yes (0)		
	Predators	No (5)	Yes (−5)		
	Depth of tank	>2 m (5)	<2 m (0)		
	Area/animal	4 × length (10)	2 × length (5)	<2 × length (0)	
	Salinity-manatee	Freshwater (10)	Brackish (8)	Saltwater (4)	
	Salinity-dugong	Saltwater (10)	Brackish (6)	Freshwater (2)	
Enrichment	Included in tank	Yes (5)	No (0)		
	Form/structure used	Complex (10)	Cognitive (10)	Other objects (5)	
	Public contact allowed in tank?	No (5)	Yes (−10)		
Five Freedoms	Nutrition	Good (10)	Poor (−10)		
	Shelter	Adequate (10)	Absent (−10)		
	Normal Behavior	Yes (scored below)	No (0)		
	Freedom from fear	Yes (10)	No (−10)		
	Health care assessments	Daily (10)	Weekly (2)	None (−10)	
Individual Assessment (including answers based on those already housed)					
Behavior	Demeanor	Passive (5)	Aggressive (−10)		
	Eating	Well (5)	Small qty. (0)	No (−10)	
	Stereotypies (of others in tank)	No (10)	Yes (−25)		
	Average stay of animals in tank	<6 months (5)	>6 months (0)		
	Weight change in first 28 days	Gained weight (10)	Same weight (5)	Lost >5% weight (−20)	
	Medical issue (new since arrival)	No (10)	Yes (−20)		
Release	Date/timing of release	Known (20)	Unknown (−10)		
	Release site suitability	Known (20)	Unknown (−20)		
Total					

The premise of the assessment is that each parameter is assessed as accurately as is possible and the appropriate response is circled. Each response has a numeric value in parentheses next to it. From these values, each line is tallied (aggregated) to provide a subtotal. All assessments should be given a score, as some parameters may subtract from the final overall aggregated score. The subtotals are then tallied to provide a final score. In this example, a score of ≥100 is proposed to indicate a

suitable facility, 80–99 may require further investigation and resource or other inputs prior to use of the facility, and <80 suggests the facility may not be suitable for the holding of sirenians.

21.9 Conclusions

The dugong and manatees are a group of species that is held in high regard by the public, and yet they are all threatened across the world. Through the efforts of many conservationists over the last few decades, it has been possible to collate a large amount of learned information about these animals and, to gain a greater understanding of their biology, habitat requirements and what is required to maintain these animals in healthy environments. In Chaps. 17–21 we have identified a range of human and natural threats that are creating stressed habitats and which are challenging sirenian survivorship. We have surveyed sirenian caretakers and the available literature to propose a standard set of requirements to assist successful care for individuals in rehabilitation. Finally, we used this collective knowledge to create and interpret assessments for wild and captive dugongs and manatees.

We hope that these chapters can improve the welfare of wild and captive sirenians and serve as a foundation from which to further fill in the gaps which exist in critical knowledge. With the current shift in public perception, and an increase in public awareness of the plight of numerous species, we hold hope that sirenians will become another recovered species that can be enjoyed for generations to come.

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