Polar Bear (*Ursus maritimus*) Care Manual

Created by the
AZA Bear Taxonomic Advisory Group
in Association with the
AZA Animal Welfare Committee

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Authors and Significant contributors:
See Appendix J

AZA Staff Editors:
Dr. Debborah Colbert, AZA Vice President, Conservation & Science

Reviewers:
Dr. Randi Meyerson (ACM Coordinator, Toledo Zoo)
Dr. Joseph C.E. Barber, (AZA, ACM Consultant)
Dr. Don Moore (SI-NZP, AZA Bear TAG Advisor)
Dr. Barbara Kohn (APHIS)
Dr. Steven Amstrup (USGS)
Dr. Lydia Kolter (EAZA Bear TAG Chair)
Barbara Henry, M.S. (AZA Nutrition SAG, Curator of Nutrition, Cincinnati Zoo & Botanical Garden)
Ann Ward, M.S. (AZA Nutrition SAG, Director, Nutritional Services for Fort Worth Zoo)

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Introduction

Preamble

AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (www.aza.org) which might not be included in this manual.

Taxonomic Classification

Table 1: Taxonomic classification for polar bears.

Classification	Taxonomy
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Carnivora
Family	Ursidae

Genus, Species, and Status

Table 2: Genus, species, and status information for polar bears.

Genus	Species	Common Name	USA Status	IUCN Red List Status	AZA Status
Ursus	*maritimus*	Polar bear; Ice bear; Sea bear; White bear	Threatened	Vulnerable A3c	Species Survival Plan® Program

General Information

The information contained within this Polar Bear Care Manual (PBCM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including Association of Zoos and Aquariums (AZA) Taxon Advisory Groups (TAGs), Species Survival Plan® (SSP) Programs, biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers. They are based on the most current science, practices, and technologies used in animal care and management and are valuable resources that enhance animal welfare by providing information about the basic requirements needed and best practices known for caring for *ex situ* polar bear populations. This PBCM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the PBCM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for polar bears must comply with all relevant local, state, and federal wildlife laws and regulations; AZA accreditation standards that are more stringent than these laws and regulations must be met (AZA Accreditation Standard 1.1.1).

AZA Accreditation Standard

(1.1.1) The institution must comply with all relevant local, state, and federal wildlife laws and regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

The ultimate goal of this PBCM is to facilitate excellent polar bear management and care, which will ensure superior polar bear welfare at AZA-accredited institutions. Ultimately, success in our polar bear

management and care will allow AZA-accredited institutions to contribute to polar bear conservation, and ensure that polar bear are in our future for generations to come.

Polar bears (*Ursus maritimus*) are carnivorous marine mammals and are the largest bear species in the Ursidae family (Table 1). They are protected under the Marine Mammal Protection Act (MMPA, 2007), have recently been listed as threatened under the Endangered Species Act (1973), are listed as vulnerable under the International Union for Conservation of Nature (IUCN) Red List, and are managed as an SSP Program within AZA (Table 2).

They show a pronounced sexual dimorphism not seen in other species of bears (Stirling & Derocher, 1990), with adult males being larger and heavier than females. Kolenosky, et al. (1992) calculated the average weight of males to be 1078lb (489kg), with some individuals weighing 1442lb (654kg), or even greater than 1763lb (800kg) (DeMaster & Stirling, 1981). Females are smaller, and generally do not weigh more than approximately 881lb (400kg), although some individuals may put on enough body fat to weigh more than 1102lb (500kg) just prior to giving birth (Ramsay 1986; Stirling, 1998). Polar bear neonates are extremely altricial, weighing approximately 1.3-1.5lb (600-700g), and are initially blind and only lightly furred (Ramsay & Dunbrack, 1986). When standing in a quadrupedal posture, the shoulder height of adult polar bears can reach up to 5.3-5.6' (1.6-1.7m), and they generally measure between 8-8.4' (2.4-2.6m) in length (DeMaster & Stirling, 1981), with some males measuring as long as 9.4' (2.85m) (Brown, 1993). Standing bipedally, large males can reach almost 13.1' (4m) (Lynch, 1993).

Polar bear skulls are similar to the skulls of other bear species, and can be smaller than skulls from large brown bears as they are typically narrower across the palate (Kurten, 1964). Polar bears show a similar dental formula with the other bear species: I 3/3, C 1/1, P 4/4, M 2/3 (Stirling, 1998). To enable powerful bites, the jaw of the polar bear shows a long diastema between the canines and molariform teeth at the back of the jaw. Jaw adaptations for their predatory lifestyle include smaller molariform teeth that have a smaller surface area (reducing the functional grinding surface of the teeth), but more pronounced carnassial teeth that are effective for shearing muscle and hide of prey (Burton & Burton, 2002). Males typically have larger canine teeth than females (Kurten, 1955).

The skin of polar bears is black, and is completely covered by dense pelage, except for the tip of the nose. Even the footpads can be covered with fur in the late winter, and this fur may serve to insulate the bears' feet, and may provide greater traction on the ice and snow (Stirling, 1998). The skin of the footpads is similar to that of other bears species, and is made of a cornified epidermis (Storer & Tevis, 1955; Ewer, 1973). The fur is made up of a thick, dense underfur and guard hairs of various lengths (DeMaster & Stirling, 1981). These guard hairs are notable because they have a hollow medulla. While the pelage is unpigmented, it typically appears somewhat yellowish because of impurities (e.g., food oils/blood) that become incorporated into the fur (Ortisland & Ronald, 1978; Grojean, et al. 1980), and can appear green in zoos and aquariums if pool algae present in the bears' habitat areas become lodged within the guard hairs (Lewin & Robinson, 1979). Wild polar bears generally molt in late April/May, and molting is complete by late summer.

In situ populations of polar bears are solitary, and no long-term, social interactions between adults have been recorded (Meyerson, 2007); females and nursing cubs form the only long-term (~2.5 years) social grouping. When the marine ecosystem is resource poor, cubs can remain with their mothers for 3.5-4.5 years (Stirling, 1998). Adult bears can be seen in closer proximity of one another in resource-rich environments (e.g., when large amounts of food are available) when there seems to be a degree of social tolerance between them in these situations. However, these interactions are generally resource-dependent. During the breeding season, males can be found in close proximity to females prior to and during copulation (Stirling, 1998), but they do not play any role in cub rearing or care. Adult females with yearling cubs generally avoid interaction with adult males, as there is a risk of predation by males upon the cubs, especially when food resources are scarce (DeMaster & Stirling, 1981). The breeding season for *ex situ* and *in situ* polar bears is usually between March-May (Meyerson, 2007); most cubs are born in November and December and emerge from their dens with their mothers in March and April (Meyerson, 2007).

Polar bears are the largest terrestrial carnivore and the diet of *in situ* populations consists of ringed seals, especially their pups, and the bearded seal (Meyerson, 2007). Polar bears use a variety of hunting techniques, including taking the seal pups out of their ice birthing dens, pulling them out of the water at breathing holes, and hunting them on the ice surface. Other food sources include beluga whales, reindeer, and walrus. Polar bears have also been observed consuming kelp along shores, as bears wait for the sea ice to freeze over in the winter (Meyerson, 2007). The function of kelp eating is unknown, but

may serve to provide limited nutrition to the bears, or may be a displacement behavior that can function to decrease aggression between the hungry, congregating bears when they are in close proximity to one another.

Additional information on the behavior of polar bears in the wild can be found in Stirling (1998), and from the Polar Bears International website (www.polarbearsinternational.org).

Laws and regulations about standards of care for polar bears: AZA-accredited institutions caring for polar bears must abide by all AZA Accreditation Standards as set forth in the AZA Accreditation Standards and Related Policies document (AZA, 2009). Given the polar bear's threatened status under the Marine Mammal Protection Act, additional laws, regulations, and standards of care must be followed in addition to the specified AZA Accreditation Standards. The following list provides regulations that affect the management of polar bears in zoos and aquariums. Institutions must be familiar with these regulations, have access to the documents containing these regulations, and, where appropriate, must fully comply with the standards of care detailed within them. AZA Accreditation Standards require that these regulations must be followed as appropriate for the specific individual animals in question. Regulations pertaining to polar bears (and other marine mammals) are contained within:

- USDA Animal Welfare Act (AWA) and Animal Welfare Regulations (AWR, 2005)
- Marine Mammal Protection Act (MMPA 2007)
- Manitoba 'Polar Bear Protection Act' (PBPA, 2002)*
- International Air Transport Association (IATA, 2007)
- Endangered Species Act (ESA, 1973)

* Only institutions seeking to acquire polar bears from the Manitoba region are subject to the regulations stated in the Polar Bear Protection Act (PBPA 2002), and there is continuing debate about how these standards apply to AZA-accredited zoos and aquariums. The AZA Bear TAG recommends that all institutions housing polar bears be aware of and consider the management and housing approaches described in the Polar Bear Protection Act (PBPA 2002). For more information, contact the AZA Polar Bear SSP Program Coordinator.

Polar bears are covered under the USDA Animal Welfare Act in the marine mammal section Subpart E 3.100-3.118 (AWR 2005). Regulations regarding parameters such as water quality, and minimum exhibit and pool sizes can be found within these regulations. It should be noted that these are the minimum standards enacted by law, and the recommendations provided within this Polar Bear Care Manual should be carefully considered as best practices that go beyond these minimum requirements.

Polar bears are listed under the Marine Mammal Protection Act of 1972 (MMPA 2007) and under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II. The primary purpose of the MMPA is to ensure marine mammal populations are maintained at (or restored to) healthy levels. MMPA requirements vary both by the legal status of the individual polar bear under the MMPA, and by the type of activity requested (see Meyerson. 2007 for additional information). The primary purpose of CITES is to ensure wild species in international trade are not exploited unsustainably (Meyerson, 2007). Polar bears have recently been listed as threatened under the Endangered Species Act (1973). The primary purpose of the ESA is to prevent the extinction of native and non-native animals and plants by providing measures to help alleviate the loss of species and their habitats (Meyerson, 2007).

Regulations and specific standards for polar bear associated with the Endangered Species Act are currently under review by the US Fish and Wildlife Service, and will be included within future versions of this manual Endangered Species Act regulations affect the requirements stated by the MMPA (2007) for polar bear display and importation. More information on the regulations associated with the Marine Mammal Protection Act (1972) and CITES can be found in Meyerson (2007). The AZA Bear TAG and Polar Bear SSP Program should be contacted for more information about specific ESA (1973) requirements, and for details on permits required for the display and transport of bears.

Terms and definitions: The following terms are used throughout the Polar Bear Care Manual, and definitions have been provided below to avoid confusion:

- *Cubbing den*: An area separated from other management areas where pregnant females are denned up for cubbing.
- *Den*: Off-exhibit management area, where individuals can be separated for feeding, veterinary procedures, etc.
- *Exhibit area*: "Area of the *ex situ* habitat where a polar bear may be viewed by the public and is considered the bears' primary living space" (PBPA, 2002); can be indoor and/or outdoor.

- *Off-exhibit area* (also called “management area”): An area of the *ex situ* habitat where public viewing of the polar bear is not permitted, which includes isolation areas, medical treatment areas, separation areas, individual animal dens, and cubbing dens. Under the USDA Animal Welfare Act (AWA, section 3.104(a)) and Animal Welfare Regulations (AWR, 2005), all habitat areas and pools are required to meet AWA space requirements (AWR, 2005). AWA space requirements apply to all portions of the animal exhibit and management areas (AWR, 2005). Smaller management areas can be available for use, but cannot be used for extended holding of bears. See Chapter 2, section 2.1 and AWR (2005) for additional information.

Chapter 1. Ambient Environment

1.1 Temperature and Humidity

> **AZA Accreditation Standard**
>
> **(1.5.7)** The animal collection must be protected from weather detrimental to their health.

Animal collections within AZA-accredited institutions must be protected from weather detrimental to their health (AZA Accreditation Standard 1.5.7). There has been no scientific determination of minimum or maximum temperatures for polar bears cared for in zoos and aquariums. Though polar bears originate from an arctic environment, most are tolerant of fluctuating temperatures, as summers in Churchill, Manitoba can average 64°F (17.8°C), but can reach more than 79°F (26°C) degrees. It is not known if there is an optimal temperature range for polar bears or if and how they utilize environmental resources to thermoregulate within this wide range of environmental conditions. Polar bears cared for by zoos and aquariums, should have access to shade throughout the day, especially during the warmer months of the year, regardless of the temperature and level of acclimation by the bears, and must do so to comply with regulations in the Polar Bear Protection Act (PBPA 2002).

The orientation of and features within the exhibit can affect the range of temperatures the bears will experience. Hills, trees, shrubs, branches, rocks, and stumps are good pieces of habitat furniture that can be used to provide shade throughout the day. Institutions in warmer climates should consider how to provide cooler areas for their bears using approaches such as free-access to air-conditioned spaces, chilled water, or ice piles. Artificial shade structures that can also incorporate sprinklers and misters, and wind generating fans, are approaches that have also been used. It is important that several cooling areas be made available if multiple bears are on exhibit together. If these features are not available, access to temperature regulated indoor holding areas is recommended.

Polar bears without young require only minimal unheated shelter at night, although institution-specific management needs may dictate that they be brought into nighttime housing. Older polar bears, or ones with minimal coats, may require additional bedding or supplemental heat to keep them comfortable in the coldest weather. Heat stress is a greater risk to healthy polar bears than cold. In one zoo a female polar bear who cubbed in October abandoned her cubs when the outside temperatures were still warm.

> **AZA Accreditation Standard**
>
> **(10.2.1)** Critical life-support systems for the animal collection, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

AZA institutions with polar bear exhibits that rely on climate control life-support systems must ensure that their system is equipped with a warning mechanism should this system fail and an emergency backup systems to fall back upon in these instances. This equipment should be included in a documented preventative maintenance program and maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1). The AZA Bear TAG and Polar Bear SSP Program recognizes that a variety of climate control systems and equipment, manufactured by different companies, has been successfully used to maintain appropriate temperatures for polar bears.

In situ populations of polar bears may experience a variety of humidity ranges depending on the season and their location (e.g., on the ice during winter, and on land during summer in Hudson's Bay and the Alaska North Slope), however It is not known if there is an optimal humidity range for them. In zoos and aquariums, great care should be taken to monitor the interaction between high temperatures and high humidity to ensure that bears are provided with a gradient of temperatures and humidity within their environment and have the ability to regulate their own temperatures at all times through their behavior, but there is currently no specific recommendation for humidity levels. A varied and complex environment provides the bears with choices and control over their environment, both of which are essential to animal welfare. Techniques to raise or lower humidity within indoor and outdoor exhibits include air conditioning, misters, sprinklers, fans, and pools in which the bears can swim. The use of self-draining substrates and provision of nesting materials (see Chapter 2, section 2.1) can also minimize any problems that high humidity can have on the skin and coat of the bears.

Until specific recommendations can be made, appropriate temperature and humidity guidelines should be outcome-based, ensuring that bears do not experience heat stroke, skin or hair-coat problems, and show no significant deviations in activity (e.g., increased lethargy, decreased activity) in environments where the ambient humidity and temperature are high.

1.2 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums, however, no information is known about the effect that daily changes in light intensity or seasonal changes in light intensity and duration have on polar bear health or behavior. Because of their large size and activity patterns, polar bears should be maintained in outdoor habitats under conditions of natural light and any indoor areas, except cubbing dens, should have skylights to provide natural lighting. Additional indoor lighting should mimic natural light patterns of the geographic area of the exhibit. Indoor areas should have sufficient light for animal caretakers to work safety within them for exhibit cleaning and maintenance.

1.3 Water and Air Quality

AZA-accredited institutions must have a regular program of monitoring water quality for polar bear pools and a written record must document long-term water quality results and chemical additions (AZA Accreditation Standard 1.5.9). Monitoring selected water quality parameters provides confirmation of the correct operation of filtration and disinfection of the water supply available for the animals. Additionally, high quality water enhances animal health programs instituted for polar bears (see Chapter 6 for more information on veterinary care).

AZA Accreditation Standard

(1.5.9) The institution must have a regular program of monitoring water quality for collections of fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Polar bears should have access to clean, potable drinking water at all times, and must do so to comply with the Polar Bear Protection Act (PBPA, 2002). The AZA Bear TAG defines “potable water” as water that would be appropriate for human consumption as it exits the tap. Watering devices may consist of exhibit/habitat built-in containers, and automatic drinkers. However, automatic watering devices (Lixit-type) should be used with caution with polar bears, due to the potential for the bears to damage them or their teeth. Regardless of size, potable water containers should be cleaned and disinfected daily; built-in streams and pools should be cleaned at least weekly, unless appropriately filtered and disinfected by an institutionally-approved filtering system. Algae control can be performed using applications of copper sulphate or simazine, as well as denitrification of the water, although each institution should work with veterinarians to ensure the safety of the bears whenever chemical additives are added to the habitat water sources. Any chemicals added to the water must in no way harm or cause discomfort to the bear (AWR, 2005).

Tests for pH, salinity (for saltwater pools), and any chemicals that are added to the water should be performed daily. All water quality tests must be recorded, and the records must be readily available for inspection (AWR, 2005). When testing water quality, water samples should be taken 2-3' (61-91cm) below the surface. Coliform bacteria levels must be checked at least weekly, and must not exceed 1,000 MPN (most probable number) per 100ml of water (AWR, 2005). A coliform bacteria count over 1,000 MPN is an indicator of potentially harmful conditions. If there is a high reading, conditions must be corrected immediately by changing the water, reducing the number of animals having access to the pool, chlorinating the pool water, or lowering water levels and physically cleaning the pool (AWR, 2005).

Ozone can be utilized for disinfection of polar bear water sources. When ozone is used, institutions should develop specific water filtration and disinfection protocols. The following information on the use of ozone has been adapted from approaches used at Sea World (see www.zoolex.org). Ozone disinfection can be achieved by using a 10% by-pass flow supplied by a 40g ozonator through dry air (2mg/l) that is mixed with filtered water in a vortex mixing chamber with a contact time of two minutes. The oxidation reduction potential (ORP) taken from the mixing chamber can be used to measure and monitor the automation of the ozonator, along with oxidation-reduction probes in the return to pool line. In all cases, a back-up oxidization treatment system should be available (e.g., 1.0mg/l sodium hypochlorite), and should become operative if the ozonator experiences any mechanical difficulties.

A pH of 7.5-8.2 and salinity 15-36 parts per thousand are recommended for marine mammals that require salinized water for their good health. However, the USDA Marine Mammal Standards and the Manitoba Standards (PBPA, 2002) do not currently require salt water for polar bear exhibits. Filtration of water flow must keep the quality of water within the standards specified (AWR, 2005). Placement of enrichment substrates should be a reasonable distance from major water sources so as not to interfere with pool filtration. The following publications from the USDA provide more information on pool sterilization and water quality for marine mammals: "Marine Mammal Water Quality – Technical Bulletin No. 1868" (Coakley & Crawford, 1998) and "Sterilization of Marine Mammal Pools" (Spotte, 1991: www.aphis.usda.gov/ac/mmsterile.pdf).

Polar bears should generally be exhibited in outdoor exhibits where the frequency of air changes is not applicable; however, air change standards for indoor exhibits should meet or exceed federal standards for air changes in dog/cat/primate indoor facilities that require ventilation systems to "to minimize odors, drafts, ammonia levels, and moisture condensation" (AWR, 2005).

1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by polar bears in the care of AZA-accredited zoos and aquariums. Research into the sensitivity of polar bears to sounds and vibration is currently underway (see Chapter 9, section 9.1), and there are no specific results available at this time to formulate management recommendations. In general, polar bears appear adaptable to auditory stimuli within their environments, and can acclimate to new noises and vibrations that are slowly introduced and associated with positive stimuli. However, new sounds and/or sources of vibrations (e.g., generators, water filters, construction noise, concerts, etc.), and activities that may create chronic or acute auditory stressors, should be eliminated or minimized during sensitive animal management periods (e.g., animal introductions, denning, cub rearing, the arrival of animals in quarantine, and when animals are sick).

Results from formal and informal research into the responses of polar bears to sounds and vibrations within zoo and aquarium environments, the welfare issues that may result from this exposure, and methods of minimizing the effect of these stimuli, should be reported to the AZA Bear TAG and Polar Bear SSP Program. The AZA Bear TAG and Polar Bear SSP Program supports research that advances the development of management recommendations and exhibit designs to best meet the needs of these polar bears in AZA-accredited zoos and aquariums.

Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

> **AZA Accreditation Standard**
>
> **(1.5.2)** Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

Careful consideration should be given to habitat design so that all areas meet the physical, social, behavioral, and psychological needs of the polar bears. Polar bears should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs (AZA Accreditation Standard 1.5.2). With the aid of innovative exhibit designs, different feeding strategies, appropriate use of environmental enrichment (see Chapter 8, section 8.2), and the development of a cooperative husbandry training program, polar bears can be housed in a dynamic and stimulating environment that maximizes their welfare. All exhibits should contain structural features such as resting platforms, water features, and nesting sites, and must do so to comply with the Polar Bear Protection Act (PBPA, 2002). Habitats that include features such as foraging pits and underwater boulders have been associated with a decrease in stereotypic behavior (Bucciarelli & Cronin, cited in: IPBHC, 2004).

Habitat design and species-appropriate behaviors: To promote species-appropriate behaviors, the landscape should be naturalistic (e.g., planted with grass, bushes, and trees for shade) and functional, including as key elements: a pool, foliage, habitat furniture (e.g., boulders, trees, logs, etc.), open/panoramic views, and substrate pits with various materials. The substrate should be "soft" rather than hard (e.g., gunnite, concrete) (Ames, 2000). An important component of the habitat design (including both exhibit and non-exhibit areas) is the ability to make changes in the terrain, vary elevations, and to modify physically (with crane and truck access) the habitat on a periodic basis (e.g., changes to trees, rocks, browse and substrate). Elevated areas (plateaus) within the exhibit, which provide an overview of the exhibit and the locations of the conspecifics, are an important element of habitat designs (Stephan, 2006). Climbing structures and platforms can be used to provide polar bears with accessible vantage points that enable them to observe distant vistas beyond their habitat, and this can serve to increase the sensory complexity of the habitat itself. Elevated resting areas such as boulders will also be well utilized by the animals. Any elevated areas provided should to be designed so that animals of all ages (including cubs) can negotiate them safely without injury.

The AZA Bear TAG recommends that polar bears should not be limited to the exhibit area during the day or the off-exhibit area at night and have the ability to choose between these areas at all times, unless housed inside at night, or when maintenance of the exhibit is performed (PBPA, 2002). Twenty-four hour access to exhibit and off-exhibit areas has been associated with a decrease of stereotypic behaviors in both male and female polar bears (Ross, 2006; T. Mengel, personal communication). It has also been found that polar bears with unlimited access to off-exhibit areas did not spend significantly more time out of public view (Ross, 2006).

In situ populations of polar bears live in an extremely dynamic marine habitat that is affected by wind, currents, and temperature, and has many sea-ice features that influence prey distribution and are continuously changing (Smith & Stirling, 1978; Smith, 1980; Stirling & Lunn, 1997; Mauritzen, et al. 2001). Sea-ice dynamics create unpredictable variability in the distribution of resource patches (i.e., patches of higher and lower seal/prey density) that the bears have to reach using their behavioral and physical adaptations (Mauritzen, et al. 2001). The *ex-situ* habitat should stimulate all of the bears' senses (visual, olfactory, tactile, gustatory, and auditory), but provide appropriate space and complexity (e.g., visual barriers) so that the bears have control within their environment to avoid over-stimulation (e.g., areas of reduced as well as enhanced sensory experiences may be desirable).

Bears benefit from a large habitat areas that allow expression of their natural behavioral repertoire and the maintenance of individual distances between conspecifics. Important polar bear behaviors include swimming, resting, walking, running, climbing, hunting, foraging, and social interactions (avoidance behavior is also a social interaction). Polar bear habitats should provide comfort and encourage stimulating activities to invoke species-specific behaviors. Providing a wide variety of enrichment objects gives polar bears choice and control in their environment (Ames, 2000). Enrichment items provided to the bears should be placed on a variable schedule to maintain interest and all

enrichment items should be approved by managers and veterinarians before use. See Chapter 8, section 8.2 for more information on environmental enrichment.

Polar bears are strong mammals with claws adapted to climbing trees, navigating on difficult terrain, and digging. Their ability and motivation to climb and to claw open trees should be carefully considered when designing habitats (Renner & Kelly, 2006). Habitat designs and sizes that allow for variation in "furniture" layout are recommended, even though most furniture for polar bears is large and not easily repositioned. Moveable items such as large rocks, logs, and branches should be placed in the exhibit and rearranged daily or weekly to facilitate climbing and exploratory behaviors and prevent stereotypic behaviors (PBPA, 2002).

Polar Bears create nests both during the day and/or night in their natural habitat. The Manitoba Polar Bear Protection Act regulations state that exhibit areas must include an area of ground at least 1350ft^2 (125m^2) that is covered by "soil, straw, woodchips or another suitably soft substrate" (PBPA, 2002). Appropriate nesting materials include hay, straw, wood wool, mulch, and bark chips. Where possible, multiple soft substrate areas should be available in exhibits with multiple animals. Females nearing parturition should be provided with one or more dens filled with appropriate bedding material, such as clean hay or straw. It is important that this material is clean and low in dust and all browse and substrates need veterinary and curatorial approval before being used (see Chapter 7, sections 7.3 and 7.4 for additional information on pregnancy and birthing facilities). Informal observations have shown that polar bears seek out soft or smooth surfaces and avoid, hard, irregular, or rough surfaces (Ames, 2000; D. Moore, personal communication, 2005) and habitats should be designed to minimize the amount of hard or rough surfaces available to them, allowing them the option to move away from hard surfaces (e.g., concrete) if they choose to do so.

In the wild, polar bears use their large front paws to haul seals out of the water at breathing holes, or to smash through ice and snow into seal lairs. Bears also stalk basking seals on land-fast ice. Providing enrichment opportunities that facilitate behaviors that are functionally similar to these hunting behaviors is important for polar bears Appropriate enrichment used on exhibit and in the off-exhibit den areas can promote many of the polar bears' natural behaviors such as manipulation, foraging, exploring, digging, tearing, scratching, pouncing, hunting, swimming, and playing. Care should be used in selecting items that may damage glass in exhibits that have above- or underwater viewing windows. See Chapter 8, section 8.2 for additional information on enrichment.

Polar bears are mostly solitary animals in the wild (see Chapter 4, section 4.1 for additional information), but have also been observed congregating in groups to feed upon a large food resource like a whale, or when waiting for ice to form so that they can enter the bay in Churchill. Observations of wild polar bears gathering during the summer on Wrangel island, when they are more "gregarious" than during any other time, demonstrate that communicative signals, perceivable by humans, occur when the distance between bears is 49.2' (15m) or less, although many react at a greater distances by moving away from others (avoidance behavior) and looking for another location, without any obvious signal to human observers (L. Kolter, personal communication, 2006). Historically, *ex situ* populations of polar bears have been managed in varying sex ratio group sizes. When caring for multiple animals, the habitat should be large enough to provide each polar bear with an area that is blocked from view on at least one side from other parts of the exhibit (Renner & Kelly, 2006). Exhibits should be viewable by the public for no more than 180°, so that animals can avoid each other and the public if they so choose (PBPA 2002) and trees or snags in the exhibit can help provide these opportunities.

Polar bears have very sensitive olfactory and auditory senses. Males actively locate females in estrus in the wild by their scent (Lentfer, 1982), and polar bears are able to detect seal breathing holes up to half a mile away, even when covered by layers of ice and snow 3' (91cm) or more thick (Stirling, 1998). Care should be taken to monitor the effects that visual, auditory, and olfactory stimuli have on the bears in *ex situ* habitats.

AZA Accreditation Standard

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being; and exhibit enclosures must include provisions for the behavioral enrichment of the animals.

Habitat Size and Complexity: The same careful consideration regarding exhibit size and complexity and its relationship to the polar bear's overall well-being must be given to the design and size all habitats, including those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3).

Polar bears in the wild are nomadic animals that cover large

landmasses. Although in some parts of their range polar bears cover relatively large areas while on solid ground, their mobility on land is dwarfed by their movements while on the sea ice, their preferred habitat. The bears' normal gait in the wild is a slow, lumbering walk of about 3 miles per hour. Bears can gallop for short distances, and immature bears can run as far as a mile. *Ex situ* habitats should be designed to provide walking and running opportunities and should maximize the variability that the animals encounter in their surroundings through daily enrichment opportunities that promote species-appropriate behaviors (for additional information see Chapter 8, section 8.2). The Manitoba Standards state that 1-2 bears must be given access to 5400ft^2 (500m^2) of dry land, with an additional 1650ft^2 (150m^2) of land for each additional polar bear (PBPA, 2002). The AZA Bear TAG recommends that these criteria be implemented in AZA zoos and aquariums. Habitats with complex pathways and designs can help reduce stereotypic behaviors (Clubb & Mason, 2003).

Polar bears are excellent swimmers, using their large front paws as powerful oars and their rear paws as rudders, they can remain submerged for over a minute. The USDA Animal Welfare Act's Animal Welfare Regulations (AWR, 2005) mandate that polar bear pools be a minimum of 5' (1.5m) deep, and have a surface area of at least 96ft^2 (9m^2). The Polar Bear Protection Act (PBPA, 2002) requires a pool with area of 760ft^2 (70m^2), and with a deep end that is 9' (3m) or more deep be incorporated within the polar bear habitat. The AZA Bear TAG recommends that accredited institutions meet or exceed these requirements and that the pools be irregularly shaped, containing both deep and shallow areas, as polar bears often utilize shallow areas to wade and play. It is not known if specific pool designs or shapes are more effective in preventing water-based stereotypic behaviors, but pools containing cool saltwater (55-70°F/12.7-21°C) with live fish, smooth walls and ledges, an island, polar themed floats, moving logs/trees, waterfalls or streams, changing currents, and a wave machine, are suggested. If floating objects are provided in the pool, care must be taken to ensure that they do not damage the pool structure. It is also important to have freshwater (pond, stream, pool and/or drinking trough/s) available for the bears in addition to the pool.

Off-exhibit areas: The ability to separate and shift individual animals is critical in any *ex situ* habitat design. Polar bear behavior can change seasonally and with the age of individuals, and they may need to be separated for prolonged periods of time. Off-exhibit areas should provide similar behavioral opportunities for the animals as the primary exhibit. As identified by the Polar Bear Protection Act (PBPA, 2002), an off-exhibit area for an institution housing two bears must be at least 807ft^2 (75m^2), with an additional 269ft^2 (25m^2) for each additional bear within the habitat. Regardless of the number of individuals living in this area, each bear should have its own area for sleeping or temporary holding and all areas should have shift facilities to permit safe cleaning, habitat maintenance or repair, or other separations. The Polar Bear Protection Act (PBPA, 2002) mandates that temporary holding areas for polar bears must be at least 13' x 9.8' x 8.2' (4m x 3m x 2.5m). The AZA Bear TAG recommends that that accredited institutions meet or exceed these requirements even if it needs to be accomplished by providing access to multiple holding areas.

Cubbing den: Although polar bears of both sexes and all ages may occupy temporary dens or shelters during periods of cold or stormy weather in the wild, only pregnant females remain in dens throughout the winter. In zoo and aquarium environments, the cubbing den should be in a quiet area away from the exhibit. The female should be given access to it routinely prior to separation in order to develop familiarity with the area. At one facility, giving the female polar bear choices of dens, and letting her choose her normal routine, has increased the success of mother-rearing cubs (D. Weinhardt, personal communication). This set-up allows the female to move the cubs if she wants to. The Manitoba Polar Bear Protection Act regulations state that maternity dens for pregnant polar bears (or polar bears with cubs under four months old) must be at least 8.2' x 8.2' x 8.2' (2.5m x 2.5m x 2.5m) (PBPA, 2002). AZA-accredited institutions often have a smaller maternity den with access to a larger shift area adjacent to it. If possible, males should not have access to the cubbing den prior to the denning season. The scent of the male may discourage its use, or cause additional stress to the female.

Habitat cleaning: Dirt and grass substrates in outdoor habitats should be spot-cleaned daily. Hard surface areas, both inside and out, should be cleaned daily and disinfected with detergent and disinfectant on a regular basis to prevent accumulation of organic material and pathogenic organisms. All washable surfaces, logs, enrichment objects (such as Boomer Balls®), and food containers should also be cleaned as needed. Substrates that cannot be washed need to be cleaned or replaced to maintain a

healthy environment (AWR, 2005). Polar bears should be shifted from the exhibit when chlorine or other chemicals are used to disinfect/clean the exhibit or pool, and any time personnel are in the habitat. Veterinarians at each institution should develop their own cleaning protocols using safe, effective disinfectants and detergents.

2.2 Safety and Containment

Primary Containment: Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). Polar bear habitat design must be considered carefully to ensure that all areas are secure, and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms, and exhibit barrier dimensions and construction. Buildings, exhibits, and grounds must be structurally sound and maintained in good repair, protecting the animals and keepers from injury (AZA 2009).

AZA Accreditation Standard

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

As large, powerful carnivores, polar bears pose a serious potential risk to other animals and humans within zoos and aquariums. Polar bears have been seen to jump 6' (1.8m) horizontally and 4' (1.2m) vertically (S. Amstrup, personal communication; D. Moore, personal observation), and habitat containment must take into account their strength, persistence, and agility. The AZA Bear TAG and Polar Bear SSP Program recommend that dry moats or exterior walls be no less than 16' (4.9 m) deep or high. The Polar Bear Protection Act (PBPA, 2002) states that barrier walls and dry moats must be 5 m high/deep, and glass windows, which allow public viewing, must be 2" (5cm) thick. If glass partitions are used, they should be positioned where the bears can avoid being viewed by the public if they so desire (PBPA, 2002). The effect of enrichment objects on viewing windows, including above/underwater pool viewing windows, should be considered before they are designed and used.

Habitat areas can employ a combination of glass, gunnite, solid masonry products, heavy mesh (4-6 gauge), or bars for barriers, the last requiring adequate space to protect staff and public from being scratched or bitten by animals reaching through the barriers (20'/6m between animals and the public is mandated by the Polar Bear Protection Act (PBPA, 2002). Zoos and aquariums with outdoor exhibit areas using wire fence perimeters should consider the nature of the soil. Polar bears are capable of digging, and chain link fencing that makes contact with a natural substrate should be buried to a depth of 36" (91cm) along the perimeter in order to prevent digging or bending of the fencing at the bottom. Buried fencing materials should be of a type that will not disintegrate over time. Fencing on hard surfaces with horizontally supported fencing or metal panels is adequate without burial.

Electric fences have been used in the wild to deter polar bears (Wooldridge, 1983), and similar approaches can be used in zoos and aquariums from a containment perspective. A 'hot cable' attached to a concrete footing can be installed at adult bear chest height to prevent polar bears from trying to manipulate fences and one institution successfully uses an electric fence box of 8000 volts strength. Animal access to the exhibit should be by remotely operated shift doors (manual, electric, or hydraulic), preferably sliding or guillotine styled doors. All materials used in the construction of polar bears exhibits and holding areas should be non-toxic, non-abrasive, and easy to clean (PBPA, 2002).

When incorporating containment into the design of habitats, it is recommended that polar bears be allowed to see beyond the bounds of their containment. While high walls are necessary to keep polar bears from escaping, exhibit designs (e.g., bear pits) where the animals are unable to see people or other animals that they can detect by scent or sound should be avoided. There should be elevated areas in the habitat so that the high walls do not result in a pit-like effect. Habitats should also be designed to allow bears with 24/7 access to outdoor areas, and containment considerations should take into account human and animal safety if this continuous access is feasible (e.g., alarmed hot-wire cables; video monitoring, etc.). Safety protocols associated with 24-hour access should be carefully developed to accompany specific containment provisions.

Secondary Containment: Secure secondary containment of animal areas that are directly connected to keeper access areas should be used. All gates securing the bears from public and keeper areas should have redundant security devices (e.g., second lock, security pin). Visual access to all parts of the exhibit and all shift doors should be available to prevent injury. Mirrors can be used to provide visual access to blind corners. All entry points to secured areas of polar bear habitat areas should be appropriately designed to prevent animal escapes or unauthorized entry by any persons. Utilizing at least two separate

sets of high strength, bear-containment doors is beneficial, and additional video surveillance of all polar bears dens and keeper service corridors should be considered. See Chapter 8, section 8.3 for additional information on safety protocols to ensure the safety of animal care staff working with polar bears.

The Polar Bear Protection Act (PBPA, 2002) requires that the public should be kept at least 20' (6m) away (vertically or horizontally) from the polar bears through the use of barrier walls, dry moats, or other safe and appropriate means (AZA Accreditation Standard 11.3.6), except where viewing is provided through a 2" (5cm) thick window (PBPA, 2002). Further space may be needed between polar bear maternal nesting dens and the public or other bears depending upon the personalities of the moms.

AZA Accreditation Standard

(11.3.6) Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

Safety: AZA-accredited institutions which care for polar bears must have appropriate procedures in place to prevent animal escapes and visitor/staff injuries, as well as to prevent attacks and injuries by these animals.

Emergency protocols: All polar bear emergency safety procedures must be clearly written, provided to appropriate staff and volunteers, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.3). Staff training for emergencies must be undertaken and records of such training maintained.

Personnel authorized to utilize firearms for emergency containment of polar bears should have professional training and regular practice. Stored firearms must be in a locked cabinet that will impede unauthorized entry and located in a secure area that is accessible only to authorized personnel trained in their use (AZA Accreditation Standard 11.6.3).

Security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, security personnel may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2). See Chapter 8, section 8.4 for more information on staff training.

AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.4), and must ensure that written protocols define how and when local police or other emergency agencies are contacted and specify response times to emergencies (AZA Accreditation Standard 11.2.5).

Polar bears are dangerous animals and each institution should develop their own safety protocols applicable to their facility design, staffing responsibilities, and area operating procedures. These protocols should specifically address animal containment monitoring when bears are provided with 24/7 access to outdoor areas (e.g., the need for trained animal care staff to be present at all times during any 24-hour period, and after-hour response protocols for gun teams, etc.), but such protocols should be in place whether the animals have 24-hour access to the exhibit or not. For facilities that use hot wire as part of their containment system, back-up emergency generators should be considered. Safety protocols should address animal escapes as well as natural disasters relevant to the location of the zoo or aquarium. Protocols should address moving animals at any time of the year, if needed, and include crate and transportation availability, as well as an agreement with other zoos and aquariums in the local/extended area in regards to housing displaced bears on a temporary basis, if necessary.

AZA Accreditation Standard

(11.2.3) All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

AZA Accreditation Standard

(11.6.3) Stored firearms must be in a locked cabinet of sufficient construction and design to impede unauthorized entry, and located in a secure area and accessible only to authorized personnel trained in their use.

AZA Accreditation Standard

(11.6.2) Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e., shooting teams).

AZA Accreditation Standard

(11.2.4) The institution must have a communication system that can be quickly accessed in case of an emergency.

AZA Accreditation Standard

(11.2.5) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

The USDA AWA requires a written emergency plan in the event of a natural disaster for all marine mammals, including polar bears (AWR, 2005). All emergency protocols should address the role that veterinary teams play in animal immobilization, as well as the role of the gun team plays in an escape. Inclusion of local law enforcement personal in the development of these safety/emergency protocols is recommended, and notification of emergency agencies of existing protocols will also be beneficial.

Safety protocols: Polar Bear attack emergency response procedures must be defined and personnel must be trained for these protocols. Drills should be conducted at least once annually to ensure that the institution's staff know their duties and responsibilities, and know how to handle polar bear attack emergencies properly when they occur. All drills need to be recorded and evaluated to ensure that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained, and improvements in the procedures duly noted whenever they are identified. If a polar bear attack occurs, and injuries result from the incident, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident and should be sent to the AZA Bear TAG, Polar Bear SSP, and Conservation Department (AZA Accreditation Standard 11.5.3).

AZA Accreditation Standard

(11.5.3) Institutions maintaining potentially dangerous animals (sharks, whales, tigers, bears, etc.) must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

The strength, speed, and carnivorous nature of polar bears make them dangerous animals to work with. The AZA Bear TAG and Polar Bear SSP Program recommend that all institutions include polar bears as one of the key species in any animal attack emergency drills, and that appropriate training be provided to animal caretakers involved in any aspect of polar bear management and care. Given the wide range of institutional staff and facility set-ups, no specific emergency response recommendations can be provided to individual zoos and aquariums. Some institutions do not have a veterinarian on-site at all time, others do not have gun teams made up of zoo staff, but rely on armed personnel from the local police force in case of specific animal emergencies. It is recommended that all relevant staff members at institutions housing polar bears be involved in the process of developing safety procedures, staff training protocols, effective documentation procedures, and documentation templates, which make the most sense for the individual institution and its staff, equipment, and local conditions.

Chapter 3. Transport

3.1 Preparations

> **AZA Accreditation Standard**
>
> **(1.5.11)** Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to.

Polar bear transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). Safe polar bear transport requires the use of appropriate conveyance and equipment that is in good working order. The equipment must provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the polar bear(s). An adequate number of appropriately trained personnel who are equipped and prepared to handle contingencies and/or emergencies that may occur in the course of transport should be included.

Polar bear transport is regulated by the USDA Animal Welfare Act Regulations (AWR, 2005) sections 3.112-3.118, and requires appropriate ESA (1973) permits. It is essential that these regulations be reviewed prior to planning any polar bear shipment. Ideally, polar bears should be "crate trained" before relocation. This involves the gradual acclimation of the animal to the transport container over a period of time using positive reinforcement (see Chapter 8, section 8.1 for additional information on animal training). The use of medications to calm bears prior to crating or transport should be determined by veterinarians at the shipping and receiving institutions, and be based on the current behavioral and health status of the animals to be shipped. Animals should be awake prior to the commencement of the transport if any form of chemical calming or immobilization agent is used for crating.

Pre-Transport Testing: Prior to the transport of polar bears, the shipping institution should provide the following medical information to the receiving institution to ensure that the health needs of the animals are accommodated during and after shipping:

Current within last 12 months	Current within last 14 days
- Physical exam - Complete blood count (CBC) - Serum chemistry panel - Documentation of immunization if required by receiving institution - Rectal culture negative for intestinal pathogens	- Weight - Fecal floatation/direct negative for parasites - Rectal cultures

Salmonella positive cultures should be evaluated given the raw meat diet that bears are provided. Pre-treatment of sub-clinical pathogenic forms, or veterinary treatment during transport, could prevent shedding or serious infection caused by the transport. If there is a history established of negative rectal cultures from physical exams, and the collection of polar bears has been closed, then requiring the negative rectal culture within the last year versus within 14 days of transport may be sufficient.

Ideally, all of the veterinary procedures listed above should be completed within 14 days of transport to provide baseline information and decrease the odds of transport of an ill animal that could lead to health complications. Complete medical records should be sent to the receiving institution no later than 14 days prior to the actual transport date so that medical issues can be reviewed and husbandry/diet issues addressed. The AWA also requires that copies of all medical records accompany the animal on any transport (AWR, 2005).

Transport Container: For shipment purposes, all transport crates should meet both IATA (International Air Transport Association) guidelines (see Appendix D) and USDA regulations (AWR, 2005). Crates for polar bears should be heavy, durable containers made of hardwood, metal, aluminum, welded mesh, and/or iron bars. The crate must provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the animal(s) (IATA, 2007). The following crate parameters are required for polar bears (IATA 2007):

Frame: The frame must be made from solid wood or metal bolted or screwed together, and must include a spacer bar 1" (2.5cm) deep along the side for air circulation. Because of the size and strength of a polar bear, the frame must have additional metal reinforcing braces.

Doors: Sliding or guillotine exit doors must be provided; the front door must be made of steel welded mesh, or strong iron bars placed in such a way that the animal cannot extend its legs between them. Both doors must be fastened with screws or bolts to prevent accidental opening.

Interior and exterior: The inside of the container must be completely lined with sheet iron or other hard metal sheeting, with ventilation openings punched through to the exterior. The front of the container must also be provided with a light sliding wooden shutter either with 4" (10.2cm) ventilation openings, or be slated with 2.75" (7cm) spaces between the slats over the upper two thirds of the shutter, in order to reduce the disturbance to the animal and to protect handlers. Spacer bars or handles must be 1" (2.5cm) deep and formed from the framework of the container. The design of the crate and ventilation openings should include an access area for use by a pole syringe.

Ventilation: Ventilation openings must be placed at heights that will provide ventilation at all levels, including when the animal is lying down. Exterior mesh ventilation openings, with a minimum diameter of 1" (2.5cm), must be open on all sides, entry door, and roof. USDA regulations require 20% of the total crate surface area to be ventilated (AWR, 2005).

Size: The height of the container must allow the animal to stand on all fours with its head extended; the length of the container must permit the animal to lie in the prone position. Polar bears should be able to turn around, although there must be at least 4" (10.2cm) clearance around the animal when standing in a normal position.

Equipment and Supplies: Safe transport requires the assignment of an adequate number of appropriately trained personnel (by institution or contractor) who are equipped and prepared to handle contingencies and/or emergencies that may occur in the course of transport. The greatest threat to polar bears during transport is probably heat stress. Not only does the ambient temperature need to be cool, but the crates should be large enough to help for easy body heat dissipation. Planning and coordination for animal transport requires appropriate equipment (e.g., flashlight; means for communicating with shipping and receiving institution; food and water as deemed necessary by veterinarians at shipping institution; appropriate medical supplies; etc.), good communication among all parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. The AZA Bear TAG and Polar Bear SSP Program have no specific recommendations for equipment and supplies necessary for polar bear transport, above and beyond those needed for the transport of any species, or those addressed in section 3.2 below. Institutions considering shipping polar bears should contact the AZA Bear TAG and Polar Bear SSP Program with their specific questions.

3.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. At no time should animals or people be subjected to unnecessary risk or danger. Increasingly, specialized truck or van transportation is often the only means of transfer for large, dangerous animals such as polar bears. During the transport of polar bears, the following transport protocols should be considered:

Food and water: Food intake should be reduced 2-3 days prior to transport to decrease fecal contamination of the crate. Any reduction in food should be approved by veterinarians, curators, and the nutritionist (as appropriate), and will be dependent on the length of time in transit. A light feeding may be given prior to shipment if approved by a veterinarian. Polar bears do not normally require feeding during transport, but dry food can be offered. Watering during transport should be done as needed, but water must be offered daily (AWR 2005). Water containers must be positioned at the front of the crate and fixed off the floor to prevent soiling (AWR, 2005). Safe outside access to the water containers must be available, so that additional water can be provided to the bear during transport. Ice cubes can be used to provide water to the bears, and may also act as a secondary means of cooling the animal.

Bedding and substrate: Bedding such as straw may be included in the container for comfort and absorption of excreta, but care should be taken if international shipments are involved to ensure that plant material is acceptable to receiving countries. See IATA regulations (Appendix D) for additional information (IATA, 2007). The floor of the transport crate should either be constructed in a narrow slatted form over a liquid proof tray, in such a manner that all feces fall onto the tray, or it should be leak-proof and covered by sufficient absorbent material to prevent any excreta from escaping.

Temperature: Ambient temperatures around the transport crate should be between 25-70°F (3.9-21.1°C) for shipping polar bears by air or ground. Temperatures must not exceed 75°F (23.9°C) (AWR, 2005). There should be sufficient means to cool polar bears being transported in warmer weather (e.g., ice, air-conditioned vehicles). The AWA (section 3.112-AWR, 2005) requires that animals transported outside the specified temperature range must be accompanied by a certificate of acclimation, signed by the attending veterinarian, which states the animal is acclimatized to the specific temperature range under which it will be transported (AWR, 2005).

Environmental stressors: Polar bears should be kept in darkened containers during transport to avoid aversive stimuli from their surroundings. Crate doors should be secure to prevent rattling. Some polar bears can become aggressive in response to stressors from outside noises and activity. When transported via air, animals should be placed in temperature controlled quiet rooms at the airport, if available. During transport, containers should be located away from people, loud equipment, and other sources of potential stress (e.g., barking dogs).

Animal management during transportation: Polar bears should be shipped individually due to their size and carnivorous nature. Polar bear transports should not last longer than three days. Polar bears must not be released from their transport containers under any circumstances during the shipping process. USDA AWA regulations mandate that any transportation of two hours or longer requires a transport plan approved by the attending veterinarian (AWR, 2005), which should address the need for the presence of a veterinarian during the transport if necessary. If the attending veterinarian does not accompany the animal, a qualified staff member is required to accompany the bear, and communication must be maintained with the veterinarian at all times (AWR, 2005). Animal caretakers involved in the transport of polar bears do not require any specific training beyond that involved in the daily management of polar bears at their institutions. However, they should be fully aware of the transport plans, and have contact details for the receiving institution, transport companies, and staff at zoos and aquariums along the transport route, in case any emergencies occur.

Emergency scenarios: If transport crates are appropriately designed and constructed, emergency scenarios, should they occur, will likely involve transport delays and/or polar bear health issues (e.g., bears overheating). There is little that can be done to address transport delays for air travel, but the shipping institution should have contacts at zoos and aquariums at layover locations in case any assistance is needed, and travel plans should be communicated to these institutions in advance. For ground transportation, there is the potential for mechanical failure of the vehicles during transportation, and the possibility of the bears overheating if this occurs. If bears are shipped via ground transportation, contact should be made with other zoos and aquariums along travel route in case local knowledge and information is needed in regards to alternative transport options, the availability of ice to cool the bears (if needed), and possible veterinary assistance if required.

Release at receiving institution: It is important that the crate be securely anchored before releasing the bear into the holding or quarantine area of the receiving institution. Release protocols should be well defined and clear to all animal care staff prior to its occurrence.

Chapter 4. Social Environment

4.1 Group Structure and Size

In the wild, the main polar bear social unit consists of females with her cubs (Renner & Kelly, 2006), otherwise polar bears are generally solitary (Nowak, 1999). As the breeding season approaches, adult male and female pairs may be seen together. In areas where bears are ashore during the summer, groups of adult males can be observed in close proximity, and individuals can even been seen engaging in social play (Renner & Kelly, 2006). In zoos and aquariums, careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of individual animals, and facilitate the expression of species-appropriate behaviors (AZA Accreditation Standard S1.5.2). For exhibit and breeding purposes, the simplest grouping for polar bears is one male and one female. Depending on the space available in the exhibit and holding areas, larger groupings of bears (e.g., trios of one male and two females) may be kept. Groups of females can also be maintained, but such groups are best established if the bears are siblings, young (between 2-3 years), or reared together. Shepherdson et al. (2005) found that the individual bears in multi-female groups showed decreased stereotypic pacing. Groups of multiple males can also be maintained, at least while the animals are young or subadults, and if no females are present. Associations of this type should not be expected to last, however. It is important to remember that stable social groups may become incompatible seasonally or over time, and the number of holding facilities and the design of exhibits should address any changes in indoor and outdoor housing needs (see Chapter 2, section 2.1 for additional information).

Single-sex groups: Compatible male polar bears may be maintained together for years as long as they are not exposed to females in adjoining areas. Castrated males have been kept together and with females. As with all animals, the temperament of the individual bears should be taken into account when determining appropriate social group sizes and structures.

Separation of mothers and offspring: In the wild, the family group breaks up when the cubs are about two and a half years old (Stirling, 2002). In AZA-accredited zoos and aquariums, young polar bears should stay with their mothers for a minimum of one year. If the cub is not to be sent to another institution, it can remain with its mother for longer periods. In the wild, mothers drive off the cubs or abandon them suddenly. Although gradual separation may seem desirable in zoos and aquariums, some polar bears exhibit increased anxiety if this is attempted, and an abrupt separation of polar bear cubs and mothers may be best.

Group size: Polar bears typically do well alone or in the types of groups described above, given appropriate amounts of enrichment and space. Individual bear temperaments play a big role in this. Young bears do enjoy interacting with other bears. Shepherdson et al. (2005) have shown that males exhibit decreased levels of stereotypic behavior with increased numbers of females present, although additional research would still be beneficial to identified ideal group sizes. Regardless of the number of individuals living in the habitat, each bear should have its own den/holding area in case separating the bears is necessary (for additional information on off-exhibit and holding areas, see Chapter 2, section 2.1).

Polar bears are capable of actively managing social distance and minimizing aggressive interactions (Renner & Kelly, 2006) as long as the size and complexity of the habitat is sufficient. Polar bear exhibit designs should include topographical complexity and multiple pathways throughout the habitat to facilitate natural social avoidance behavior. Proper habitat design and appropriate behavioral management of the social environment can make substantial contributions to enhancing the welfare of polar bears in zoos and aquariums (Renner & Kelly, 2006).

4.2 Influence of Others and Conspecifics

Polar bears can generally be housed near other species of carnivores. Although during maternity and denning, care should be taken to keep the female isolated from male polar bears and other carnivore species. Isolation of females with cubs from males always occurs in the wild, as there is a risk of males predating upon the cubs (Amstrup, 2003). If other species are typically housed in the building with polar bears, no new individuals or species should be added during the denning period. Pregnant females

should be housed so that no other bears have direct access to any part of the habitat. Care should be taken to avoid disturbances/stimuli during maternity denning such as unfamiliar people, facility repairs, or any other non-routine activities. Indicators that a female may be responding to stressors in the environment include behaviors such as pacing, head swaying, aggression towards keepers, and abandonment or cannibalism of the cubs.

Adult males may have a negative effect on immature males housed in adjacent habitat areas, though the young males should eventually acclimatize to the presence of the mature males. Adult males housed next to reproductively active females may orient towards the females' areas, and may demonstrate more stereotypic behaviors during breeding season.

Due to their aggressive nature, polar bears should not be housed with other species in mixed-species habitats. Animals cared for by AZA-accredited institutions are often found residing with other animals of their species but may also be found residing with conspecifics.

4.3 Introductions and Reintroductions

Managing polar bears, especially reproductively active animals, within AZA-accredited zoos and aquariums is a dynamic process. Animals born in facilities or moved between and within institutions require introductions and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for the animals and caretakers involved.

Introductions: Based on the potential for serious or fatal injuries to the bears, all introductions should be well planned, not rushed, and intensely monitored. Polar bears have the ability to kill each other with little or no warning, as evidenced by interactions between polar bears in the wild. It is easier to introduce bears when they are subadults. More care needs to be taken when introducing adult bears or young adult females to adult bears. Management challenges in zoos and aquariums usually center on individual animal incompatibility. The personality of the individual bears and their previous experiences with conspecifics can influence the speed and ultimate success of the introduction. Basic steps for introducing polar bears should focus on the following considerations:

1. Staff working with polar bears should establish a familiar routine when a new bear comes into a facility. Before introductions are started, the caretakers and new bears should become familiar with each other through normal husbandry and management procedures and routines.
2. Sufficient time should be allowed for each new animal to adjust to its new surroundings before beginning the introduction process. This period can take a month or more depending upon the individuals involved. Bears should shift between habitat areas without hesitation, eat regularly, and respond to its trainers before starting introductions. All bears should be familiarized with all exhibit and holding areas before introductions to new animals are attempted.
3. Only two bears should be introduced at any one time.
4. Animals should be kept in adjacent areas for introductions. The bears should have olfactory and visual access to each other without the possibility of one bear being able to injure the other. Bears should not be able to get paws or other body parts through barriers or access portals during the early stages of the introduction. Staff members do not need to be in the immediate area for the entire time during this stage of the introduction, but should be there to observe initial interactions, even from afar. Positive behavioral signs at this stage include chuffing and bouncing on front legs. Negative signs include roaring, growling, and biting at the barrier. Different individuals may exhibit their own signs of stress. If any negative signs are seen, the visual introduction should be ended and the bears should be allowed more time to acclimate before re-attempting this stage of introduction (e.g., olfactory introductions only). If the female is in estrus, as demonstrated by her presenting her hindquarters to the male at the door and urinating in the area of the male, the bears can be put in the same space. Breeding bears are usually not aggressive, but this can vary based on the temperament of the individuals. Diligence in observation of all introductions is critical.
5. When the pair appear to be at ease at the visual access point, as demonstrated by lying side-by-side, nose-to-nose, or by one animal presenting itself in a vulnerable position while the other animal reacts non-aggressively, they are ready for a partial introduction, allowing bears to get a paw or part of their muzzle through the access point if the facility design allows.

6. If the partial introduction goes well, the full access introduction (without barriers) between the bears can be attempted. All parts of the habitat should be clearly visible to both animals and ample escape routes should be available for both so that neither can be cornered by the other. Full access should only be provided when staff members are present to separate the animals if necessary. Fighting polar bears can sometimes be separated with water, CO_2 fire extinguishers, or any object that makes a loud noise and this introduction should be done in areas where the animals can be separated if something goes awry. If possible, areas in the exhibit that are out of reach of water cannons dart guns, or other tools to break off negative encounters, should be excluded from introduction area.
7. When the physical introduction (without barriers) between the bears is attempted, the number of people present should be limited, and disturbance in the area should be kept to a minimum. If the bears are disturbed by the presence of staff, a remote video set up may be used to monitor the introduction, although staff should be nearby to respond to any emergencies.
8. The full access introduction should take place in a resource-rich environment. During both off-exhibit and subsequent on-exhibit introductions, the area should be over-stocked with enrichment, especially food items. It is critical that enough enrichment/food is offered so that there is no competition for the items, while at the same time providing both bears the opportunity to engage in safe activities in addition to interacting with each other.

Reintroductions: Care must also be taken when reintroducing pairs that have been separated for prolonged periods of time. Usually, reintroductions of bears that are familiar with each other take less time than new introductions. A short visual introduction will show if the animals are ready to be reintroduced based on the affiliative or aggressive behaviors shown by the bears to each other.

Chapter 5. Nutrition

5.1 Nutritional Requirements

> **AZA Accreditation Standard**
>
> **(2.6.2)** A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

A formal nutrition program is recommended to meet the behavioral and nutritional needs of polar bears. Diets should be developed using the recommendations of nutritionists, the AZA Nutrition Scientific Advisory Group's (SAG) guidelines (www.nagonline.net/feeding_guidelines.htm), veterinarians as well as the AZA Bear TAG and Polar Bear SSP. Diet formulation should address the polar bear's nutritional needs, feeding ecology, as well as individual and natural histories, to ensure that species-specific feeding patterns and behaviors are stimulated (AZA Accreditation Standard 2.6.2).

Polar bears are the most carnivorous of the Ursidae family, and prey primarily on ringed seals in the wild (Stirling & Archibald, 1977; Best, 1985; Derocher, et al. 2000). Other seals, whales, walrus, reindeer, sea birds, carrion, and vegetation may be consumed as well (Derocher et al., 2000; Derocher, et. al, 2002; Knudson, 1978; Russell, 1975; Smith and Sjare, 1990). Research about the nutritional needs of polar bears is limited and the formulation of dietary recommendations is based on the known diets consumed by healthy bears in AZA-accredited zoos and aquariums as well as those sucessfully used with related wild and domestic animals including domestic cats and dogs (NRC, 2006; AAFCO, 2004).

Cats are obligate carnivores since there are nutrients they need to obtain from their diet as their body's can't produce them. Dogs are not obligate carnivores as they have the ability to snyhesize these nutrients thus they can survive on a more varied diet. Bears range in their feeding types. At this point data do not exist for polar bears indicating they are obligate carnivore or strictly omnivore. Polar bears in the wild are primarily carnivorous, but will occasionally consume plant matter (Russell 1975; Knudson 1978). Polar bears in zoos and aquariums also will readily consume plant matter. Consequently, a range of nutrient levels encompassing both feeding strategies (carnivorous and omnivorous) is appropriate for the formulation of polar bear diets in zoos and aquariums. The table below (Table 3) provides the cat and dog nutrient profile minimums for all stages compared to suggested dietary recommendations for polar bears on a dry matter basis.

Table 3: Cat and dog nutrient profile minimums for all stages compared to suggested dietary recommendations for polar bears on a dry matter basis[a]

Nutrient	Unit	Minimum nutrient profile **bold = required for repro/growth**		Minimum dietary recommendations [b]
		Cat	Dog	Polar Bear
Protein	%	26.0 **(30.0)**	18.0 **(22.0)**	25.0
Fat, min	%	9.0	5.0 **(8.0)**	5.0
Fat, max	%	---	8.0	20.0
Lysine	%	0.83 **(1.2)**	0.63 **(0.77)**	1.0
Methionine + Cystine	%	1.1	0.43 **(0.53)**	1.0
Methionine	%	0.62	---	0.55
Taurine	%	0.1	---	0.1
Linoleic Acid	%	0.5	1.0	1.0
Arachidonic	%	0.02	---	0.02
Vitamin A min	IU/g	5.0	5.0	5.0
Vitamin A max	IU/g	333[a]	50[a]	---
Vitamin D_3	IU/g	0.5	0.5	1.8
Vitamin E	IU/kg	30	50	100
Vitamin K	mg/kg	0.1	---	---
Thiamin	mg/kg	5.0	1.0	5.0
Riboflavin	mg/kg	4.0	2.2	4.0
Niacin	mg/kg	60.0	11.4	40.0
Pyridoxine	mg/kg	4.0	1.0	4.0
Folacin	mg/kg	0.8	0.18	0.5
Biotin	mg/kg	0.07	---	0.07
Vitamin B_{12}	mg/kg	0.02	0.022	0.02
Pantothenic acid	mg/kg	5.0	10.0	5.0
Choline	mg/kg	2400	1200	1200
Calcium	%	0.6 **(1.0)**	0.6 **(1.0)**	0.6
Phosphorus	%	0.5 **(0.8)**	0.5 **(0.8)**	0.5
Magnesium	%	0.04 **(0.08)**	0.04	0.04
Potassium	%	0.6	0.6	0.6
Sodium	%	0.2	0.06 **(0.3)**	0.2
Iron	mg/kg	80	80	80
Zinc	mg/kg	75	120	100
Copper	mg/kg	5.0 **(15.0)**	7.3	10
Manganese	mg/kg	7.5	5.0	7.5
Iodine	mg/kg	0.35	1.5	1.5
Selenium	mg/kg	0.1	0.11	0.1

[a] Association of American Feed Company Officials (AAFCO) 2004 and National Research Council Nutrient Requirements of cats and dogs (NRC), 2006

[b] Values should be adequate for growing cubs; The nutrient were developed by the polar bear nutrition working group.

The stomach of the Ursidae is simple, a cecum is absent, and there is no obvious external differentiation between the small and large intestine (Stephens and Hume, 1995). Similar to other carnivore species, polar bears efficiently digest protein and fat (Best, 1985). Their simple digestive tract is well suited for their carnivorous diet. Many polar bears in the wild predominantly consume the blubber of seals, or the whole seal if it is small (Stirling & Archibald, 1977; Derocher et al., 2000). The use of fat to meet energy needs conserves body protein catabolism and its resulting urea formation/urine output. Best (1985) estimated the metabolizable energy requirement for free-ranging polar bears to be 140-182kcal/kg$^{0.75}$, and reported that bears in zoo and aquarium conditions consumed 110kcal ME/kg$^{0.75}$ (on a DE basis, 115kcals DE/kg$^{0.75}$).

Vitamin Supplementation: The very high serum levels of fat-soluble vitamins in wild polar bears have led many scientists to hypothesize that diets in zoos and aquariums should be heavily supplemented with vitamins A, D, and E, however, no consistent health changes have been observed with these supplements. While serum levels for all of these vitamins are of interest and need to be monitored, excess supplementation should be discouraged until convincing evidence shows that these levels are indeed necessary, and not simply part of a homeostatic mechanism for dealing with high dietary intake.

Vitamin A: There is speculation that lower levels of vitamin A in the livers of polar bears in zoos and aquariums could be a factor in mortality, low reproductive rates, and coat problems. Therefore, many institutions have supplemented polar bear diets with vitamin A. Higashi & Senoo (2003) researched the hepatic cells of polar bears and determined that hepatic stellate cells have the capacity for storage of vitamin A. They can store 80% of the total vitamin A in the whole body as retinyl esters in lipid droplets in the cytoplasm, and play pivotal roles in regulation of vitamin A homeostasis. This suggests that polar bears have the capacity to store large amounts of vitamin A (Leighton et al., 1988; Higashi & Senoo, 2003). Like cats, it is apparent that polar bears have a high tolerance for vitamin A, but there are no data to support a high vitamin A requirement. Dietary levels of 8.91-15.65 IU/g dry matter basis have been fed for years with no apparent deficiencies; therefore, a dietary minimum vitamin A content of 5 IU/g dry matter in the diet is recommended.

Vitamin E and thiamin: Due to the presence of fish in many polar bear diets, some institutions supplement polar bear diets with thiamin and vitamin E. This perceived need to supplement is based on the knowledge that thiamin and vitamin E are broken down in fish that has been stored frozen (Geraci, 1978). However, supplementation of thiamin and vitamin E is based on diets that contain greater than 30% fish. If the diet contains less than 30% fish then other non-fish food items may be providing the needed nutrients. All diets should be carefully analyzed to determine if additional supplementation of vitamin E and thiamin are necessary. However, a safe approach would be always to supplement the fish portion of the diet (30mg thiamin and 100 IU vitamin E per kg fish offered), regardless of the inclusion rate of fish. This would ensure a balanced diet even if/when the proportion of fish in the diet fluctuates.

Vitamin D and calcium: Due to a small number of reported bone fractures in polar bears housed in zoos and aquariums, there is speculation that there is a need for vitamin D and calcium supplementation. However, the data presented are on a small percentage of bears and do not appear to give any indication of compromised bone density (Lintzenich et al., 2006). Providing supplementation in excess of suggested guidelines (Table 3) is not warranted for any life stage, including pregnant or nursing females.

Factors Affecting Nutritional Needs: Structural growth of female polar bears is completed by five years of age, but body mass in adults fluctuates depending on season and reproductive status (Atkinson & Ramsey, 1995). Polar bears in the wild are unusual among large mammals for their ability to tolerate extreme body weight fluctuations between periods of hyperphagia (gorging) and those of relative food deprivation. In the wild, periods of hyperphagia may occur in spring and summer, or in autumn depending on geographic area, and periods of negative foraging may occur in late winter/early spring, or late summer, depending upon the geographic area (S. Amstrup, personal communication, 2006). In zoos and aquariums, polar bears typically eat less in the spring and summer months and more in the fall and winter months, and institutions should adjust diets as needed (Lintzenich et al., 2006). Seasonal weight targets may be desirable, based on the body size of individual bears, and on the information on seasonal hyperphagia.

In the wild, the meat and the skin or the whole seal carcass (rather than blubber alone) is more often consumed by pregnant females, females with cubs, and sub-adults. During these life stages, protein requirements are increased, and more extensive carcass consumption may be the method for meeting these increased protein needs (Atkinson & Ramsey, 1995; Atkinson et al., 1996). With the exception of the cubbing period when the female's appetite decreases, and the lactation period when caloric requirements increase, reproductive status generally has little influence on dietary preferences. The motivation of male bears to eat may be reduced during the breeding season.

Additional Information: Complete nutritional information on polar bear diets, and on the handling, processing, storing, and presentation of these diets can be found in the Polar Bears International Nutrition guidelines (Lintzenich et al., 2006). This resource provides information that can be used as the foundation of an effective nutrition program specific to polar bears, but the precise nature of any nutrition program will need to be tailored to the staff and facilities available at each zoo and aquarium. Extracts from the Lintzenich et al. (2006) document are presented in this manual, and the complete document can be accessed from the Polar Bears International website:
www.polarbearsinternational.org/rsrc/pbnutritionguidelines

5.2 Diets

The formulation, preparation, and delivery of all polar bear diets must be of a quality and quantity suitable to meet the animals' psychological and behavioral needs (AZA Accreditation Standard 2.6.3). Food should be purchased from reliable, sustainable, and well-managed sources, and nutritional analyses of the food should be regularly tested and recorded.

AZA Accreditation Standard

(2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

A balanced diet developed for polar bears in zoos and aquariums could include a combination of nutritionally complete items (dry, raw, and/or gel), saltwater fish, bones, whole prey, produce, and food presented in enrichment devices. When fed in combination, these foods should result in nutrient levels that meet the minimum dietary recommendations (see section 5.1). In a captive study spanning institutions and seasons from 1996 to 2001 on a dry matter basis, males (average body mass 432 kg) consumed 0.5-0.9% of body mass and females (average body mass 227 kg) consumed 0.8-1.1% body mass. There may be seasonal fluctuation in food intake due to changes in the bears' activity levels. For all food items offered, especially raw meat and fish products, careful consideration should be given to temperature and environmental conditions with regard to spoilage and bacterial overgrowth that may cause illness (see Appendix F).

Food Category Suggestions: Table 4 provides suggested proportions of various food categories for polar bear diets that would meet the nutritional needs of the polar bears (see Chapter 5, section 5.1 for more information) throughout the year (Lintzenich et, al, 2006). Food quantities and subsequently caloric energy offered should be regulated based on weight trends, visual assessment of body condition and weight behavior. A study at the San Diego Zoo indicated dramatic seasonal weight changes in this species can be modulated through active management of the diet. For more information on modulating calories offered to promote appropriate body condition across seasons see data provided in Lintzenich et al. 2006.

Table 4: Food categories and suggested ranges with flexibility for seasonal changes (adapted from Lintzenich, et al. 2006)

Ingredients	As fed % of the diet[1] Maintenance/Growth/Lactation	
	Minimum	Maximum
Dry Nutritionally Complete Food (see Appendix G)	5	50
Raw Meat Mix Nutritionally Complete (see Appendix G)	30	75
Marine Products – saltwater fish	15	30
Produce	0	10
Meat from Shank Bone[2]	5	7
Whole Prey[3]	0	2.5
Misc.[4]	0	3

[1] Diets outside these ranges could be fed if nutrient content of ingredients when consumed as offered meet target nutrient ranges.
[2] Meat from a shank bone is 50% of the total bone weight (i.e., if a bones weighs 454g then 227g is meat).
[3] Whole prey is large rats or rabbit.
[4] Miscellaneous may include items for behavioral enrichment (BE).

Sample diets: Examples of polar bear diets provided by the Brookfield Zoo and the San Diego Zoo from 2006 are provided in Table 5 to illustrate the proportion of food categories offered as part of an overall balanced diet.

Table 5: Food categories and quantities of sample diet as fed (adapted from Lintzenich et al. 2006)

Ingredient	Brookfield Zoo, %	San Diego Zoo, %
Nutritionally complete dry diet	18.1	14.8
Nutritionally complete raw diet	26.8	36.2
Nutritionally complete gel diet	-	6.9
Saltwater Fish	23.6	15
Meat from Shank Bone	3.8	2.8
Whole Prey	-	8.0
Produce	27.7	16.3
Total	100	100

Table 6 provides nutritional analyses of these diets and compares them to the minimum dietary recommendations for polar bears.

Table 6 Nutrient analysis of sample diets on a dry matter basis (adapted from Lintzenich et al. 2006)

Nutrient	Unit	Levels on a Dry Matter Basis		
		Minimum Dietary Recommendations Polar Bear[a]	Brookfield Zoo diet[b]	San Diego Zoo diet[b]
Protein	%	25	35.3	43.8
Fat	%	5-20	14.0	16.9
Taurine	%	0.1	0.1	-
Linoleic acid	%	1	1.28	1.16
Vitamin A	IU/g	5	8.91	15.65
Vitamin D_3	IU/g	1.8	2.18	2.12
Vitamin E	IU/kg	100	165	289.4
Thiamin	mg/kg	5	5.33	10.1
Riboflavin	mg/kg	4	5.57	11.1
Niacin	mg/kg	40	52.45	53
Pyridoxine	mg/kg	4	5.23	5.4
Folacin	mg/kg	0.5	0.79	1.2
Biotin	mg/kg	0.07	0.07	--
Vitamin B_{12}	mg/kg	0.02	0.02	--
Pantothenic acid	mg/kg	5	4.11	23
Choline	mg/kg	1200	1149	1920
Calcium	%	0.6	2.03	1.43
Phosphorus	%	0.5	1.44	1.24
Magnesium	%	0.04	0.1	0.108
Potassium	%	0.6	1.16	0.899
Sodium	%	0.2	0.62	0.432
Iron	mg/kg	80	136	199.8
Zinc	mg/kg	97	119.2	111.1
Copper	mg/kg	10	13.3	25.5
Manganese	mg/kg	7.5	11.56	38.0
Iodine	mg/kg	1.5	--	2.55
Selenium	mg/kg	0.1	0.15	0.39

[a] Suggested minimum polar values complied by the polar bear nutrition working group.
[b] Nutrient levels of successful zoo diets are those consumed by animals in good body condition with successful reproduction.

Feeding schedule: In zoos and aquariums, polar bears are traditionally fed 1-2 times daily, often in the early morning and later afternoon to facilitate shifting or other management needs, but the specific feeding schedule is up to the discretion of the facility. It is strongly recommended that a regular feeding schedule for polar bears be supplemented by irregularly timed feeding opportunities, in novel locations within the exhibits, utilizing foods that are not normally provided (PBPA, 2002), in order to meet the behavioral needs of the bears. Some facilities have found that scatter feeding or feeding smaller amounts more often decreases stereotypic behavior. Many facilities feed the morning diet as an enrichment "scatter feed" throughout the public exhibit. The caloric content of significant amounts of

enrichment foods, skins, etc., should be factored into the overall diet, as polar bears can develop weight problems if overfed (Lintzenich, et al. 2006).

Food variability and presentation: A study examining food consumption habits by island and mainland polar bears in the wild near Manitoba, Canada, found five primary food items consumed by the bears: birds, mammals, marine algae, grasses, and berries (Russell, 1975). Variation of *ex situ* offerings of food type, presentation styles, distribution locations, and provision timing could be considered when planning polar bear diet regimes. Offering a variety of food items, including high- and low-fat fishes, helps to ensure a complementary nutrient profile of the diet. Geraci (1978) emphasized the need to feed more than one food type in order to help ensure a balanced diet in marine mammals. This same concept could be applied to polar bears. Uncertainties in the future availability of fish stocks, and seasonal variation in the availability of certain fish, are issues that must be considered. It is possible for an animal to become imprinted on a specific food item, and if that item becomes unobtainable, it may be very difficult to coax the animal to eat a new species/item.

Carnivore-style feeding containers (flip dishes, feeding tubes) are appropriate for polar bears when food is not hidden or placed within the habitat. Polar bears can be separated into individual habitat areas for feeding in order to prevent competition as well as to allow accurate measurement of food consumption. Multiple enrichment feedings may be added to the habitat, usually without risk of competition. In general, the manner of presentation of the prescribed diet should be varied for behavioral enrichment purposes (e.g., scattered, chopped, whole, frozen in blocks, presented in feeder balls or barrels, training sessions). *In situ* polar bears with cubs can spend 35-50% of their activity budget hunting (Stirling, 1998). In order to provide opportunities to exhibit species-appropriate behaviors, or otherwise enable animals to work for food, a number of enrichment foods and items these foods can be incorporated into/onto can be added to outdoor or indoor habitat areas. It is recommended that polar bears be offered edible items on an ongoing but random schedule in order to combat stereotypic behaviors and avoid habituation to a routine schedule. Supplemental enrichment foods (e.g., raisins, peanut butter, honey, etc.) should not exceed 3% by weight of the total diet offered (Lintzenich, et al. 2006) to ensure a balanced diet and should go through an institutional approval processes, including review by nutritionists and veterinarians. All new diet items should be monitored closely when first provided to the bears. The following items may be considered suitable enrichment foods or objects the food can be incorporated with for polar bears. This is by no means a complete list, and many other options and ideas can be used and should be considered (see also Chapter 8, section 8.2 for more information on enrichment).

- Whole chickens
- Fish
- Soft substrate pit (may become a defecation site)
- Telephone book
- Bird feathers
- Ice blocks containing food
- Logs/stumps
- Branches/wood chips from primate or small mammal exhibits
- Rope pulls
- Pine cones
- Browse
- Peanut butter, jams & jellies, honey
- Hard-boiled eggs
- Straw/hay from ungulate exhibits
- Christmas trees
- Corn stalks
- Knuckle bones
- Gelatin made with blood, Jell-O
- Skins, feet, heads from pigs, deer, domestic stock
- Boomer ball
- Cardboard box
- PVC tubes (smaller than head size)
- Raccoon, deer or elk urine - commercially purchased
- Snow
- Melons, gourds, pumpkins
- Spices & herbs: Russian sage, mint, cumin, nutmeg, catnip, cloves, basil, oregano, rosemary, rose hips/petals, allspice, cinnamon

The food type, presentation, and order of offering may have implications for dental health in polar bears and each factor should be carefully considered to promote the removal of organic buildup that can contribute to dental health issues. The AZA Bear TAG recommends that food items that are soft, or that could become soft, should be fed first and items such as bones, fish, or those with hair/skin should be offered last to help to remove soft and sticky foods from the teeth. The suggested feeding order for polar bears is 1) ground meat product or slab meat, 2) dry diet, 3) fish and vegetables and, 4) bones and chew items (hide, carcass) such as biscuits which should be fed dry and attempts should be made to prevent the bears from wetting them. Bears may need to be offered fresh and pliable bones, rawhides, ox tails, and hides more than once a week if additional tooth-cleansing assistance is needed. Synthetic hard

bones, ice blocks, and hard frozen food items may contribute to tooth damage, and their use should be monitored.

Carcass feeding: Whole carcasses contribute to the overall diet of bears in the wild, and may be especially important to sub-adults and orphaned cubs (Stirling, 1974). *Ex situ* supplementation of whole carcasses can promote a wide range of feeding and foraging behaviors, however, no official standards of care describe procedures for the provisioning of animal carcasses to polar bears. The AZA Nutrition SAG recognizes the feeding of animal carcasses as a practice desired by some AZA institutions to stimulate activity and normal feeding behaviors. The AZA Nutrition SAG cautions institutions that choose to carcass-feed about numerous hazards (pathogenic and parasitic) that exist for collection carnivores (e.g., Harrison, et al. 2006). Precautions are necessary to ensure the carcass is wholesome and all institutions responsible for feeding *ex situ* populations of carnivores should be aware of and follow USDA policy # 25 (USDA, 1998). Although this policy was written specifically for large felids, the AZA Nutrition SAG recommends it be applied to polar bears and that caution be employed to ensure wholesome feeding practices including the acquisition of fresh carcasses with appropriate handling to ensure rapid cool down and minimal bacterial contamination. According to the AZA Nutrition SAG's statement on carcass feeding, if the carcass is not that of a neonate collected at birth, the removal of head, hide, and internal organs is recommended. The authors of this chapter would consider the removal of hide and/or feeding of hides may not be an issue in polar bears. Finally, and most importantly, unless the carcass is that of a neonate collected at birth and fed fresh or is from a USDA inspected facility, the institution must freeze the carcasses solid and properly defrost it prior to offering to an animal to minimize potential parasite exposure. The AZA Nutrition SAG only condones carcass feeding as part of a feeding program that ensures the diet of the animal is nutritionally balanced and wholesome and these institutions acquire the carcasses from USDA inspected facilities. For issues surrounding the practice of feeding whole fish to polar bears (including the use of live fish) see Appendix F. The feeding of road kill should be done only under very close veterinary consultation or supervision.

AZA Accreditation Standard

(2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

Food Selection, Storing, Handling, and Processing: Food preparation must be performed in accordance with all relevant federal, state, or local regulations (AZA Accreditation Standard 2.6.1). Meat and seafood processed on site must be processed following all USDA standards and the appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for the taxa or species specified. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines. For a complete description of the proper handling and processing of meat and fish products see Crissey (1998) and Crissey, et al. (2001a) and meat processed on site must be follow all USDA standards. Storage and handling of food enrichment items should follow the same standards as those for other diet ingredients. The inspection of fish fed to polar bears is extremely important to ensure they are of the highest quality. While no single test can determine fish quality (Lintzenich, et al. 2006), Table 7 (adapted from Lintzenich, et al. 2006) provides factors that should be carefully evaluated (Oftedal & Boness, 1983; Stoskopf, 1986; Frazier & Westhoff, 1988). Similar criteria can also be used when assessing other types of meat provided to bears (see Lintzenich, et al. 2006).

Table 7: Criteria used to assess the suitability of raw fish fed to polar bears (adapted from Lintzenich et al. 2006)

Factor	Acceptable	Inferior	Unacceptable
General appearance	Shine or luster to skin; no breaks in skin, bloating or protrusion of viscera; no dehydration	Some loss of sheen	Luster gone, lumpy
Eyes	Translucent, full; may be slightly sunken	Dull or cloudy, slightly sunken	Dull, sunken; cornea opaque(white); red-bordered eyes
Gills	Bright red to pink; moist	Pink to slight brownish	Grayish-yellow and covered with mucus
Odor	Fresh odor	Mild sour or "fishy" odor	Medium to strong odor, fatty fish may smell rancid

Factor	Acceptable	Inferior	Unacceptable
Feel	Firm and elastic; meat does not stay indented when touched	Moderately soft, slight indentation left when touched	Soft, spongy and flabby; exudes juice and easily indented when handled; may break open or skin may split when handled
Vent	Normal in shape and color	Slight protrusion	Noticeable discoloration
Lateral line	Normal, no discoloration	Pinkish tinge	Red to dark red

Browse: *In situ* polar bears have been observed ingesting vegetation (Russell, 1975; Knudson, 1978). The use of browse for enrichment purposes is common with polar bears (willow is particularly successful but other species will also be effective) who will manipulate and ingest parts of some browse species provided to them. Zoos and aquariums should have a process in place to evaluate which species of browse are selected and how they are evaluated for safety. The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual within each institution (AZA Accreditation Standard 2.6.4).

AZA Accreditation Standard

(2.6.4) The institution should assign at least one person to oversee appropriate browse material for the collection.

The program should identify if the plants have been treated with any chemicals, pesticides, or herbicides, or grown near any point sources of pollution, and should be screened for, but not limited to, known toxicities to comparable species such as dogs, cats, and humans (see Burrows & Tyrl, 2001) and the potential to cause obstruction of the gastrointestinal tract. Plant materials growing in and around animal habitats should also be evaluated to ensure they are non-toxic as there is a potential for animals to ingest parts of these plants (e.g., leaves, stems, bark, seeds, fruits, etc.).

There is currently no formalized list of approved, safe, or unsafe plant species that are specific to polar bears. The AZA Nutrition SAG and the Association of Zoological Horticulture may be able to provide additional recommendations for safe plant species. Institutions that experience negative consequences from providing a certain browse species to their bears should inform the AZA Bear TAG and Polar Bear SSP Program of the incident so that this information can be widely disseminated.

5.3 Nutritional Evaluations

It is recommended that all zoos and aquariums with polar bears develop diets that are sufficient to meet their nutritional needs in terms of amount, quality, consistency, and include food type enrichment to address some of their behavioral needs. Institutions should contact commercial laboratories to analyze their food ingredients, or physiological samples.

Body condition scoring: Table 8 provides the standard body scoring method used for polar bears by field biologists (provided by Polar Bear Specialist Group; S. Amstrup), that has been validated by continuing field research (Stirling, et al. 2008).

Table 8. Standard body scoring method used for polar bears.

1	Pelvis and scapulae protruding, ribs easily palpated. A deep hollow will be noted between the pelvis and last rib showing virtually no fat.
2	Pelvis easily palpated, ribs also felt on palpation, but with some muscle covering them. The hollow between the pelvis & last rib obvious, but softer.
3	Body is fully fleshed out. Obvious fat is present over pelvis and shoulders, ribs less obvious. The hollow between the pelvis and last rib absent.
4	Bear has a rounded or blocky appearance, very well fleshed over all bony areas, obvious fat over rump and shoulders.
5	Legs appear too short for the body, rolls of fat on neck and lower shoulders.

Body condition score '3' is the preferred condition for bears in zoos and aquariums. It is appropriate for females to put on additional weight prior to denning-up if they are expecting cubs. Farley and Robbins (1994) have estimated appropriate 'Bioelectrical Impedance Analysis' measurements for polar bear body fat and Hilderbrand, et al. (1998) have described the methodology for using this approach.

Nutrient Serum Values: Tables 9 and 10 provide information about serum concentrations of nutrients and vitamins in polar bears. 25(OH)D is the most valid measure for assessing vitamin D stores because it reflects vitamin D intake and photobiogenesis over several weeks to months. $1,25(OH)_2D$ is more reflective of immediate ingestion or exposure and not stores. Retinol has been used as criteria of vitamin A status. However, serum levels of vitamin A tend to be homostatically controlled at a level that is largely independent of total body reserves (Crissey et al, 2001b). Alpha-tocopherol is the most abundant tocopherol in animal tissues. There is a high correlation among plasma, dietary intake and liver levels of α-tocopherol. However, there are major differences among species in normal circulating α-tocopherol levels, and different animals of the same species tend to exhibit individually characteristic plasma α-tocopherol concentrations (Shrestha, et al, 1998). Thus values of low sample size may not be reflective of vitamin E status (Lintzenich, et al. 2006).

Table 9: Serum concentrations of vitamin D metabolites and vitamins A and E (adapted from Lintzenich, et al. 2006)

	Zoo[1]		Zoo[2]		Free-ranging[2]		Zoo[3]	
Nutrients	n	Value ±SD	n	Value ±SD	n	Value ±SD	n	Value ±SD
25(OH)D, ng/ml	5	64 ±11	36	139 ±86	56	144 ±54	-	nd
1,25(OH)2D, pg/ml	5	18 ±4.2	-	nd	-	nd	-	nd
Retinol, µg/dl	4	25 ±1.8	-	nd	-	nd	1	67
Retinyl palmitate, µg/dl	4	4.9 ±1.3	-	nd	-	nd	-	Trace
Retinyl stearate, µg/dl	4	2.9 ±0.8	-	nd	-	nd	-	Trace
α-tocopherol, µg/dl	4	3362 ±193	32	800±800	56	2101 ±600	1	1459
γ-tocopherol, µg/dl	4	4 0±5.8	-	nd	-	nd	-	nd

nd = no data
1 Crissey et al. 2001b
2 Kenny et al. 1998
3 Schweigert 1990

Table 10: Serum concentrations of total cholesterol, triacylglyceride, HDL cholesterol, and LDL cholesterol (adapted from Lintzenich et al. 2006)

	Crissey et al. 2004		Brannon 1985[1]		Schweigert et al. 1990	
Nutrients	n	Value ±SD	n	Value ±SD	n	Value ±SD
Total cholesterol, mmol/L	6	8.9±0.76	29-35	5.2±0.24	1	5.7
Triacylglyceride, mmol/L	6	2.91±0.48	29-35	2.21±0.14	1	2.94
HDL cholesterol, mmol/L	6	5.8±0.37	-	nd	-	nd
LDL cholesterol, mmol/L	5	6.8±1.49	-	nd	-	nd

nd = no data
[1] data for grizzly bears

The AZA Bear TAG nutrition advisors are currently in the process of collecting blood samples from polar bears in zoos and aquariums to determine more specifically normal vitamin and mineral levels for this species. Results of this research will be shared in future versions of this manual.

Evaluating Patterns in Weight Fluctuations: Most *in situ* polar bears, including those in the high arctic and polar basin, prey on seals year-round (Derocher, et al. 2002; Amstrup, 2003) although food consumption varies depending on season and location. In locations where ice recedes and bears are restricted to land for up to 6 months, seasonal adaptations may include fasting or very limited food intake (Knudsen, 1978). The ability of polar bears to endure prolonged fasting depends on the accumulation or replenishment of fat and lean body mass during the active phase of the year (Atkinson & Ramsay, 1995; Atkinson, et al. 1996).

Dramatic seasonal weight changes demonstrated in polar bears in zoos and aquariums can be modulated through active management of the diet. Examples of weight changes across the year can be found in data from four polar bears housed in southern California (Lintzenich, et al. 2006). The goal of all balanced diets throughout the seasons is good physical and psychological health and condition. Each institution should assess seasonal diet changes based on the body condition and appetite of their bears. General feeding patterns in wild bears are largely irrelevant to the zoo and aquarium situation, and so feeding in zoos and aquariums should be regulated by the health and condition of each individual. Lintzenich, et al. (2006) provide a tool which is available from the Nutrition Advisors of the AZA Bear TAG to assess stool quality/condition in polar bears that can be used as part of a more comprehensive health assessment of the bears in relation to their diet.

Chapter 6. Veterinary Care

6.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices in zoos and aquariums. A full-time staff veterinarian is recommended for every institution, and especially those housing polar bears. In cases where this is not practical, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the whole animal collection and to respond to any animal emergencies (AZA Accreditation Standard 2.1.1). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be detected and responded to in a timely manner (AZA Accreditation Standard 2.1.2). All AZA-accredited institutions should adopt the guidelines for veterinary medical programs developed by the American Association of Zoo Veterinarians (AAZV) www.aazv.org/associations/6442files/zoo_aquarium_vet_med_guidelines.pdf

AZA Accreditation Standard

(2.1.1) A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

AZA Accreditation Standard

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animal collection 24 hours a day, 7 days a week.

Helpful veterinary resources about polar bears include the CRC Handbook of Marine Mammal Medicine (Dierauf and Gulland, 2001), Zoo and Wild Animal Medicine (Ramsay, 2003) and the Polar Bear International website (www.polarbearsinternational.org) which contains general polar bear information, natural history, Polar Bear Nutrition Guidelines, as well as field and research information.

USDA regulations require that a visual exam of polar bears be conducted at least every 6 months (AWR, 2005), however it is strongly recommended that the veterinary staff meet with the polar bear keepers and conduct visual health inspections on a bi-monthly basis to assess:

- Appetite, activity, behavior, social, husbandry and medical status.
- Diet/caloric intake and trends in appetite.
- Current weight and trends in weight.
- Body, coat, skin, and foot condition (See Body Condition Score Sheet in Appendix B)
- Respiration rate and quality.
- Stool quality and the presence or absence of parasites
- Presence of lesions.
- Gait quality.
- Enrichment schedule, device safety, and interaction records.

Veterinary drugs and medications: Protocols for the use and security of drugs used for veterinary purposes must be formally written and available to polar bear care staff (AZA Accreditation Standard 2.2.1). Procedures should include, but are not limited to: a list of persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure. The AZA Bear TAG and Polar Bear SSP Program recommend that veterinarians at each institution be involved in the formulation of their own institutional protocols for the storage and use of drugs that could be used in the care and management of polar bears. Given the wide variation in the staff, medication, and equipment available to veterinarians at different institutions, no specific polar bear medication recommendations can be made.

AZA Accreditation Standard

(2.2.1) Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes and appropriate security of the drugs must be provided.

Animal recordkeeping: Animal recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available to animal care staff. A designated staff member should be responsible at each institution for maintaining an animal recordkeeping system, and for conveying relevant laws and regulations to the animal care staff with regards to polar bears (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and documented on a daily basis (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal

records must be retained in a fireproof container within the institution (AZA Accreditation Standard 1.4.5), as well as be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4).

AZA Accreditation Standard

(1.4.6) A staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all animal care staff members apprised of relevant laws and regulations regarding the institution's animal collection.

AZA Accreditation Standard

(1.4.7) Animal records must be kept current and data must be logged daily.

AZA Accreditation Standard

(1.4.5) At least one set of the institution's historical animal records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

AZA Accreditation Standard

(1.4.4) Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

All pertinent health information for polar bears should be recorded as per institutional protocols in ARKS and MedARKS. When the new Zoological Information Management System (ZIMS) becomes widely available, it is recommended that institutions make full use of this resource. ZIMS provides the opportunity to record key animal behavior information along with health records, including data collected on the onset or elimination of stereotypic behavior and responses to enrichment initiatives, conspecifics, or heterospecifics. The AZA Bear TAG and Polar Bear SSP Program can be contacted for more information on current research being undertaken on polar bears for which institutional records may be valuable (see also Chapter 9 section 9.1for additional information on current polar bear research).

As required by the USDA Animal Welfare Act an Animal Welfare Regulations (AWR, 2005), records must be kept of water quality assessments for all marine mammals. Regulations state:

> "*Water samples shall be taken and tested at least weekly for coliform count and at least daily for pH and any chemical additives (e.g., chlorine and copper) that are added to the water to maintain water quality standards. Facilities using natural seawater shall be exempt from pH and chemical testing unless chemicals are added to maintain water quality. However, they are required to test for coliforms. Records must be kept documenting the time when all such samples were taken and the results of the sampling. Records of all such test results shall be maintained by management for a 1-year period and must be made available for inspection purposes on request*" (AWR, 2005).

Meyerson (2007) lists federal permit and recordkeeping requirements for polar bears based on the Convention on International Trade in Endangered Species (CITES) and the Marine Mammal Protection Act (MMPA, 2007) regulations. Since polar bears are now listed under the Endangered Species Act (ESA, 1973), additional permits and recordkeeping requirements are needed for the care, management, transport, acquisition, and disposition of these animals. Specific regulations for polar bears as part of the Endangered Species Act (ESA 1973) are currently under discussion, and will be added to this manual once finalized.

Veterinary contacts and training: The current AZA Bear TAG Veterinary Advisors are Dr. Holly Reed (Point Defiance Aquarium) and Dr. Mike Briggs (African Predator Conservation Research Organization). As part of its commitment to provide up-to-date information to animal caretakers, the AZA Bear TAG and Polar Bear SSP Program work with the AZA and outside organizations such as Polar Bears International (www.polarbearsinternational.org) to provide periodic workshops for zoo and aquarium staff. These workshops provide information on husbandry, nutrition, veterinary care, enrichment, animal training, and research. For more information, contact the AZA Polar Bear SSP Program.

6.2 Identification Methods

AZA Accreditation standard

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

Ensuring that each polar bear can be reliably identified, with corresponding ID numbers in the medical records so that health data can be recorded for the animal throughout its life, increases the ability to provide appropriate care for individual animals more effectively (AZA Accreditation Standard 1.4.3). Polar bears should be identifiable as individuals both by visual appearance and behavior, and through the use of identification microchip transponders or other techniques such as lip tattoos (e.g., PBPA,

2002). All animal care staff should be able to use the visual appearance of the animals to be able to comment on the health and behavior of the animal on a day-to-day basis (e.g., activity, feeding behavior, injuries and other health concerns, etc.). The use of transponder microchips placed intramuscularly between the scapula ensures that animals can be tracked among different zoos and aquariums, and any possible confusion due to changing staff within an institution can be clarified. Transponders can be placed in polar bear cubs during their first round of vaccinations (see section 6.4).

Acquisitions and Dispositions: AZA member institutions must inventory their polar beat population at least annually, and document all polar bear acquisitions and dispositions (AZA Accreditation Standard 1.4.1). Transaction forms can help to document that potential recipients or providers of polar bears are adhering to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy (see Appendix B), and all relevant AZA policies, procedures, and guidelines. In addition, transaction forms must guarantee compliance with the applicable laws and regulations of local, state, federal, and international authorities, including the Manitoba Standards as identified in the Polar Bear Protection Act (PBPA, 2002). All AZA-accredited institutions must abide by the AZA Acquisition and Disposition policy (Appendix C), and the long-term welfare of animals should be considered in all acquisition and disposition decisions. All polar bears owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2).

AZA Accreditation Standard

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions in the animal collection.

AZA Accreditation Standard

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

Additional regulations may be put in place regarding movements of polar bears among zoos and aquariums, now that they are listed under the Endangered Species Act (ESA, 1973), and the movement of bears between institutions or from the wild must abide by all relevant federal requirements. The United States Fish and Wildlife Services (USFWS) must provide permits to transport any polar bears; USFWS will also contact the AZA Polar Bear SSP Program prior to approving any permit application, and will consult with the AZA Polar Bear SSP Program Master Plan to determine if it is a planned move.

6.3 Transfer Examination and Diagnostic Testing Recommendations

The transfer of animals between AZA-accredited institutions or certified related facilities due to SSP or PMP Program recommendations occurs often as part of as concerted effort to preserve these species. These transfers should be done as altruistically as possible and the costs associated with specific examination and diagnostic testing for determining the health of these animals should be considered.

Preshipment exams should be conducted before transport to assure the animal is well to travel, inform the receiving institution of the animal's health status, and determine any preshipment or during transit treatments. Prior to the exams, the veterinarian of the receiving institution should be contacted for a list of their preshipment test requests. At this time any preexisting conditions should be discussed so that the receiving vet can prepare for the animals arrival and treatment needs. It is helpful if a full set of medical records can be sent to the receiving institution before the arrival of the polar bear. As well, the Department of Agricultures State Veterinarian of the receiving state should be contacted for information on test requirements necessary for the animal to enter the state, statements that need to appear on the health certificate and how to go about acquiring permit numbers. For a list of the basic examination procedures and diagnostic tests that should be performed during a preshipment exam, see section 6.4 Quarantine.

6.4 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived polar bears and isolation facilities or procedures for the treatment of sick/injured polar bears (AZA Accreditation Standard 2.7.1). All polar bear quarantine, hospital, and isolation areas should be in compliance with AZA quarantine standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix D). All quarantine procedures should be supervised by a

AZA Accreditation Standard

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

veterinarian, formally written, and available to staff working with quarantined animals (AZA Accreditation Standard 2.7.2).

AZA Accreditation Standard

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

AZA Accreditation Standard

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all staff working with quarantined animals.

Upon arrival at a new institution, polar bears should be quarantined separately from other species of carnivores, particularly other bear species. Quarantine can be established in a hospital building separate from the exhibit area, or in an area in the habitat that can be isolated (via solid walls, use of disinfectant foot pans, separate keepers, or keepers that use dedicated quarantine boots and coveralls) from the rest of the collection, in order to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA-accredited institution or an American Association for Laboratory Animal Science (AALAS) accredited institution may be applicable.

AZA Accreditation Standard

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

Zoonotic diseases and quarantine: AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases with all polar bears, including and especially those newly acquired in quarantine (AZA Accreditation Standard 11.1.2). Keepers should be designated to care only for quarantined polar bears if possible. If keepers must care for both quarantined and resident polar bears, they should care for the quarantined animals only after caring for the resident animals. Equipment used to feed, care for, and enrich polar bears housed in quarantine should be used only with these animals. If this is not possible, then all items must be appropriately disinfected, as designated by the veterinarian supervising the quarantine procedures before use with resident animals. The AZA Bear TAG and Polar Bear SSP Program recommend that veterinarians at each institution develop their own specific disinfection protocols for animal management equipment and enrichment initiatives provided in quarantine. These protocols should take into consideration the material to be disinfected, and should ensure that disinfectants are thoroughly rinsed off or neutralized before the equipment or enrichment is used again with the bears.

Quarantine duration: Polar bears being introduced to new to a new facility should be quarantined for a minimum of 30 days, unless they have an infectious issue that requires isolation from other ursids or carnivores for longer periods, or as otherwise directed by the staff veterinarian. If additional polar bears are introduced into the quarantine area, the minimum quarantine period must begin over again. However, the addition of mammals of a different order than polar bears (order: Carnivora) to those already in quarantine will not require the re-initiation of the quarantine period.

Quarantine protocols: If the diet at the new institution differs from the old one, a gradual transition should be made to the new diet starting no sooner than the second week of quarantine. In consultation with the receiving institution, the sending institution should include a weeks worth of the original diet with the animal shipment. It is important to make sure the animal is acclimating to the new environment and is apparently “normal/healthy” before introducing a new diet.

Polar bears are not generally a social species, and isolation during quarantine is usually not a problem for these animals. An exception to this may be when cubs are separated from their mother for the first time. If animals were housed together at the previous institution, they may be housed together at the receiving institution. These animals should be watched closely for signs of aggression that could be triggered by the transport event or the new environment. Enrichment should be an important part of quarantine protocols to maximize the complexity of the space, provide opportunities for the animals to perform species-appropriate behaviors, and decrease the chance of developing stereotypic behaviors. For more information on enrichment, see Chapter 8, section 8.2.

Quarantine examinations: During quarantine, examination of feces for parasites via direct examination and floatation should be performed, and any necessary de-worming treatments administered. Animals should also be evaluated for ectoparasites and treated accordingly. To determine whether polar bears can be released from quarantine, individuals should have three consecutive negative fecal exams (once a week for three collections), but results from diagnostic testing should also be considered, and the ultimate decision should be left to the veterinarian supervising the quarantine. After an acclimation period within

quarantine, the bear should receive a complete physical exam that should include the procedures listed below.

- Venipuncture for CBC/serum, chemistry/serum bank, and heartworm antigen-antibody where appropriate
- Immunization updates
- Weight measurement
- Palpation (whole body – as fur may obscure masses/lesions)
- Auscultation
- Dental evaluation and cranial radiographs
- Skin and fur evaluation
- Feet evaluation (to detect evidence of abscesses/dermatitis)
- Identification microchip reading or placement (intramuscularly between the scapula)
- Urinalysis
- Cardiac evaluation in older bears (thoracic ultrasound)
- Otic/ophthalmic exams
- Reproductive evaluation, if reproductive status, reproductive history, and SSP Program recommendations indicate the need. This would include palpation of testicles (for abnormalities in size, shape, and firmness), semen evaluation, and ultrasound evaluation of the reproductive tract in females.

Blood should be collected, analyzed, and the sera banked in an appropriate freezer (e.g., with cold-storage temperatures of between -94°F/-70ºC and -4°F/-20ºC) for retrospective evaluation. Vaccinations should be updated as appropriate, and if the vaccination history is not known, the animal should be treated as immunologically naive and given the appropriate series of vaccinations (see section 6.5, Table 14 for recommended vaccines).

Vaccinations should be updated as appropriate, and if the vaccination history is not known, the animal should be treated as immunologically naive and given the appropriate series of vaccinations. Medical records for each animal should be accurately maintained and easily available during the quarantine period.

All medical records associated with complete physical examinations should be recorded and submitted via institutional protocols to the appropriate animal management database (e.g., ARKS, MedARKS, ZIMS). These databases also contain information on normal values for polar bear health parameters (e.g., size, weight, blood and urine values, etc.). Veterinarians and animal managers are encouraged to compare their data with normal ranges to determine the health status of the animals at their institutions.

Before immobilizing a polar bear, the AZA Polar Bear SSP Program Veterinarian should be contacted for a list of current sample requests that can be obtained during the exam. Currently, the AZA Bear TAG nutrition advisors are requesting blood samples from polar bears in zoos and aquariums in order to evaluate vitamin and mineral levels. Dr. Ann Ward (award@fortworthzoo.org) should be contacted prior to any immobilizations to find out what specific samples are needed, and how they should be collected, stored, and shipped.

Necropsy: If a polar bear should die in quarantine, a necropsy should be performed on it and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standard 2.5.1). The AWA requires that complete necropsies are performed on all marine mammals by, or under the supervision of, the attending veterinarian or a marine mammal expert (AWR, 2005). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples form the body organs should be submitted for histopathological examination. See Appendix H for the formal AZA Polar Bear SSP Program Necropsy protocol. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA Polar Bear SSP Program approved active research requests that could be filled from a necropsy. Gross necropsy and associated histopathology reports should be submitted to both the AZA Polar Bear SSP Program coordinator and Veterinary Advisor.

AZA Accreditation Standard

(2.5.1) Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

6.5 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.4.1). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals including polar bears (www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf).

AZA Accreditation Standard

(S2.4.1) The veterinary care program must emphasize disease prevention.

Routine Medical Assessments: Routine veterinary evaluations should be performed on polar bears. Health assessments may be visual or involve more extensive assessments. The USDA AWA requires that marine mammals have at least a visual exam by the attending veterinarian every 6 months (AWR, 2005). The type of examination performed may vary with the age of the animal and their history of medical issues. Some examinations can be performed under anesthetic for an extensive work up (see section 6.6 for information on chemical restraint). These exams will be the most thorough and yield the most valuable and practical information. Alternatively, other exams can be conducted at the animal's habitat with assistance from keepers, by reviewing nutrition and husbandry procedures, and evaluating the animals' condition with the help of trained medical behaviors ("open mouth" for an oral exam, "paw presents" to evaluate dorsal and ventral surfaces of the feet and nails, presentation of limbs for administration of immunizations via projectile dart, and blood collection via rear leg vein; see Chapter 8, section 8.1). In this case, follow-up immobilizations can be scheduled to address any medical issues identified. A complete physical examination under anesthesia should include everything listed for the quarantine exam (see section 6.3), in addition to addressing specific individual diagnostics and collecting AZA Polar Bear SSP Program sample requests.

A comprehensive, animal behavior training program that allows polar bears to play an active and willing role in their own health assessments (e.g., presenting body parts, opening mouth, etc.) is highly recommended. Appropriate staff training, habitat areas that allow safe, protected interactions, and training tools (e.g., targets, meat sticks, etc.), are all necessary for the husbandry training approach to be successful. For more information, see Chapter 8, section 8.1.

Typical polar bear health parameters: The average life span of polar bears cared for in zoological settings is approximately 18 years, based on studbook data (Meyerson, 2007) although the oldest polar bear is 41 years of age. In the wild, the average life expectancy is estimated to be between 15-18 yrs old (Polar Bear International) although polar bears biologists Steve Amstrup and Ian Stirling reported working on 33 and 31 year old polar bears respectively (S. Amstrup, personal communication, 2005).. Adult male polar bears weigh between 770-1320lb (350-600kg) and adult females can weigh between 330-660lb (150-300kg). At birth, cubs weigh between 1-1.5lb (0.454-0.68kg) (DeMaster & Stirling, 1981). Table 13 provides additional normal physiological information for adult polar bears.

Table 13: Normal adult polar bear physiological information

	Immobilized	**Awake****
Temperature	99-101°F (37.2-38.4°C)	97.7°F (36.5°C)
Pulse	120 beats/min*	60-90 beats/min (sitting) 30-40 beats/min (asleep) 45-60 beats/min (awake/inactive) 80-150 beats/min (active/moving)
Respiration	17 resp/min*	15-30 resp/min

*Data from Point Defiance Zoo & Aquarium polar bears under Telazol® anesthesia
**Data taken in part from Folk et al. (1973)

Dental assessments: Every routine examination of a polar bear should include a dental evaluation. The dental formula is I3/3, C1/1, P4/4, M2/3. Fractured teeth usually result from a husbandry issue (e.g., chewing on habitat barriers), and can be addressed at that level. Fractures do not necessitate action. However, if the pulp cavity is exposed, it can become packed with food which could lead to infection, increases and preventative treatment should be arranged. All dental issues should be evaluated by the veterinarian, often with a consulting veterinary or human dentist, endodontist, periodontist, or oral

surgeon present. This professional relationship can enhance the quality of care offered, as the consultants can provide expertise and equipment not readily available in zoo and aquarium practices, and is productive and beneficial for all involved. Reported dental issues should include:

- Fractured teeth (mostly canines)
- Worn teeth
- Tooth root abscesses (periodontal, around the tooth root, or endodontic, within the tooth root)
- Dental caries
- Calculus/tooth staining
- Gingivitis
- Peridontitis (disease of tissues surrounding the tooth)

Immunizations: To prevent specific disease transmission, vaccinations should be updated as appropriate for polar bears (Table 14). According to the 1999 AZA Bear TAG Survey and recent AZA Polar Bear SSP Program, and Veterinary Scientific Advisory Group's Annual Reports, immunization protocols have varied depending upon whether the bears are housed indoors or outdoors, and on the vector control programs used at each institution. Viral infections in polar bears have been limited however rabies and morbillivirus have been the most noted. At this time there is little evidence demonstrating problems with distemper or adenovirus, though possibilities for infection with these viruses should not be dismissed. Moribillivirus and canine distemper antibodies were found in wild polar bears in a study by Tryland, et al. (2005). Bears should be monitored for exposure to these viruses, as these may be commonly associated with contact between polar bears and phocid or cetacean species. *Brucella* bacteria was found in polar bears living in Svalbad and the Barents Sea regions (Tryland, et al. 2001), but there are currently no known adverse reproductive or health effects of *Brucella* bacterial infection in polar bears. Polar bears are also susceptible to leptospirosis infections, but vaccination may not be necessary if rodent populations are not a problem or if rodent control is effective. Table 14 identifies the current polar bear immunization recommendations provided by the AZA Polar Bear SSP Program:

Table 14: Recommended polar bear immunizations

Immunization	Type	Frequency
Rabies	Killed	Annually
Tetanus toxoid	Killed	Annually
Leptospirosis bacterin	Killed	Annually

At 16 weeks of age, cubs should be given 2ml of a rabies vaccine, and 2ml of tetanus toxoid. At one year of age, cubs should be given a follow-up rabies vaccination (2ml) and a booster every three years after the initial annual dose. Adults should receive annual vaccinations of tetanus toxoid,. Adults should also receive an annual vaccination of *Leptospira* bacterin if there are concerns about rodent vectors in the area.

Parasite control: Table 15 provides preventative care and treatment protocols that are recommended for endo- and ecto-parasites commonly found in polar bears. For details about issues of parasite control and 'salmon poisoning' linked to the use of live anadromous fish as food/enrichment, see Appendix E. The following deworming medications can be used on a rotational basis to manage many polar bear parasites effectively.

Table 15: Recommended deworming medications for polar bears

Medication	Dose
Pyrantel pamoate	12mg/kg/d x 3 orally
Fenbedazole	25mg/kg/d x 3 orally
Ivermectin	200ug/kg/d x 1 orally
Mebendazole	20mg/kg/d x 3 orally

Nematodes (round worms): Nematodes are commonly found in polar bears and often require an ongoing de-worming program every 6-8 weeks to control them. Veterinarians should develop their own deworming programs at their institutions. One nematode of particular interest for polar bear management includes *Baylisascaris sp*. *Baylisascaris* which has been documented as the cause of illness or death in many different species in zoo and aquarium collections (e.g., Ball et al., 1998; Sato, et al. 2005; Thompson et

al., 2008). *Baylisascaris transfuga* and *B. multipapillata* have been identified in polar bears, and they differ from the species typically found in raccoons. Clinical signs include loose stool to diarrhea and rough hair coat. Severe cases can lead to significant weight loss and intestinal obstruction. This parasite can be diagnosed by fecal float or visualization of the parasite (Briggs, 2001). See 'Zoonotic issues' below for information on potential human exposure to this parasite. These nematodes can be treated with Milbemycin oxime at a dose of 1mg/kg orally, or with Mebendazole at a dose of 20mg/kg/d x 3 orally. If there is no need for a frequent deworming program, fecal direct and floatation exams should be performed at least twice a year and deworming treatments administered as needed and appropriate for the parasite found.

Heartworm: Polar bears are susceptible to heartworm disease, but reports are rare. Heartworm has been documented more often in marine mammals such as sea lions and seals (e.g., Measures et al., 1997). Heartworm ELISA antigen tests should be conducted annually in polar bears exposed to mosquitoes in heartworm endemic areas. If heartworm is a documented problem with pinnipeds in the local area, it is suggested that polar bears be tested for it. If the test is negative, then a heartworm preventative program, such as ivermectin monthly at 200ug/kg orally, should be initiated. If the polar bear tests negative in an area where local pinnipeds have not been reported to succumb to heartworm disease, no prophylactic treatment is recommended. If positive for heartworm, further diagnostics (e.g., radiographs) should be performed to determine the severity of the disease, and then a treatment initiated. Once treatment is completed, preventative therapy should begin.

Trichinella: *Trichinella* sp. is considered an incidental finding, rather than a cause of overt disease. If signs do occur, they are seen as muscular pain and eosinophilia, possibly central nervous system involvement. Polar bears can become infected with the parasite when ingesting seal meat (Forbes, 2000; Larsen & Kjos-Hanssen, 2007). In humans, recommended treatment includes albendazole or mebendazole, along with corticosteroids in severe cases (e.g., Kociecka, 2000; Dupouy-Camet, et al. 2002), and the veterinary staff caring for polar bears should consider these as possible treatment options. Avoiding or cooking potential meat sources that the parasite might be found in is the best method of control.

Tapeworms: Tapeworms have been found in polar bears fed salmon (S. Amstrup, personal communication, 2006). The use of fenbendazole (10mg/kg/bw once daily for 3 days) may be appropriate for the treatment of tapeworms in polar bears, and the veterinary staff caring for polar bears should consider this treatment option.

Mites: *Demodex* and *Sarcoptes* may be responsible for some of the seasonal dermitis seen in polar bears. Symptoms include pruritis (itching), localized hair loss, and thickening and crusting of skin. To diagnose the problem, deep skin scrapings at the edge of the lesion should be performed after squeezing the skin to extrude the *Demodex* from the hair follicles. Treatment options include ivermectin and multiple topical sprays, dips, and liquid applications commonly used on dogs.

Medical management of neonates: Although it is always preferred to have a mother-raised polar bear cub, occasionally hand-rearing is required due to situations involving lack of sufficient milk for the cubs, aggression, maternal neglect, and mother or cub injury/illness. In these cases, the cub should be removed for treatment and/or hand rearing. Refer to Chapter 7, section 7.5 for more detailed hand-rearing protocols. Veterinary staff should perform an exam soon after retrieval of cubs to be hand-reared that should include the following:

- Temperature, pulse, respiration, and weight measures
- Assessment of whether the respiratory tract is cleared
- Cleaning of the umbilical stump (chlorhexidine solution can be applied), or examination for herniation if no stump is seen
- Identification of any abnormalities (cleft palate, imperforate anus, hernias, etc)
- Assessment of hydration
- Administration of colostrum administered, if possible. For alternatives see Chapter 7, section 7.5

For parent-reared cubs, it may be possible to separate the cub for weighing and sexing when the cubs start leaving the den with their mother. However, the AZA Bear TAG does not recommend routine neonatal exams, and there should be no need to handle a healthy looking polar bear cub that is being mother-reared. Where disease is a concern, neonates may show only subtle clinical signs in the early

stages of the illness, and they can deteriorate rapidly. Close monitoring and quick action may be necessary to deal with illness. Some of the following medical issues may arise in both hand-reared and parent-reared neonates:

- *Hypothermia/hyperthermia*: To treat hypo- or hyperthermia, cubs should be warmed or cooled to within 3° of normal body temperature (99.6°F/37.5°C), as momentum will carry the temperature the rest of the way. Caution should be used when warming or cooling with direct skin contact, as peripheral circulation may be compromised and unable to dissipate hot or cold, resulting in burns.
- *Hypoglycemia*: Cubs found moribund may be suffering from hypoglycemia. A 50% dextrose treatment can be applied to the gums to raise blood sugar levels, but hypothermic cubs may require warming up before oral or subcutaneous administration of glucose can be effective.
- *Aspiration/pneumonia*: Aspiration of fluids can occur as a result of bottle-feeding, but cubs should always be checked for presence of a cleft palate if this occurs. Appropriate bottle-feeding techniques are described in Chapter 7, section 7.5.
- *Dehydration*: Dehydration can be rectified with oral liquids (Pedialyte®), powdered electrolyte solutions, or subcutaneous electrolyte solutions. A veterinarian should evaluate skin turgor and calculate appropriate fluid needs.
- *Diarrhea*: Diarrhea can be caused by bacterial, viral, parasitic, nutritional (e.g., food allergy, dietary changes, inappropriate formula concentration), or husbandry factors. Establishing a quarantine protocol (including foot baths changed daily, dedicated quarantine/nursery keepers, hand wash, and disinfection protocols) for care of neonates may help to prevent some of these causes of diarrhea.
- *Constipation*: Constipation can be treated in hand-reared cubs by feeding a more dilute formula (about half strength of the infant formula being used) for a 24-hour period, then increasing the formula concentration over a couple of days once the constipation is resolved. Severe cases may require a warm water enema and supplemental subcutaneous fluids.
- *Parasites*: Ascarid infections can be passed on to the cub from the mother if she has not been properly monitored and treated through her own preventative health program. Routine fecal analysis and deworming program should be initiated within the first month of the cub's life.
- *Nutrition*: Balanced nutrition is very important for the neonate. Rickets has been documented in a pair of hand-reared polar bears (Kenny, et al. 1999). Information on appropriate nutritional levels for hand-reared cubs can be found in Chapter 7, section 7.5, Appendix G, and Chapter 8 of the Polar Bear Nutrition Guidelines (Lintzenich B, et.al, 2006).

Medical Management of Geriatric Animals: The following list describes medical conditions commonly associated with geriatric polar bears, and provides recommended management protocols to address these issues:

Body weight and condition: Body weight of geriatric polar bears should be carefully monitored, and may need to be managed by adjusting diet. Obesity can contribute to development of joint and back ailments. It can be very helpful to chart monthly body weight and food intake, and then compare annual and seasonal changes to be able to make dietary adjustments accordingly. Older bears may not be as active as younger individuals, and may require fewer calories on a daily basis. Diet should also be adjusted as medical issues (e.g., renal or liver disease) arise, as certain veterinary health issues may require varying levels of nutritional management. Geriatric bears should be closely monitored through preventative health programs. The earlier medical issues such as degenerative organ disease can be detected, the more effective any medical or nutritional management can be.

Arthropathies: Joint issues can lead to decreased activity that can contribute to other medical issues if not managed well. Special attention should be given to securing climbing structures and easing access up and down in the exhibit and in denning areas of habitats containing geriatric bears in order to avoid injuries related to falling or aggravating existing arthopathies. Table 16 provides a list of potential treatments, and their reported success, that have been used to treat ursid arthropathies.

Table 16: Treatments[1] for ursid arthropathies reported in AZA's Polar Bear SSP Vet Advisory Annual Report Forms

Drug	Notes
Cosequin	Grizzly bear did well for several years on this; one bear better on meloxicam. Easy to administer
Ascriptin	Good for short-term use (1-2 weeks) with grizzly bear after injury
Carprofen	Worked well on grizzly bear for 2 weeks before dose was increased to achieve same effect.
Meloxicam	One grizzly bear showed significant increase in mobility – dose decreased from canine dose to low once a day dose. Black bear dosed slightly under 0.1mg/kg SID, and backed off to every other day for a year with good effect.

[1] A specific dose was given in only one case.

Dental problems: The dental issues described above for polar bears in general may be encountered more frequently in older bears. Worn teeth may require that a more easily ingested/digested diet be provided, and that the health of the teeth and weight of the bear be more closely monitored. Where tooth issues are identified, vital pulpotomies and fillings are usually preferred rather than extractions in geriatric bears.

Neoplasia: Neoplasia is most commonly seen in the livers of older bears. The AZA Polar Bear SSP Program Veterinary Advisor should be contacted with any questions regarding neoplasia in geriatric bears.

Parasites: Trichinosis has been seen in geriatric bears, but disease indicators are often difficult to define, as older bears commonly have multiple, pre-existing medical problems.

Zoonotic Issues: AZA-accredited institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases with all animals including polar bears (AZA Accreditation Standard 11.1.2). When working with polar bears, caretakers should always be aware of potential zoonotic diseases that can be transmitted from the animals to humans and visa versa. When working with polar bears, all animal staff should be educated about the preventative measures necessary to prevent spread of these kinds of diseases. Zoonotic diseases can be spread by fecal-oral transmission, contamination of human mucus membranes with polar bear excretions or secretions (e.g., feces, saliva, blood, pus, etc.), and contact with infected/infested tissues. Pathogens of concern when working with polar bears are *Leptospira* in urine, rabies virus in oro-nasal secretions, *Baylisascaris* larvae and *Salmonella* bacteria in feces, and *Trichinella* in tissues. Effective measures that help prevent the transmission of these diseases include: 1) washing hands between and after handling animals, feces, urine, other bodily fluids or secretions, or animal diets, 2) wearing gloves, goggles, and a mask when cleaning animal habitats, and 3) wearing gloves when handling tissues.

Although a tuberculin testing and surveillance program is a requirement for institutions housing animals that can be affected by tuberculosis, there are no requirements or recommendations associated specifically with polar bears, or for staff members working directly with polar bears. Animal caretakers may require tuberculin testing if they also work with other species within their institutions. Recommendations for a testing and surveillance programs should be developed by each institution, and by AZA TAGs that include species most affected by this disease.

6.6 Capture, Restraint, and Immobilization

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(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

The need for capturing, restraining, and/or immobilizing polar bears for normal or emergency husbandry procedures will be required as part of the care and management of the animals. All equipment used in the restraint of polar bears must be in good working order and available to authorized and trained animal care staff at all times (AZA Accreditation Standard 2.3.1). Given their large size and carnivorous nature, polar bears should not be manually handled or restrained without the use of chemical immobilization methods.

Anesthesia: Most procedures performed on polar bears require some form of chemical restraint. The drug combination used is dependent upon the length and invasiveness of the procedure, medical history

of the animal, and experience of the veterinary staff. An appropriate fasting protocol (a minimum of eight hours off food and water) should be employed before scheduled surgery to minimize the possibility of regurgitation or aspiration.

Drug delivery systems: Many different remote delivery systems are available, and appear to be appropriate for use on polar bears (e.g., Tel-inject®, Dan-Inject®, Pneu-Dart®). Polar bears in culvert traps or small habitat areas may be injected with a pole syringe or blow dart. Volume limitations with blow darts necessitate the use of drug combinations and concentrated forms of commonly used anesthetic agents (e.g., only half the amount of dilutent to make concentrated Telazol®; lyophilized ketamine; or concentrated forms of medetomidine or midazolam). Polar bears demonstrate seasonal variation in fat distribution. Most often the thickest fat layer is over the rump and thighs, requiring a minimum 2.5" (6.4cm) needle to penetrate. Otherwise, the favored target for darting polar bears is the neck area.

Drug dosages: Injectable anesthetics are commonly used in polar bear care and management. Short, non-invasive procedures can be accomplished with injectables alone (see Table 17). Longer procedures may require maintenance on gaseous anesthesia such as isoflurane provided via facemask or endotracheal (ET) tube (adults on 0.4-0.55"/11-14mm ET tubes).

Table 17: Recommended anesthetic agent and dose for polar bears

Anesthetic agent	Dose	Reversal agent	Dose
Medetomidine + Ketamine + Midazolam[1]	Med 0.05mg/kg IM Ket 3mg/kg Mid 0.5mg/kg	Atipamezole	5mg Ati / 1mg Met ½ IV & ½ IM
Tiletamine + Zolazepam (Telazol)[2]	8mg/kg IM	None	None
Telazol + Medetomidine*	T 0.5-3mg/kg IM + M 0.015-0.05mg/kg IM	Atipamezole	0.15mg/kg IM
Ketamine + Xylazine (Adults)[3]	K 6.7mg/kg IM + X 6.7mg/kg IM	Yohimbine	0.1mg/kg IV
(Cubs)	K 2.3mg/kg IM + X 2.3mg/kg IM		
Ketamine+ Medetomidine[2]	K 2.5mg/kg IM + M 0.03mg/kg IM	Atipamezole	0.15mg/kg IM
Etorphine[2]	0.02-0.05mg/kgIM (avg 0.035mg/kg)	Diprenorphine	2mg Diprenorphine per 1mg etorphine IV IM
Carfentanil[2]	0.02mg/kg	Naltrexone	100 times the carfentanil dose (in mg) ½ IM & ½ IV

[1] Black & Whiteside 2005.
[2] Kreeger 1997.
[3] Dierauf & Gulland 2001.
*There have been reports of polar bears waking partially during procedures using medetomidine or etorphine. It is important to avoid loud or sudden noises when these agents are used.

Monitoring anesthesia and supportive care: The depth of anesthesia should be closely monitored during veterinary procedures with polar bears. In xylazine-ketamine, medetomidine-ketamine, and etorphine anesthesia, sudden recoveries may be encountered. Factors that increase the risk of sudden arousal include: loud noises (distress vocalizations of cubs are particularly arousing); movement of the bear (i.e., changing the body position or location of the anesthetized animal); and painful stimuli (e.g., tooth extraction).

Techniques for monitoring depth of anesthesia will depend on the agent used. Tiletamine-zolazepam (Telazol®, Zoletil® (ZT)) produce reliable anesthesia with predictable signs of recovery. As anesthesia lightens, spontaneous blinking occurs, bears show chewing movements and paw movement, and they will attempt to lift their head, and raise themselves with their forelimbs. Animals with significant head movement generally require a 'top-up' of tiletaminezolazepam or ketamine, unless the procedure is nearly complete and can be safely completed without additional drugs. Top-up doses of tiletamine-zolazepam

can significantly prolong recovery, and should only be used if >30 minutes of additional anesthesia is required. Ketamine is a better choice if 5-20 minutes of additional time is needed. With xylazine-ketamine or medetomidine-ketamine, head lifting or limb movement signal that the bear is extremely light and should not be approached or manipulated. Increased intensity of the palpebral reflexes or nystagmus are earlier indicators that the bear is light. With xylazine-zolazepam-tiletamine (XZT) or medetomidine-zolazepam-tiletamine (MZT), head lifting should be absent before the bear is approached. The palpebral reflex can be used to determine depth of anesthesia. Lightly anesthetized bears will begin to breathe deeply, and may sigh. They may start to lick, and will develop a spontaneous palpebral. Head lifting or paw movement should be a sign to be extremely cautious, as the bear may soon rouse.

During periods of anesthesia, the eyes should always be lubricated, and caution must be exercised to avoid corneal abrasions or ulceration. A blindfold should be placed on anesthetized bears to protect the eyes and decrease visual stimuli. Bears are not particularly prone to hypoxemia. Oxygenation under tiletamine-zolazepam is generally good. The addition of an alpha-2 agonist can result in hypoxemia. Oxygenation can be monitored by visualization of the mucous membranes or with a pulse oximeter. The pulse oximeter probe can be placed on the tongue. This may be difficult in bears lightly anesthetized with ZT, as they tend to chew. A hemoglobin saturation of <85% is indicative of hypoxemia. In this situation, bears should be provided with supplemental inspired oxygen. Portable equipment is available to facilitate oxygen delivery with polar bears. An ambulance type regulator (Easy Reg®; Precision Medical, Inc. 300 Held Drive, Northampton, PA 18067) and aluminum D-cylinder is lightweight, portable, and sturdy, and can be a very useful piece of equipment. It can provide a 10L/min flow for up to 30 minutes. An E-cylinder will provide this flow for an hour or more. A nasal catheter is a simple method to provide supplemental inspired oxygen. The catheter should be threaded as far as the medial canthus of the eye. A flow rate of 5-10L/min is required in most bears. Efficacy of oxygen therapy can be monitored with a pulse oximeter.

Bears can be positioned in dorsal or lateral recumbency, with few adverse effects. Animal should be positioned carefully to avoid excessive pressure on limbs that could result in compartment syndrome. The cardiovascular system should be closely monitored. Polar bears anesthetized with ZT commonly have heart rates of 70-90 beats/min. Heart rate is slightly lower with XZT and MZT, at 50-70 beats/min. Bradycardia is common with medetomidine-ketamine, and heart rates of 30-40 beats/min. are not uncommon in polar bears. The femoral artery is the best location to palpate a pulse; the brachial artery can also be used. Blood can be sampled from the jugular or medial saphenous vein. Intravenous catheters may be placed in the jugular or cephalic vein. Blood pressure can be measured directly, via the femoral artery. In smaller bears, oscillometric monitors can be used. The cuff width should be approximately 0.4 times the limb circumference. Mean arterial pressure in polar bears anesthetized with TZ is approximately 150mmHg. Polar bears anesthetized with MZT are hypertensive (MAP >200mmHg).

Rectal temperature should be closely monitored. Rectal temperature tends to decrease over time with TZ, and it tends to increase with XZT and MZT. In hot ambient temperatures, body temperature can increase to dangerous levels (>41ºC/105°F). In these situations, the alpha-2 agonist should be antagonized as quickly as possible. When possible, anesthesia should be reversed. This is particularly important for sows with cubs.

Transport of Anesthetized Bears: Bears may be transported during periods of anesthesia as part of normal management procedures. Translocation or handling (e.g., weighing) of bears using a cargo net can induce hypertension and hypoxemia resulting from airway obstruction. Ideally, when cargo nets are used with polar bears, the bears should be transported or weighed with their head and neck extended and their body extended in sternal or dorsal recumbency. A stretcher-type sling is recommended to facilitate this positioning. Stretchers can be designed to support the weight of a polar bear, and should be designed with the straps and poles that allow proper support and positioning of the bear during a forklift or boom truck short move. If polar bears are anesthetized prior to crating for a long duration transport (e.g., between institutions), they should be awake before transport begins, as an anesthetized bear can gravitate towards the door of the crate, pressing the nose downward and compressing the airway resulting in possible suffocation.

6.7 Management of Diseases, Disorders, Injuries and/or Isolation

AZA-accredited institutions should have an extensive veterinary program that effectively manages animal diseases, disorders, or injuries. Polar Bear hospital facilities should have x-ray equipment or access to x-ray services (AZA Accreditation Standard 2.3.2); appropriate equipment, supplies, facilities,

and habitat areas for treatment of diseases, disorders or injuries; and have trained staff members available to address health issues, manage short- and long-term medical treatments, and control for zoonotic disease transmission. Polar Bear keepers should be trained to meet the animal's dietary, husbandry, and enrichment needs, and to recognize behavioral indicators that may indicate compromised health (AZA Accreditation Standard 2.4.2). Protocols should be established for reporting these observations to the veterinary department.

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(2.3.2) Hospital facilities should have x-ray equipment or have access to x-ray services.

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(2.4.2) Keepers should be trained to recognize abnormal behavior and clinical symptoms of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not evaluate illnesses nor prescribe treatment.

Given the size and power of polar bears, moving animals to the veterinary hospital for medical emergencies or short/long-term care can be challenging and may not be possible within all institutions. Polar bear habitats should contain holding areas that allow individual bears to be separated from conspecifics, if needed, while still providing the same habitat complexity and containment described in Chapter 2, section 2.1 of this manual to avoid the onset of stereotypic behavior. Within hospital/quarantine or holding areas, maintaining an appropriate ambient temperature, and providing the animals with opportunities to regulate their own temperature if appropriate (e.g., ice, ice bags, cold fluids, air conditioning, etc.) is a priority for bears that are sick or receiving medical treatment. Veterinarians at each institution should develop protocols for maintaining appropriate environments for bears receiving medical attention, and should pay particular attention to overheating issues.

In general, polar bears tend to be fairly hardy animals. Loss of appetite, increased inactivity and lethargy, and even increased aggression, can all indicate a potential health issues. Following husbandry/nutritional guidelines, implementing a routine preventative medicine program, and communicating with the AZA Polar Bear SSP Program, are all recommended approaches to help institutions maintain healthy *ex situ* polar bear populations. Medical problems and necropsy reports should be reported to the AZA Polar Bear SSP Program Veterinary Advisor for summary and analysis, so that all facilities can benefit from the information. Reported medical problems that are common in polar bears include parasites, skin and hair problems, and dental issues. The following diseases and disorders have occurred within the *ex situ* polar bear population and more information about annual mortalities can be found in the Annual Polar Bear SSP Vet Advisory Group Report Form which is available to veterinarians on the aazv.org web site:

Pododermatitis: Reports of pododermatitis have ranged from general inflammation of the plantar surface of the foot to networks of fistulous tracts on the dorsal surface of the foot. Other cases have included small cuts to the surfaces, punctures, abscesses, and localized swellings. Contributing factors to these conditions include warm environmental temperatures, constantly moist environment with no chance to "dry out" (the arctic is actually a very dry environment), lack of disinfection, residue disinfectants that cause inflammation, rough and hard substrates, broken wire brush bristles, and trauma. Some conditions may be responsive to a change in husbandry practices, a simple course of antibiotics, but in other cases, bears may require immobilization for diagnostic assessments and treatment. Training polar bears for "paw presents" can be a valuable diagnostic tool that can minimize the need for immobilizations (see Chapter 8, section 8.1 for additional information).

Alopecia: Alopecia is one of the more commonly reported conditions in polar bears housed in zoos and aquariums. An in-depth evaluation of polar bear nutrition, conducted by the AZA Polar Bear SSP Program Nutrition Working Group (Feb 2004-April 2005) concluded that nutritional issues were not documented as the primary factor in cases of alopecia. Two extensive surveys (2000 AZA Bear TAG Bear Husbandry and Health Survey; and 2003 Polar Bear Diet and Facility Review) provided the background information upon which this conclusion was reached by the working group of bear keepers, curators, nutritionists, veterinarians, and other scientists. Other factors more often responsible for hair loss included:

- Seasonal allergies
- Ectoparasites – mites (audycoptic mange) or fly strike
- Trauma – rubbing, self-inflicted due to stress
- Water quality issues
- Reproductive hormonal imbalances

Each of these problems can be dealt with using commonly prescribed treatments (see Chapter 6, section 6.5 for parasite treatments), behavioral modification, enrichment, or scrutiny of life support systems and water quality. The issue of reproductive hormonal imbalances remains under investigation, but may lead to some management changes in how males and females of different reproductive status are housed during the breeding season. Cases of mange have been most responsive to amitraz spray or sponge-on dip. Ivermectin has not been routinely successful (Ramsay, 2003). All cases of alopecia, diagnoses, and treatment successes or failures should be reported to the AZA Polar Bear SSP Program Veterinary Advisor, as this topic is currently under investigation.

Greening of hair coat: This phenomenon is caused by the growth of a cyanophyte (blue-green algae) within the hair shaft of polar bear coats (Ramsay 2003). Control measures have included salt-water treatments and peroxide baths for the polar bears, and water treatment measures designed to reduce the presence of algae in the water (see Chapter 1, section 1.3 for additional information on water quality control).

Other medical issues and potential research questions: There are other diseases, disorders, and potential health issues that may warrant further research for polar bears in zoos and aquariums. Oxley et al. (2005) identified *Helicobacter spp*. in the feces of polar bears showing no clinical manifestations of disease. The role of these bacteria in disease issues associated with polar bears has not yet been investigated. Banks et al. (1999) describe Aujeszky's disease (caused by porcine herpesvirus-1) as the cause of death for two polar bears, and additional research may be needed to determine the risk associated this viral disease for the zoo and aquarium polar bear population Additional reported problems for polar bears have been reported and are listed below. Further information is needed on successful treatment approaches for these diseases and medical disorders, and this information should be reported to the AZA Polar Bear SSP Program Veterinary Advisor.

1. Pneumonia
2. Neoplasia
    a. Lung
    b. Liver - hepatocellular carcinoma
    c. Biliary adenocarcinoma
    d. Pancreatic beta cell carcinoma
    e. Gastrointestinal
3. Hepatic lipidosis
4. Gall stones
5. GI bacterial infections – *Salmonella*, *Shigella*, *Aeromonas*
6. Bloat
7. Enteritis
8. Acute pancreatitis
9. Lameness
10. Limb fractures
11. Arthritis (spondyloarthrosis)
12. Osteomyelitis
13. Glomerulonephritis
14. Hypothyroidism
15. Umbilical hernia

Medical Concerns and Communication: AZA-accredited institutions must have a clear process for identifying and addressing animal welfare concerns within their facilities (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee (IAWC), or similar committee, that can address these issues. This process should identify the protocols needed for animal care staff members to communicate animal welfare questions or concerns to their supervisors, their IAWC, or if necessary to the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues specific to polar bears, coordination and implementation of appropriate

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(1.5.8) The institution must develop a clear process for identifying and addressing animal welfare concerns within the institution.

responses to these issues, evaluation of the outcome of these responses, adjustment of any responses if necessary, and the dissemination of the knowledge gained from these issues.

Given the wide variety of zoos and aquariums that house polar bears, the AZA Bear TAG and Polar Bear SSP Program cannot provide specific recommendations for the best approaches to take in order to communicate animal welfare issues effectively within every institution. All animal caretakers that work with polar bears should be aware of institutional protocols in place for them to identify, communicate, and address potential animal welfare issues that are associated with the care and management of polar bears.

Euthanasia and necropsies: The AZA Bear TAG and Polar Bear SSP Program do not currently have any specific recommended protocols for polar bear euthanasia within zoos and aquariums. Veterinarians at each institution are encouraged to contact the AZA Polar Bear SSP Program Veterinary Advisors for more specific information or advice on the most effective, safe, and humane approaches. Each institution housing polar bears should have a euthanasia protocol in place, developed by the veterinary team, in case euthanasia becomes necessary in a particular situation. The AZA Animal Welfare Committee also encourages each institution to develop a process to determine when elective euthanasia might be appropriate from a quality of life perspective, taking into account behavioral, health, social, nutritional, and animal caretaker perspectives. Examples of approaches used by institutions are available from the AZA Animal Welfare Committee. The death of polar bears in zoos and aquariums must be reported to the appropriate regulatory agencies (e.g., USFWS, USDA) as stated in the federal regulations that affect polar bears (e.g., Animal Welfare Act, Marine Mammal Protection Act, Endangered Species Act). For more information on federal requirements, see Meyerson (2007).

AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support polar bear longevity; In the occurrence of death however, information obtained from necropsies is added to a database of information that assists researchers and veterinarians in zoos and aquariums to enhance the lives of polar bears both in their care and in the wild. As stated in Chapter 6.4, necropsies should be conducted on deceased polar bears to determine their cause of death, and the subsequent disposal of the body must be done in accordance with local, state, or federal laws (AZA Accreditation Standard 2.5.1). The AWA requires that complete necropsies are performed on all marine mammals by, or under the supervision of, the attending veterinarian or a marine mammal expert (AWR, 2005). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples form the body organs should be submitted for histopathological examination. See Appendix H for the formal AZA Polar Bear SSP Program Necropsy protocol. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA Polar Bear SSP Program approved active research requests that could be filled from a necropsy. Gross necropsy and associated histopathology reports should be submitted to both the AZA Polar Bear SSP Program coordinator and Veterinary Advisor.

Chapter 7. Reproduction

7.1 Reproductive Physiology and Behavior

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of polar bears in the care of zoos and aquariums. This knowledge facilitates all aspects of reproduction, artificial insemination, birthing, rearing, and even contraception efforts that AZA-accredited zoos and aquariums strive to achieve.

Females: Female polar bears have been shown to reach reproductive maturity at 4 years of age, and successfully give birth as young as 5 years old (Stirling et al., 1977, 1980, 1984; Ramsay & Stirling, 1982, 1988; Furnell & Schweinsburg, 1984). Females may remain reproductively active throughout their lives (Derocher et al., 1992), and a record exists of a 29-year-old wild female being in estrus and associating with a reproductively active male (Meyerson, 2007). *In situ* female polar bears enter a prolonged period of estrus between March and June, with a peak in late April and early May. *Ex situ* estrus can be determined by vulva turgidity and vaginal discharge. Research by Tumanov (2001) on reproduction in *ex situ* polar bears revealed that most copulations performed by the animals in the sample population occurred in March-April, independent of local weather conditions and ambient temperatures. Coitus was observed to last between 10-40 minutes. Induced ovulation and delayed implantation are both known to occur in polar bears (Wimsatt, 1963; Ramsay & Dunbrack, 1986; Derocher & Stirling, 1992). Research is currently underway to track female estrous cycles and determine pregnancy and reproductive cyclicity in female polar bears from both a behavioral and physiological perspective. For more information see Chapter 9, section 9.1.

Males: In reproductively mature males, sperm production in the testes is controlled by their position. The testes of *in situ* males appear to be located within the abdomen for the majority of the year, but descend in late winter, and can remain descended until May. Spermatogenesis occurs in the descended testes from February-May (Erickson, 1962; Lentfer & Miller, 1969). Males have been recorded as having mature spermatozoa in their testes as early as 3 years of age, and up until 19 years of age (Lentfer & Miller, 1969). Bears older than 5 years of age appear to produce abundant spermatozoa, and are capable of breeding successfully, at least from a physiological perspective (Rosing-Asvid et al., 2002). Observations of 3-year-old males consorting with females in estrous have been recorded, suggesting that males may be behaviorally capable of reproduction as this age too (Lentfer et al., 1980). Reproduction is usually more likely to be successful when one or both animals are older than 6 years of age.

Reproductive behavior: *In situ* males only associate with females for breeding and have been observed interacting with females from March to June. *Ex situ* polar bears start to show courtship behavior , such as the male following the female, increased play behavior, and increased acceptance of the male's presence by the female as early as January, with breeding seen in February and lasting sometimes into May. Cubs are born usually in November-December, though they have been born as early as October and as late as the end of January (see Chapter 7, section 7.3 for additional information). Transfers or introductions of potential breeding animals should be completed in a timely manner to ensure that potential mates have finished quarantine and are fully introduced prior to courtship.

The decision of whether to introduce males and females for specific breeding interactions, or whether males and females can be housed together year-round, will need to be based on the temperaments of the bears, evidence of affiliative or aggressive interactions, and the facilities available at each institution. Some males and females can stay together the whole time. The design and size of habitat areas provided to polar bears that are separated during any point during the reproductive process should follow the recommendations and requirements described in Chapter 2. The challenges that can arise during the breeding season, or during specific breeding interactions, include males being overly aggressive, and females not being receptive to males. Inexperienced and young bears may require additional time together before successful copulation occurs.

7.2 Artificial Insemination

The practical use of artificial insemination (AI) with animals was developed during the early 1900s to replicate desirable livestock characteristics to more progeny. Over the last decade or so, AZA-accredited zoos and aquariums have begun using AI processes more often with many of the animals residing in their

care. AZA studbooks are designed to help manage animal populations by providing detailed genetic and demographic analyses to promote genetic diversity with breeding pair decisions within and between institutions. While these decisions are based upon sound biological reasoning, the efforts needed to ensure that transports and introductions are done properly to facilitate breeding between the animals are often quite complex, exhaustive, and expensive, and conception is not guaranteed.

AI has become an increasingly popular technology that is being used to meet the needs identified in the AZA studbooks without having to re-locate animals. Males of many species can be trained to voluntarily produce semen samples and females can be trained for voluntary insemination and pregnancy monitoring procedures such as blood and urine hormone measurements and ultrasound evaluations. Techniques used to preserve and freeze semen has been achieved with a variety, but not all, taxa and should be investigated further.

Currently, there has not been any successful artificial insemination of polar bears, and no protocols are in place to address this subject. As induced ovulators (Wimsatt, 1963; Ramsay & Dunbrack, 1986; Derocher & Stirling, 1992), there may be several challenges associated with this approach that will need to be addressed if this technique is attempted. The AZA Bear TAG and Polar Bear SSP Program encourage future research on this topic, especially in light of potential new permit requirements and transport restrictions of polar bears now that they are listed under the Endangered Species Act (ESA, 1973), and the difficulty of shipping such large, dangerous animals between institutions for breeding.

The potential for collecting and cryo-preserving viable sperm from male polar bears post-mortem is currently being investigated. With appropriate collection and storage protocols and methodologies, this research could help with the development of a polar bear sperm bank. Electro-ejaculation and cryopreservation of sperm has been performed for black and brown bears (Ishikawa et al., 2002; Okano et al., 2004, 2006a,b; Chen et al., 2007; Anel et al., 2008), and research has also been undertaken on the in-vitro maturation of oocytes derived from brown bears (*Ursus arctos*) (Yin et al., 2007). This research may be applicable to the artificial insemination techniques developed for polar bears. Research into female estrus and pregnancy assessment in polar bears using fecal samples is also being performed, and could play a role in artificial insemination procedures for this species in the future.

7.3 Pregnancy and Parturition

It is extremely important to understand the physiological and behavioral changes that occur throughout a polar bear's pregnancy. The mean pregnancy duration for *ex situ* polar bears studied by Tumanov (2001) was 224 days (range = 164-294 days), with greater variation in the timing of breeding than in the timing of parturition (typically occurring in November or December regardless of when mating occurred). As polar bears show delayed implantation (Wimsatt, 1963; Ferguson et al., 1996), a relatively narrow window of parturition is expected. Including the period of delayed implantation, total gestation times for *in situ* polar bears have been recorded between 195-265 days (Uspenski, 1977). Tumanov (2001) found a slight trend for females that bred early (February) or late (June) to have fewer cubs per litter than those that bred in March-May, however, this trend was based on a small sample size. Mean litter size for polar bears was found to be 1.76 cubs, with two-cub litters being most common (Tumanov, 2001).

Separation of the sexes is necessary when the female polar bear is pregnant, as they become less tolerant of the male as parturition approaches. Any female that is suspected of being pregnant should be denned up within a familiar cubbing den until proven otherwise. See Chapter 7, section 7.4 for more information on appropriate birthing and cubbing dens. Monitoring the behavior of the female is necessary to have enough information to make the decision to release the female from the cubbing area if she is not pregnant. Females who are pregnant will eventually settle down into the cubbing den. The activity level of females who are not pregnant will increase and females will bang on the doors or give other indications that they want to have access to other areas of the habitat. Currently, there is no pregnancy test for female polar bears, however, research on fecal assays to determine pregnancy are currently underway (see Chapter 9, section 9.1). Pregnant females tend to gain a lot of weight, and their hair coat looks better towards the end of summer when implantation is due to occur. Usually, a pregnant female's activity decreases significantly in the early fall, and her appetite will also decrease if she is pregnant or pseudo-pregnant.

Keeping the daily routine and regular staff as close to normal as possible is recommended during late pregnancy and cub rearing. Prior to birth many females will exhibit changes in behavior such as loss of appetite, increasing amounts of time in the cubbing den, and restlessness. Some bears may spend

increased amount of time manipulating straw bedding within the den about 2-3 weeks prior to parturition (Kenny & Bickel, 2005). Immediately prior to birth, individuals may appear to be uncomfortable, frequently lying down and standing up, stretching, and licking themselves (Kenny & Bickel, 2005). However, first time mothers carrying only a single cub may give little warning of parturition. As the female's appetite decreases in the late stages of pregnancy, consideration should be given to offering only dry food as a way to lessen the chance of bacterial overgrowth in and around the cubbing den, as managers in some facilities may choose to avoid disturbing the area by not performing daily cleanings of the maternal den area.

Given the denning behavior shown by females, and the need for 'protected contact' when interacting with polar bears, there is little assistance that can be provided to pregnant females during parturition. Due to the small size of the cubs, dystocias are rare in this species. The actual birth process typically occurs rapidly, with the mother delivering while standing, or sometimes while sitting and licking the vulva area (Kenny & Bickel, 2005). Video and sound monitoring equipment can provide information to caretakers on the progress of the parturition, and no interference is recommended unless a serious medical emergency needs to be addressed. Faint vocalizations from the cubs can typically be heard from den microphones within minutes after their birth (Kenny & Bickel, 2005).

Cub rearing: *In situ* polar bear cubs are typically born by early January, but do not emerge from the den with their mother until late March or early April (Amstrup & Gardner, 1994). *In situ* litter size averages 2-3 cubs (Stirling et al., 1977; Ramsay & Stirling, 1988; Derocher & Stirling, 1992), and can vary with the age of the mother (Derocher & Stirling, 1994). Females will rear cubs for 2-3 years, and they will not breed again until the cubs are weaned due to lactational anestrus. Although the minimum successful reproductive interval for polar bears is generally 3 years, early weaning of cubs (*in situ* and *ex situ*) can lead to some females experiencing a 2-year reproductive interval (Ramsay & Stirling, 1988). Many polar bear cubs can die within their first year of life (*in situ* and *ex situ*) (Amstrup & Durner, 1995). If cub loss occurs early enough in the spring, *in situ* female polar bears have the potential to breed again within the same year of the cub loss.

Newborn polar bears are altricial, and the haired, blind cubs weigh only about 1.3lb (0.6kg) at birth (Blix & Lentfer, 1979). When *in situ* cubs emerge from their winter dens, they can weigh up to 22-26.5lb (10-12kg), and continue to grow rapidly over their first 1-3 years. Cubs can double their body weight between their first and second years of life. Polar bear milk is rich, and contains a higher fat and protein content than milk from other bear species or carnivores (Jenness et al., 1972; Ramsay & Dunbrack, 1986). The high nutritional composition of the milk that allows cubs to grow quickly represents a significant physiological and metabolic demand for the nursing female (Arnould & Ramsay, 1994). Weaning occurs between the 1-3 year of life, and the composition of the milk changes throughout the cub rearing period, with a significant decline in fat content between the first and second year of the cub's life (mean fat content of milk decreases from 31.2% to 18.3%) (Arnould & Ramsay, 1994).

Ex situ cubs are usually born between November and January and more information on the time of births is available in Meyerson (2007). Once birth has occurred, access to the female's den and the holding area should be strictly limited and the female left completely alone. All disturbances should be kept to a minimum while the female is in the cubbing den (e.g., turning off the phone ringer in adjacent keeper offices). It is strongly recommended that access to the area be limited to necessary personnel only, and only for short periods of time even for approved staff. Fresh water should be available to the females at all times, and automatic waterers, such as Nelson waterers or Lixits work well for this. The female and cubs should not be disturbed for a period of at least 72 hours before offering food. Remote cameras can be used to evaluate if the female is coming out to look for food. Some females may not eat for weeks after the birth. If the female is spending large amounts of time in the cubbing den and all is quiet, the young are probably being taken care of satisfactorily. It is necessary to monitor the female's behavior and listen to the cubs' cries. Cub cries can be very loud, and have a distinctive sound (described as a hum or trill) during a nursing session. Observations by Dr. Karin Linke, Rostock Germany, Personal Communication, 2005) have shown that the humming vocalization is generated during breathing out, with the tongue pressed against the palate. The humming vocalization is a good indicator that the cubs are being cared for appropriately. From a developmental perspective, cubs start to open their eyes for the first time around 35 days of age (Kenny & Bickel, 2005). Parent-reared cubs begin eating solid food at about 4 months of age (Kenny & Bickel, 2005).

Females should be given every opportunity to raise their cubs, and hand-rearing should be considered as a final resort. If the female is out of the den for prolonged periods of time, or the cubs' cries are sustained, it may be necessary to intervene. Each institution needs to make a plan before the female is denned up to identify the criteria of if and when intervention will happen.

7.4 Birthing Facilities

In situ cubbing dens vary in size but there is always a maternity den chamber that can typically be found at the upper end of an average entrance tunnel 3-7' (0.91-2.1m) long and 1.6' (49cm) high (Durner et al., 2003); some dens have secondary chambers as well (Durner et al., 2003). Dens average 5' (1.5m) in diameter, 4.9' (1.48m) in length, 4.2' (1.27m) in width, and 2.6-3' (0.79-0.91m) in height (Durner, et al. 2003). Primary chambers usually include a nest-like depression where the adult and cubs spend most of their time and some have more than one exit (Durner et al., 2003).

Ex situ cubbing dens are normally smaller, confined spaces adjacent to larger holding areas in which the female can move around. See Chapter 2, section 2.1 for a discussion on the size of the cubbing den recommended for polar bears in AZA-accredited zoos and aquariums. Remote monitoring of the cubbing den via video camera and microphone is strongly recommended, and can be accomplished by modifying the den to include a camera and low-level lighting prior to parturition. The use of video and audio equipment in the den has proven to be an excellent resource in the management of the cubs, and in sharing the experience with the public in a controlled forum.

Additional heat should not be required within the cubbing den. Cubbing facilities should have a layer of heavy bedding, such as straw that can provide insulation for the female and cubs. However, additional cooling may need to be provided for institutions with high ambient temperatures during the birthing season. If ambient temperatures are abnormally high when the cubs are born, the female may become overheated and abandon them. Ambient temperatures below 64.4°F (18°C) may be appropriate (Kenny & Bickel, 2005). As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed". A 17.8" (45cm) high cubbing gate can be used to prevent the cub(s) from following their mother out of the den when they become mobile (Kenny & Bickel, 2005).

Cubs should not have access to large pools until they are old enough to swim, usually at about 4-5 months of age (Greenwald & Dabek, 2003). However access to pools and water is important and some facilities design in a small pool in the holding area associated with the denning box for this purpose. If possible, pool water levels should be initially lowered to desensitize the cubs to water, and to ensure that they are able to get out of the pool. As with other mammalian neonates, the birthing area and any holding areas associated with it should be free of places where the cubs could fall or get their heads, feet, or body stuck. If hot-wire is used as part of the containment system for the polar bear habitat, consideration should be given as to whether this is needed when cubs are present, and whether there is any possibility of cubs gaining access to live hot wire.

7.5 Assisted Rearing

There are times when both *in situ* and *ex situ* polar bear females are not able to care for their offspring properly. Challenges that have been associated with mother-rearing of polar bear cubs include females not producing sufficient milk, females abandoning the cubs if conditions or birthing facilities are not optimal, and in extreme cases, females killing and eating the cubs in response to extreme stressors in the environment. If it is necessary to hand-rear a young polar bear, every effort should be made to find a conspecific to raise it with as early as possible. Hand-rearing protocols should be established prior to parturition. Each institution should develop a protocol that works best for them based on the staff and facilities available, and should contact the AZA Polar Bear SSP Program Coordinator to provide information from institutions that have successfully hand-reared polar cubs in the past.

Once the decision is made to hand-rear polar bear cubs (or provide any sort of assisted rearing at any time), it will not be possible to return the cubs to the female when their condition improves or they have been stabilized as she will not accept them. If cubs cannot be hand-reared with siblings or similar-aged conspecifics, efforts should be made to introduce them to older cubs that have been successfully weaned from their mothers. Over-familiarization with or over-reliance on human caretakers should be avoided in order to promote normal behavioral development and to increase the likelihood that they will be able to successfully reproduce and rear their own offspring as adults.

Incubation: Polar bear neonates hand-reared at the Denver Zoo were initially maintained in an incubator at 84.2-87.8°F (29-31°C) until about two weeks of age, when their thermoregulatory abilities improved due to the replacement of their natal coats with longer guard hairs and undercoat (Kenny & Bickel, 2005). At around two weeks of age, the cubs were visibly distressed when kept at these warm conditions, and the their vocalizations and abnormal activity levels did not decrease until the temperature was decreased to 64.4°F (18°C) (Kenny & Bickel, 2005).

Infant Formula: If the cubs have not had the opportunity to nurse, then polar bear serum should be administered. It is recommended that serum be administered at 3-5ml per pound of body weight in two doses spaced 5-10 days apart (G. Hedberg, personal communication, 2005). Most institutions that have hand-reared polar bear cubs have used either a combination of milk products (cream or half and half) with Esbilac®, various dilutions of Esbilac®, or a combination of Esbilac® and another milk replacer (such as Multi Milk® or Enfamil®). Medical problems associated with formula composition including rickets/vitamin D deficiency (Kenny et al., 1999), thiamin deficiency (Hess, 1971), lactobezors (indigestible lumps of casein in ursids that can have serious health implications), constipation, dehydration, and bloating (Kenny et al., 1999) have been noted in some cubs. Pediatric vitamins are added to milk formulas by most institutions with experience hand-rearing polar bears, but may not be necessary if a nutritionally complete milk replacer is used. Polar bear milk is low in lactose (Urashima et al., 2000), however, most milk replacers are bovine based and contain significant amounts of lactose. The ability of polar bear cubs to digest lactose has not been determined. For this reason, formula predigested with a lactase enzyme preparation (Lacteeze®) has been successfully employed by some institutions. Cod liver oil has been frequently added to formulas, however, a number of cubs have been raised successfully without it. Reducing casein (a milk protein) and increasing whey in the formula can help prevent lactobezors. Examples of formulas used successfully to hand-rear polar bears cubs at the San Francisco Zoo, Brookfield Zoo, and San Diego Zoo are provided in Appendix I. Comparisons of the nutrient compositions of these formulas are provided in Lintzenich et al., (2006).

Feeding/intake: As a guideline, cubs should be fed 15-25% of their body weight per day, not to exceed 5% per feeding. It is important that the cub be weighed at the same time each day. Quantities of food can gradually be tapered off to 10-20% of body weight by 90 days of age. Initially, feedings should be offered around the clock, evenly spaced 2-3 hours apart. The feeding regime should be reflective of the cub's health status. By one month of age, feedings can be reduced to 5-7 times per day, and the number of feedings should be gradually reduced until weaning.

A variety of human infant bottles have been used for hand-rearing polar bears, including preemie and orthodontic "Nuk" nipples. Playtex® nipples may prevent chafing of the cub's nose. Elongated nipples and those designed for human infants with cleft palates have also been utilized. A hole in the nipple may need to be opened, and this should be done very carefully to prevent aspiration of formula flowing too quickly. If necessary, a nasogastric tube can be used to provide nourishment for an ill cub. However, close monitoring is essential to prevent infection at suture sites. Beginning at 90 days of age, syringes have been used successfully to offer formula to the cubs.

- *Feeding position*: When young polar bear cubs are fed, they should be placed in a sternal position – on their stomach on a flat surface (table). If cubs are held during feeding (e.g., in an upright or head-back position), there is a greater chance of aspiration and death. When placed in a sternal position, the cub will tend to paddle forward, but will become adjusted to this routine in time. Providing a rolled towel for the cub to push against during nursing will help control this movement.

- *Elimination*: To promote elimination, the cub should be held in a sternal position and the region extending from the belly to the anus gently stroked with a warm, moist cotton ball after every feeding. Only slight pressure is needed to help guide the fecal material through the digestive tract and out of the anal canal. After a week, this procedure need only be performed twice a day. After the cub begins eating solid food, this procedure can be performed once per day. Most cubs will defecate on their own at 8-10 weeks, if not sooner.

Weaning: *In situ* polar bear cubs nurse for up to 2-3 years in the wild. The age at which nursing transitions from nutritional dependence to social bonding with the sow however, is unclear. *In situ* weaning involves both nutritional and behavioral processes, while *ex situ* weaning typically refers to the cessation of bottle-feeding. The process of weaning polar bear cubs off the bottle (i.e., introduction them

to solids) can begin as early as 60 days, although 70-85 days is more common. Baby cereal, canned cat or dog food, and ground cat or dog food have been mixed with formula to introduce solid foods. At 3 months, most cubs can be offered dog kibble or omnivore biscuits; ground or soaked foods can be added at first before progressing to dry versions. Fish or fresh meats have been offered to hand-reared polar bear cubs as early as 100-110 days. The weaning process should be gradual, with only one variable changing at a time so that it is clear what effect the changing diet is having on the health and behavior of the cubs. For information on the physical separation of offspring from their mothers see Chapter 4, section 4.1.

Exercise: After hand-reared cubs start walking, it is vital that sufficient space and time be provided to allow them to run and climb, and they should be provided with low climbing structures and a shallow child's swimming pool (at 3-4 months of age). Cubs should be provided with a non-slip surface when learning to walk to prevent splaying. Safe enrichment initiatives should be provided to facilitate play behavior. Items such as stuffed animals (with no small removable parts) and heavy-duty plastic toys may be used. Veterinarian and curatorial staff should be consulted prior to offering novel objects to the cubs. See Chapter 8, section 8.2 for more information on environmental enrichment. Direct human contact (i.e., free contact) with hand-reared cubs should be ended when the cub is four months old in order to prevent injury to caretakers. Protected contact protocols are needed for interactions with all polar bears after this point in time. Cubs should not be allowed to imprint on specific animal care staff. Where possible, hand-reared cubs should be introduced to other, bears (preferably polar bears) of similar age and size as soon as possible. This should help elicit more natural behaviors and intra-specific activities. Introductions should follow those outlined for adults.

7.6 Contraception

Contraception techniques can be implemented to ensure that the *ex situ* population of polar bears remains at a healthy size. In addition to reversible contraception, reproduction can be prevented by separating the sexes or by permanent sterilization. In general, reversible contraception is preferable because it allows natural social groups to be maintained while managing the genetic health of the population. Permanent sterilization may be considered for individuals that are genetically well-represented, or for whom reproduction would pose health risks. The AZA Bear TAG and Polar Bear SSP Program should be consulted prior to any permanent contraceptive/sterilization approaches being taken. The contraceptive methods most suitable for polar bears are outlined below.

The progestin-based melengestrol acetate (MGA) implant has been associated with uterine and mammary pathology in felids, and similar pathologies are suspected in other carnivore species (Munson, 2006). Other progestins (e.g., Depo-Provera®, Ovaban®) are likely to have the same deleterious effects. For carnivores, the AZA Wildlife Contraception Center recommends GnRH agonists, e.g., Suprelorin® (deslorelin) implants or Lupron Depot® (leuprolide acetate), as safer alternatives, although dosages and duration of efficacy have not been systematically evaluated for all species. GnRH agonists can be used in either females or males, and side effects are generally associated with gonadectomy, especially weight gain, which should be managed through diet. Suprelorin® was developed for domestic dogs and has been used successfully in polar bears. Links to more details on products, application, and ordering information can be found on the AZA Wildlife Contraception Center (WCC) webpage: www.aza.org/wildlife-contraception-center/.

Gonadotropin releasing hormone (GnRH) agonists: GnRH agonists (e.g., Suprelorin® implants, or Lupron Depot®) achieve contraception by reversibly suppressing the reproductive endocrine system, preventing production of pituitary (FSH and LH) and gonadal hormones (estradiol and progesterone in females and testosterone in males). The observed effects are similar to those following either ovariectomy in females or castration in males, but are reversible. GnRH agonists first stimulate the reproductive system, which can result in estrus and ovulation in females or temporary enhancement of testosterone and semen production in males. Down-regulation then follows the initial stimulation. The stimulatory phase can be prevented in females by daily Ovaban administration for one week before and one week after implant placement (Wright et al., 2001).

GnRH agonists should not be used during pregnancy, since they may cause spontaneous abortion or prevent mammary development necessary for lactation. They may also prevent initiation of lactation by inhibiting progesterone secretion, although effects on established lactation are less likely. New data from

domestic cats have shown no effect on subsequent reproduction when treatment began before puberty; no research in prepubertal polar bears has been conducted.

A drawback of these products is that time of reversal cannot be controlled. Neither the implant (Suprelorin®) nor the depot vehicle (Lupron®) can be removed to shorten the duration of efficacy to time reversals. The most widely used formulations are designed to be effective for either 6 or 12 months, but these are for the most part minimum durations, and can be longer in some individuals. In one female, after the use of deslorelin during one breeding season, estrus behavior was not observed for 3 years.

Although GnRH agonists can also be an effective contraceptive in males, they are more commonly used in females, because monitoring efficacy by suppression of estrous behavior or cyclic gonadal steroids in feces is usually easier than ensuring continued absence of sperm in males; most institutions cannot perform regular semen collections. Suprelorin® has been tested primarily in domestic dogs, whereas Lupron Depot® has been used primarily in humans, but should be as effective as Suprelorin®, since the GnRH molecule is identical in all mammalian species. If used in males, disappearance of sperm from the ejaculate following down-regulation of testosterone may take an additional 6 weeks, as with vasectomy. It should be easier to suppress the onset of spermatogenesis in seasonally breeding species, and treatment should be initiated at least 2 months before the anticipated onset of breeding.

Progestins: If progestins (e.g., Melengestrol acetate (MGA) implants, Depo-Provera® injections, Ovaban® pills) have to be used, they should be administered for no more than 2 years and then discontinued to allow for a pregnancy. Discontinuing progestin contraception and allowing non-pregnant cycles does not substitute for a pregnancy. Use of progestins for more than a total of 4 years is not recommended. MGA implants last at least 2 years, and clearance of the hormone from the system occurs rapidly after implant removal. Progestins are considered safe to use during lactation. In particular, progestin treatment should not be initiated during the period of embryonic diapause, because early embryo development may be stimulated resulting in young being born in the wrong season.

Vaccines: The porcine zona pellucida (PZP) vaccine has not been tested in polar bears, but may cause permanent sterility in many carnivore species after only one or two treatments. This approach is not recommended for polar bears.

Ovariectomy or ovariohysterectomy: Removal of ovaries is a safe and effective method to prevent reproduction for animals that are eligible for permanent sterilization. In general, ovariectomy is sufficient in young females, whereas, removal of the uterus as well as ovaries is preferable in older females, due to the increased likelihood of uterine pathology with age.

Vasectomy: Vasectomy of males will not prevent potential adverse effects that can be experienced by females resulting from prolonged, cyclic exposure to the endogenous progesterone associated with the pseudo-pregnancy that follows ovulation. This approach is not recommended for polar bears.

Chapter 8. Behavior Management

8.1 Animal Training

Classical and operant conditioning techniques have been used to train animals for over a century. Classical conditioning is a form of associative learning demonstrated by Ivan Pavlov. Classical conditioning involves the presentation of a neutral stimulus that will be conditioned (CS) along with an unconditioned stimulus that evokes an innate, often reflexive, response (US). If the CS and the US are repeatedly paired, eventually the two stimuli become associated and the animal will begin to produce a conditioned behavioral response to the CS.

Operant conditioning uses the consequences of a behavior to modify the occurrence and form of that behavior. Reinforcement and punishment are the core tools of operant conditioning. Positive reinforcement occurs when a behavior is followed by a favorable stimulus to increase the frequency of that behavior. Negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus to also increase the frequency of that behavior. Positive punishment occurs when a behavior is followed by an aversive stimulus to decrease the frequency of that behavior. Negative punishment occurs when a behavior is followed by the removal of a favorable stimulus also to decrease the frequency of that behavior. AZA-accredited institutions are expected to utilize reinforcing conditioning techniques to facilitate husbandry procedures and behavioral research investigations.

The AZA Bear TAG and Polar Bea SSP Program recommend that all polar bear training be performed in a protected contact setting and trained through positive reinforcement and patience. A husbandry-training program should be implemented for more effective health care and trained behaviors can include separations, shifting between habitat areas, crating, physical/medical exams, oral exams, foot exams, x-rays, sonography, injections, weights, unrestrained blood sampling, sample collection, and blood pressure monitoring. These behaviors should be identified and prioritized in coordination with veterinarians and curators. A husbandry-training program not only aids in the early diagnosis and simple treatment of minor injuries or medical problems, but can also be enriching, because it mentally and physically challenges the bears to solve problems and perform specific behaviors. Polar bears can be easily trained to tolerate close proximity (protected contact) to caretakers (e.g., for visual inspections, etc.). Training techniques can be used to induce individuals to approach habitat sides/barriers for visual inspection and vaccination or contraceptive injections. Operant conditioning can also be used to promote natural behavior, and encourage better utilization of the habitat by the bears.

Most polar bears are very food oriented and can be trained to shift to other quarters when offered favorite food items. The appetite of the bears can vary seasonally, and training should be adjusted to accommodate this change. Predictable feeding schedules may lead to stereotypic behavior or anticipatory pacing, and should be avoided. With training, polar bears can respond well to a variety of secondary reinforcers and S^D's. Generally, adult bears should be separated from other adults prior to and during training sessions to prevent any aggressive interactions between bears, especially when food is offered as reinforcement.

Training protocol: Before starting to train a new behavior, it is important to develop a training plan for shaping the desired behavior (see www.animaltraining.org for information on setting up a training plan). The training plan should include the identity of the primary trainer, steps needed to reach the desired end, the proper S^D, and the criteria for the final behavior. There are dramatic seasonal motivational differences in polar bears that may affect training, and these should be considered in the training plan. It is recommended to include the veterinary and management staff in the development of the training plan. Veterinarians should also be involved in the training process itself, so that the bears experience positive reinforcement from veterinary staff as well as their primary trainer, and experience less apprehension in their presence. The AZA Bear TAG and Polar Bear SSP Program strongly suggest the use of 'meat sticks' as a safe tool that can be used to provide meat to bears during training in the protected contact setting. If keepers do not use meat sticks during training sessions, care should be taken that fingers do not enter the bear's space.

Teaching animals how to problem solve, increasing their level of activity and making learning a positive experience are important parts of the training process. A trusting, cooperative, respectful relationship needs to be developed with the bears before any true training progress can be made. Animal caretakers should concentrate on the constructive process of training such as strengthening their positive relationship and rapport with the bears by using a calm, pleasant voice, and avoiding any sudden

movement or loud noises which may upset the bears. By taking small steps and attainable approximations toward some final behavior, rewarding the bears' apparent motivation and attitude, teaching the basics of operant conditioning to the bears, making learning interesting, and allowing the animals every opportunity to succeed, the training process can become a positive, constructive, and stimulating experience. Many resources are available to assist in the development of a successful institutional animal training program and in the choice of appropriate husbandry and preventative medicine behaviors (e.g., www.torontozoo.com/meet_Animals/enrichment/polar_bear_conditioning.htm), Institutions caring for polar bears should become familiar with these and further develop and refine pre-existing approaches as appropriate.

Training area: All areas of the polar bear habitat should be designed to include a 'training area' that allows the bears and keepers to interact in protected contact. Institutions with multiple areas may wish to consider installing a squeeze cage (Sea World San Diego; Seneca Park Zoo) and a mesh door to facilitate training. This area, or any door to holding, should not be hidden, as bears are likely to remain close by to look/listen/smell for their keepers instead of being on exhibit. A training area that allows for the animal's entire body length to be adjacent to the mesh is recommended. An L-shaped area allows both the trainer and vet (or other specialists) to work with the animal at the same time. Mesh size should allow for the behaviors that will be trained. A 2" x 2" (5cm x 5cm) 6-gauge mesh allows bears to put a nose or claw through and allow the trainer to see the oral cavity when its mouth is opened.

Undesirable behaviors: Positive punishment should not be used in polar bear training, but 'time-outs' are a suitable form of negative punishment. It can be difficult to extinguish undesirable behaviors like door-banging. Animal care staff should not attempt to discourage unwanted behaviors, but should instead ignore them and reinforce behaviors that are inconsistent with these behaviors. Trainers should be careful to avoid inadvertently reinforcing undesirable behaviors like stereotypy and aggression. Husbandry behaviors that have been successfully trained using reinforcing conditioning techniques with polar bears include scale training, mouth open, eye open for administration of eye drops, injection, paw presentation, gating, and stationing. Research behaviors that have been successfully trained include auditory recognition testing.

8.2 Environmental Enrichment

Environmental enrichment, also called behavioral enrichment, refers to the practice of providing a variety of stimuli to the polar bear's environment, or changing the environment itself to increase physical activity, stimulate cognition, and promote natural behaviors. Stimuli, including natural and artificial objects, scents, and sounds are presented in a safe way for polar bears to interact with. Some suggestions include providing food in a variety of ways (i.e., frozen in ice or in a manner that requires the animal to solve simple puzzles to obtain it), using the presence or scent/sounds of other animals of the same or different species, and incorporating an animal training (husbandry or behavioral research) regime in the daily schedule.

Enrichment programs for polar bears should take into account the natural history of the species, individual needs of the animals, and facility constraints (including the water filtration system). The polar bear enrichment plan should include the following elements: goal-setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. Environmental enrichment programs should ensure that all environmental enrichment devices (EEDs) are polar bear "safe" and are presented on a variable schedule to prevent habituation. AZA-accredited institutions must have a formal written enrichment program that promotes polar bear -appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1). AZA-accredited institutions must have specific staff members assigned to oversee, implement, train, and coordinate interdepartmental enrichment programs (AZA Accreditation Standard 1.6.2).

AZA Accreditation Standard

(1.6.1) The institution must have a formal written enrichment program that promotes species-appropriate behavioral opportunities.

AZA Accreditation Standard

(1.6.2) The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

Enrichment should be based on desirable behavioral goals for the polar bears and evaluated on a regular basis. Enrichment approval processes developed by institutions should include veterinarians, nutritionists (for enrichment initiatives that are food-based or can be ingested), curatorial staff, and animal

keepers. This coordination will serve to ensure each enrichment initiative is carefully considered from the perspective of the health of the bears, the structural integrity of the habitat, the potential for self or conspecific injury, disease transmission, weight loss/gain, and visitor safety.

Enrichment has been shown to have a particularly positive influence on the behavior of developing cubs, and care should be taken to provide complex environments during this critical period to prevent the development of abnormal behaviors in the adult animal. Greenwald & Dabek (2003) hypothesize that a low level of object manipulation or carrying, shown by cubs at around 8 months of age, may have been caused by a lack of novel objects in the environment earlier in development. Novel items were found to elicit exploratory behavioral responses that were not observed when the bears encountered objects that were present in the habitat every day (Greenwald & Dabek, 2003). Specific types of enrichment initiatives, including puzzle feeders, additional habitat furniture, scents, and physical toys, was found to effectively reduce stereotypic behaviors in polar bears (Shyne, 2006). Additionally, Altman (1999) found that manipulable EEDs greatly increased the activity levels and visibility of the polar bears. As additional enrichment studies are completed, the results should be incorporated into institutional plans and shared with the AZA Bear TAG, Polar Bear SSP Program, and the zoological community.

Enrichment opportunities for polar bears may include, but are not limited to: the provisioning of live fish and invertebrates; hiding peanut butter, lard, fruits, etc.; kelp; browse (e.g., straw, alfalfa, bamboo, ficus, pine, willow, palm fronds, etc.) in rock-face cavities or other areas of the habitat; introduction of tactile materials such as shrubs, trees, wood shavings, cardboard, ice and snow (block, cubes or shavings in large piles, etc.), soft bones, dirt, sod, moss, sand, gravel, branches, tree stumps, as well as artificial EEDs. Large floating objects should also be available in the pool. These items can be combined with other enrichment devices or food in an effort to create novelty. Plant materials introduced into, or growing in or around the habitat should be screened for a number of criteria including, but not limited to: known toxicities to comparable species such as dogs, cats, and humans (Burrows & Tyrl, 2001); potential to cause obstruction of the gastrointestinal tract, physical irritation; and exposure to pesticides, herbicides, and other noxious chemicals that could harm the bears. Additional ideas for polar bear enrichment are listed below and can also be found in various publications and on the following websites: www.animalenrichment.org and www.enrichmentonline.org.

Objects

- 55 gal barrels
- Cut-up lengths of rubber and canvas hoses
- PVC pipes
- Beer kegs and plastic water cooler jugs
- Plastic buckets
- Burlap bags
- Tires: tractor, car, golf cart – not steel-belted
- Cardboard boxes and carpet tubes
- Plastic garbage cans and lids
- “Jolly” brand balls (marketed for horses)
- Sports balls: soccer, volley, basket, footballs
- “Fortex” brand rubber tubs
- Traffic cones
- Heavy duty plastic outdoor play equipment with hardware removed: sleds, pools, picnic tables, wagons, climbing structures. (“Little Tikes” brand is very sturdy)
- Digestible nylabones
- Grapevine wreaths
- Hoof stock hair
- Rubber pipeline balls
- Phone books
- Cardboard piñatas
- Papier-mâché balls
- “Boomer” brand balls w/ and w/o sawed holes for foraging

Browse

- Willow, Mulberry, Alder Bark chips, Box Elder, Ash
- Poplar, Maple, Aspen, Elm, Grapevines

Food

- Honey
- Peanuts
- Flowers
- Grapes/raisins
- Eggs
- Peanut butter
- Blueberries
- Applesauce
- Unhusked corn
- Flavored and natural rawhides
- Freeze-dried liver treats (marketed for dog training)
- Pumpkins
- Watermelons
- Other seasonal fruit
- Calf carcasses
- Comb honey
- Cheerios
- Crayfish and live fish
- Kelp
- Cow hooves and ears, smoked & plain
- Ice treats made with sugar-free flavored powdered drink mix
- Pig ears and snouts

Scents & sounds

- Any cologne or perfume
- Spices: oregano, garlic, mint, allspice, nutmeg, cinnamon, ginger, pepper
- Seal vocalizations
- Catnip
- Scented items from other species e.g., other bears, porcupine, aardwolf, meerkat, jackal

Substrates

- Cedar mulch
- Straw
- Chipped pine trees
- Wood wool – excelsior

8.3 Staff and Animal Interactions

Most polar bears quickly adapt to daily routines, shifting readily between habitat areas, as well as participating in training to allow routine and non-routine veterinary tasks to be performed. The relationship between polar bears and keepers is an important contributing factor in terms of the success of animal training and management approaches. Staff should be attentive to any changes in the appearance, appetite, behavior and stool/feces of the polar bears under their care. Ideally, holding areas and the habitat should provide staff with the opportunity to observe the bears at least twice daily. Polar bears may quickly recognize familiar keepers by their voice, scent, movement, and other behaviors, and respond differently to familiar and unfamiliar staff members. Feeding, enrichment, and training of the bears through bars, wire, or other containment surfaces allows for animal/staff reinforcement and the building of trusting relationships, as well as providing an opportunity for the administration of medication as necessary.

Human-Animal Contact: Polar bears can easily cause injury or death to other polar bears or humans. Great care should also be used when working with hand-reared cubs, as they may appear very tame toward humans and direct human contact should be terminated when the cub is four months old. These cubs are capable of injuring caretakers, and staff should always use protected contact for interactions with all polar bears after this point in time (and at all times for mother-reared cubs). It is imperative that keepers follow the safety protocols set up by their institution when working with hand-reared animals.

Ensuring that doors, gates, and guillotines are secure is critical when working with polar bears. A system of redundant locking mechanisms and keeper labels on entrances, gates, and doors help to ensure that staff does not enter a habitat area while animals are present. Keepers should always follow their institution's lock check protocol when working with polar bears; some institutions require keepers to carry pepper spray as one form of personal protection and others require two keepers to physically check animal locations and locks before someone enters a habitat area. Where possible, the presence of two keepers is recommended, especially when shifting the animals. In addition to staff safety concerns, two secured doors should separate bears from the public. Institutions should develop their own institutional protocols for all staff interactions with bears on and off-exhibit.

8.4 Staff Skills and Training

Polar bear staff members should be trained in all areas of polar bear behavior management. Funding should be provided for AZA continuing education courses, related meetings, conference participation, and other professional opportunities. All animal care staff working with polar bears need to be familiar with the husbandry and daily routines necessary for maintaining large, dangerous carnivores, as well as with operant conditioning techniques that can be used in the routine management of these animals. Websites

such as www.animaltraining.org and www.animalenrichment.org provide examples of comprehensive frameworks for developing training and enrichment programs. Staff should be encouraged to attend conferences, classes, and seminars sponsored by professional behavior and training organizations including the International Marine Animal Trainers Association (IMATA) and the American Behavior Management Alliance (ABMA). The AZA Bear TAG and Polar Bear SSP Program also offer occasional workshops in conjunction with organizations such as Polar Bears International, to provide up-to-date information on polar bear care, management, and research in zoos and aquariums. The AZA Polar Bear SSP Program can be contacted for more information on the availability of these educational opportunities.

As polar bears are dangerous animals, staff training for emergencies must also be undertaken, and records of such training maintained. Security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of the institution and in some cases, may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2). Each institution must develop their own staff training protocols for any emergency situation that might involve the polar bears housed within their institutions. See Chapter 2, section 2.2 for additional information on emergency protocols and procedures.

A reference library appropriate to the size and complexity of the institution should be available for all staff and volunteers to provide them with accurate information on the behavioral needs of the animals with which they work.

Chapter 9. Research

9.1 Current Investigations

AZA asserts that contemporary polar bear management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected to, conduct or facilitate research both in *in-situ* and *ex-situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. This knowledge might be achieved by participating in AZA Bear TAG or Polar Bear SSP Program sponsored research, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials (AZA Accreditation Standard 5.3). Research and conservation are very much a priority for polar bears. The following excerpt, taken from the Polar Bears International website, illustrates the continued commitment needed to ensure the long-term survival of this species:

AZA Accreditation Standard

(5.3) Institutions should maximize the generation of scientific knowledge gained from the animal collection. This might be achieved by participating in AZA TAG/SSP sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

> "Scientists predict that, if current warming trends continue in the Arctic, two-thirds of the world's polar bears could disappear by 2050. At the 2005 meeting of the IUCN Polar Bear Specialist Group (Seattle), the world's leading polar bear scientists reported that of the 19 subpopulations of polar bears, five were declining, five were stable, two were increasing, and seven had insufficient data to make a determination. The group reclassified the polar bear as vulnerable on the IUCN World Conservation Union's "Red List of Threatened Species", noting that the species could become extinct due to sea ice changes. Individual countries with polar bears have reclassified the species as well. Citing concerns about shrinking sea ice habitat, the U.S. Department of the Interior announced on May 14, 2008, that it is listing the polar bear as a Threatened Species under the Endangered Species Act. Canada and Russia both list the polar bear as "a species of concern". The major threat to the polar bear is shrinking sea ice habitat due to climate change. Other threats include pollution, poaching, and industrial disturbances. Hunting could become a threat if populations are not well managed".

Organizations such as Polar Bears International and individual research scientists continue to play a key role in performing and completing research projects that provide additional information for the best approaches to take to manage *in situ* and *ex situ* polar bear populations. Information on key scientists in the field, and funded research projects that address animal management, conservation, and education, can be found on the AZA Marine Mammal Conservation webpage (http://www.aza.org/marine-mammal-cons/) and the Polar Bears International website (www.polarbearsinternational.org).

Research methodologies and goals: Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of polar bears and may provide results which benefit the health or welfare of *in situ* populations of polar bears. Many AZA-accredited institutions incorporate superior positive reinforcement training programs into their routine schedules to facilitate sensory, cognitive, and physiological research investigations and these types of programs are strongly encouraged by the AZA.

The following studies are being conducted to provide valuable information about polar bears and more information about each can be obtained from the AZA Polar Bear SSP.

- *Audition*: The response of polar bears to noise stimuli is being assessed to determine whether there are any implications to the management of bears in zoos and aquariums (e.g., assessing noise and vibration from zoo and aquarium equipment and activities), and for the management of *in situ* populations that may be exposed to industrial noise (e.g., drilling, snowmobiling, etc.).
- *Behavioral research*: Several studies are being carried out that focus on changes in the behavior of polar bears moved from old to new habitats, and provided with enrichment initiatives. Bears showing stereotypic behaviors remain a focus for this type of behavioral research.

- *Contraception*: The effects of contraception on the reproductive tract of carnivores, including polar bears, is an on-going research focus.
- *Estrous cycle research*: Using a multi-disciplinary approach, research is being performed to identify the estrous cycle of polar bears using vaginal cytology, changing levels of reproductive hormones assessed from fecal samples, and from male/female behavioral interactions. Fecal hormone monitoring is also being utilized to develop a valid pregnancy diagnosis tool that has potential implications for the management of the *ex situ* population and for monitoring the reproductive activity of *in situ* populations.
- *Mother-offspring behavior*: Research into the behavioral interactions of mothers and cubs in dens is being undertaken, with a special focus on acoustic communication. This research will also have relevance to the management of *in situ* populations that may be exposed to industrial noise near to maternal denning areas.
- *Olfaction:* A multi-institutional study is currently investigating the olfactory behavior and abilities of polar bears associated with pedal scents taken from reproductively active females and males. The chemical components of pedal scents and the response of bears to these scents will be analyzed.
- *Sperm sampling and cryo-preservation*: The potential for collecting and cryo-preserving viable sperm from post-mortem male polar bears is being investigated. With appropriate protocols and methodologies, this research could help with the development of a polar bear sperm bank.
- *Veterinary care*: There are multiple projects in progress that focus on *ex situ* polar bear health including the role of endogenous hormone fluctuations in alopecia/dermatitis; improved control measures for helminth parasites; a multi-institutional fecal survey focusing on *Balyascaris*; and a study on aging and bone loss in polar bears.

The AZA Bear TAG and Polar Bear SSP Program communicate directly with AZA-accredited institutions housing polar bears to encourage participation in on-going research programs, or to seek input on the development of potential research priorities, and additional information is often shared via the AZA Polar Bear SSP Program listserv.

Research policy: AZA-accredited institutions are required to have a clearly written research policy that identifies the types of polar bear research being conducted, methods used, staff involved, evaluations of the projects, the animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified individual to oversee and direct its research program (AZA Accreditation Standard 5.1). If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by AZA Bear TAG and Polar Bear SSP Program.

AZA Accreditation Standard

(5.2) Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

AZA Accreditation Standard

(5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

9.2 Future Research Needs

The Polar Bear Care Manual is a dynamic document that will be updated as new information is acquired. Knowledge gaps have been identified throughout the manual and are included in this section to promote future research investigations and discussions about what priority research should be. In addition to the on-going research identified throughout the manual and in section 9.1, knowledge gained from research to address these gaps will maximize AZA-accredited institutions' capacity for excellence in animal care and welfare, as well as enhancing conservation initiatives for the species. The following areas have been identified as knowledge gaps within this manual:

Temperature and humidity: More research is recommended to determine and identify what effect humidity levels have on polar bear health and behavior, and to determine if there is an optimal temperature and humidity range for zoo and aquarium environments. Research is also needed on the type of resources

(e.g., habitat designs, furniture, substrates, etc.) polar bears need in order to regulate their temperatures within a wide range of ambient environmental conditions.

Artificial insemination: Artificial insemination of polar bears has not been attempted and no protocols are in place to address this subject at this time. The potential for collecting and cryo-preserving viable sperm from post-mortem male polar bears is currently being investigated. With appropriate collection and storage protocols and methodologies, this research could facilitate the development of a polar bear sperm bank. Research into female estrus and pregnancy assessment using fecal samples is also being performed, and could play a role in artificial inseminations procedures for this species in the future.

Contraception: The development of a predictably short term and safe contraceptive is needed.

Euthanasia: Research is also needed into appropriate euthanasia protocols for polar bears, and the types of animal welfare questions that should be considered when considering elective euthanasia decisions for these animals.

Exhibit design: Research is encouraged to determine if innovative pool designs and shapes, such as donut-shaped pools, may decrease water-based stereotypic behaviors in zoo and aquarium polar bears.

Group size: Polar bears typically do well alone or in groups, given appropriate amounts of enrichment and space. Individual bear temperaments play an important role in the success of social groupings. One study has shown that males exhibit decreased levels of stereotypic behavior with increased numbers of females present (Shepherdson et al., 2005). Additional research is needed to determine the long term effects of different group sizes and structures.

Light: No information is available about the impact of and need for daily changes in light intensity and seasonal changes in light intensity and duration; more research is required on this topic to determine if there is a relationship between changing light levels and behavioral or physiological (e.g., reproductive) changes in the bears.

Metabolic Rates: Research into the amount of oxygen consumed/energy expended during rest, walking, running, or swimming is encouraged. Results from such investigations can have direct implications for conservation of wild polar bears and would fill in important gaps in physiological knowledge.

Nutrition: *Ex situ* polar bear diets are based on known requirements for related domestic animals and other species of bears in zoos and aquariums. In order to formulate more accurate dietary recommendations for polar bears, additional research is needed to determine the nutritional requirements for this species. More in-depth data collections that specifically record intakes and body weight changes across seasons are a priority.

Reproduction: More information is needed to utilize hormonal tracking as a mechanism for identifying reproductive state, assessing feasibility of introductions, and determining if this is a useful and possible approach to assist in the reproductive management of polar bears. Research on the effects that GnRH agonists have on future reproductive abilities when provided to prepubertal polar bears as a contraceptive is also needed.

Sound and vibration: Research into the responses of polar bears to sounds and vibrations is currently underway, but a continued focus on the welfare issues that may result from exposure to these stimuli, and methods of minimizing the effect of these stimuli should help to develop management recommendations and habitat designs that best meet the needs of the *ex situ* animals.

Veterinary care: There are several polar bear diseases, disorders, and potential health issues that may warrant further research to improve the veterinary management recommendations that can be made for polar bears in zoos and aquariums. Additional information is needed on successful treatment approaches for many of the issues described in Chapter 6, sections 6.5 and 6.7, and any relevant information should be reported to the AZA Polar Bear SSP Program Veterinary Advisor for further dissemination. The AZA Polar Bear SSP Program Veterinary Advisor is particularly interested in diagnoses and treatments of alopecia (successful and otherwise), as this topic is currently a research focus. The issue of reproductive hormonal imbalances affecting alopecia also remains under investigation.

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Personal Communications:

Amstrup, Steven. U.S. Geological Survey, Alaska Science Center
Hedberg, Gail. Senior Veterinary Technician, San Francisco Zoological Gardens
Kolter, Lydia. EAZA Bear TAG Chair
Mengel, Tim. Animal Management Supervisor, North Carolina Zoo
Moore, Don. Associate Director of Animal Care, Smithsonian Institution's National Zoo
Weinhardt, Diana. Director of Conservation and Wildlife Programs, Alaska Wildlife Conservation Center

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www.polarbearsinternational.org

Complete Polar Bear Bibliography and Reference List:

http://www.polarbearsinternational.org/guravich-memorial-bibliography/all/

Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to polar bears are taken from the AZA Accreditation Standards and Related Policies (AZA, 2010) and are referenced fully within the chapters of this animal care manual:

General Information

(1.1.1) The institution must comply with all relevant local, state, and federal wildlife laws and regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

Chapter 1

(1.5.7) The animal collection must be protected from weather detrimental to their health.

(10.2.1) Critical life-support systems for the animal collection, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

(1.5.9) The institution must have a regular program of monitoring water quality for collections of fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Chapter 2

(1.5.2) Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being; and exhibit enclosures must include provisions for the behavioral enrichment of the animals.

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

(11.3.6) Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

(11.2.3) All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

(11.6.3) Stored firearms must be in a locked cabinet of sufficient construction and design to impede unauthorized entry, and located in a secure area and accessible only to authorized personnel trained in their use.

(11.6.2) Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e., shooting teams).

(11.2.4) The institution must have a communication system that can be quickly accessed in case of an emergency.

(11.2.5) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

(11.5.3) Institutions maintaining potentially dangerous animals (sharks, whales, tigers, bears, etc.) must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

Chapter 3

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to.

Chapter 5

(2.6.2) A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

(2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

(2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

(2.6.4) The institution should assign at least one person to oversee appropriate browse material for the collection.

Chapter 6

(2.1.1) A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animal collection 24 hours a day, 7 days a week.

(2.2.1) Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes and appropriate security of the drugs must be provided.

(1.4.6) A staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all animal care staff members apprised of relevant laws and regulations regarding the institution's animal collection.

(1.4.7) Animal records must be kept current, and data must be logged daily.

(1.4.5) At least one set of the institution's historical animal records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

(1.4.4) Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions in the animal collection.

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all staff working with quarantined animals.

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

(2.5.1) Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

(2.4.1) The veterinary care program must emphasize disease prevention.

(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

(2.3.2) Hospital facilities should have x-ray equipment or have access to x-ray services.

(2.4.2) Keepers should be trained to recognize abnormal behavior and clinical symptoms of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint

procedures required for the animals under their care. However, keepers should not evaluate illnesses nor prescribe treatment.

(1.5.8) The institution must develop a clear process for identifying and addressing animal welfare concerns within the institution.

Chapter 8

(1.6.1) The institution must have a formal written enrichment program that promotes species-appropriate behavioral opportunities.

(1.6.2) The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

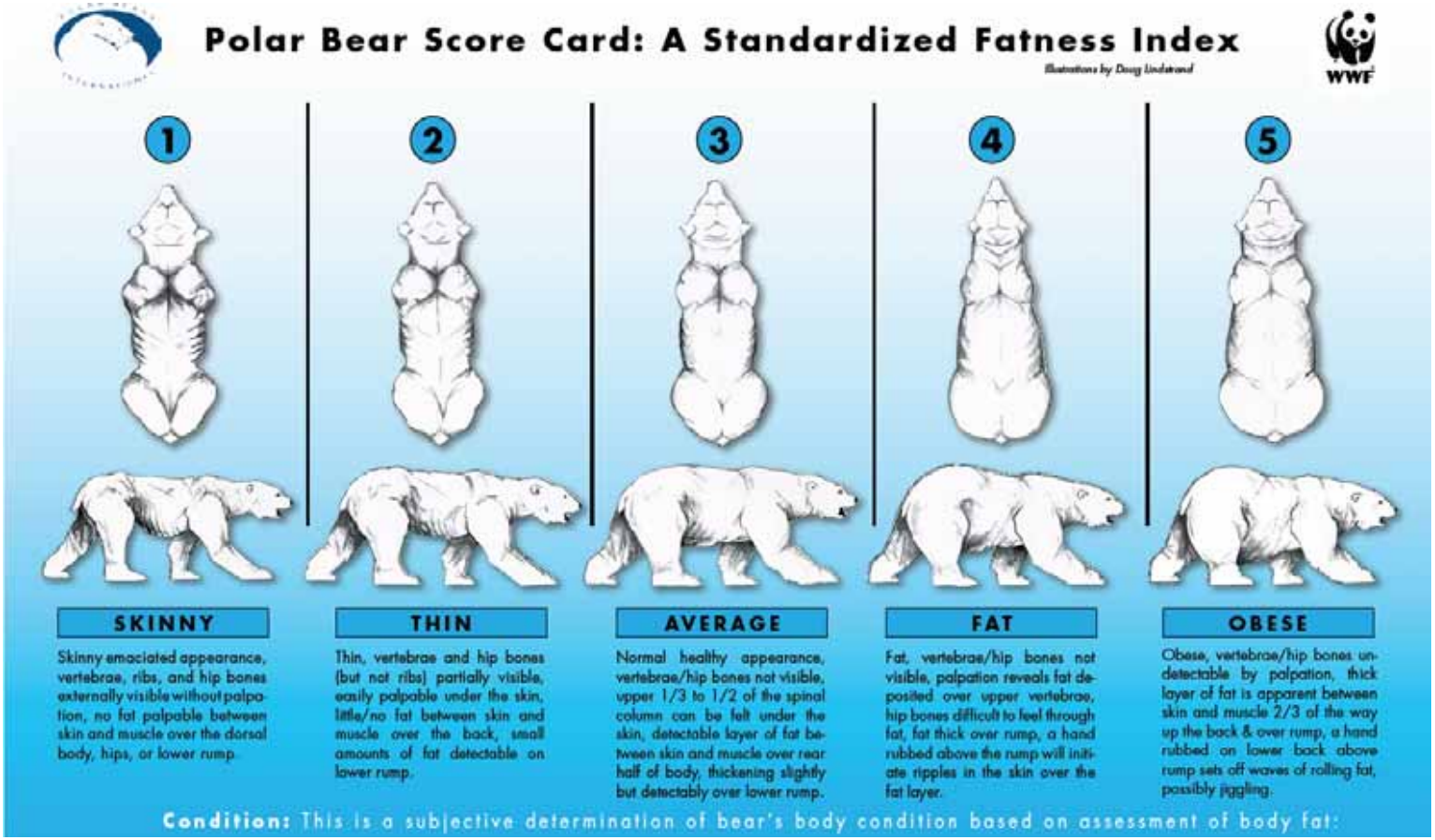
Chapter 9

(5.3) Institutions should maximize the generation of scientific knowledge gained from the animal collection. This might be achieved by participating in AZA TAG/SSP Program sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

(5.2) Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

(5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

Appendix B: Polar Bear Body Condition Score Sheet



Appendix C: Acquisition/Disposition Policy

I. Introduction: The Association of Zoos and Aquariums (AZA) was established, among other reasons, to foster continued improvement in the zoological park and aquarium profession. One of its most important roles is to provide a forum for debate and consensus building among its members, the intent of which is to attain high ethical standards, especially those related to animal care and professional conduct. The stringent requirements for AZA accreditation and high standards of professional conduct are unmatched by similar organizations and also far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. AZA member facilities must abide by a Code of Professional Ethics - a set of standards that guide all aspects of animal management and welfare. As a matter of priority, AZA institutions should acquire animals from other AZA institutions and dispose of animals to other AZA institutions.

AZA-accredited zoological parks and aquariums cannot fulfill their important missions of conservation, education and science without living animals. Responsible management of living animal populations necessitates that some individuals be acquired and that others be removed from the collection at certain times. Acquisition of animals can occur through propagation, trade, donation, loan, purchase, capture, or rescue. Animals used as animal feed are not accessioned into the collection.

Disposition occurs when an animal leaves the collection for any reason. Reasons for disposition vary widely, but include cooperative population management (genetic or demographic management), reintroduction, behavioral incompatibility, sexual maturation, animal health concerns, loan or transfer, or death.

The AZA Acquisition/Disposition Policy (A/D) was created to help (1) guide and support member institutions in their animal acquisition and disposition decisions, and (2) ensure that all additions and removals are compatible with the Association's stated commitment to "save and protect the wonders of the living natural world." More specifically, the AZA A/D Policy is intended to:

- Ensure that the welfare of individual animals and conservation of populations, species and ecosystems are carefully considered during acquisition and disposition activities;
- Maintain a proper standard of conduct for AZA members during acquisition and disposition activities;
- Ensure that animals from AZA member institutions are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them.
- Support the goal of AZA's cooperatively managed populations and associated programs, including Species Survival Plans (SSPs), Population Management Plans (PMPs), and Taxon Advisory Groups (TAGs).

The AZA Acquisition/Disposition Policy will serve as the default policy for AZA member institutions. Institutions may develop their own A/D Policy in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and disposition standards.

Violations of the AZA Acquisition/Disposition Policy will be dealt with in accordance with the AZA Code of Professional Ethics. Violations can result in an institution's or individual's expulsion from membership in the AZA.

II. Group or Colony-based Identification: For some colonial, group-living, or prolific species, such as certain insects, aquatic invertebrates, schooling fish, rodents, and bats, it is often impossible or highly impractical to identify individual specimens. These species are therefore maintained, acquisitioned, and disposed of as a group or colony. Therefore, when this A/D Policy refers to animals or specimens, it is in reference to both individuals and groups/colonies.

III. Germplasm: Acquisition and disposition of germplasm should follow the same guidelines outlined in this document if its intended use is to create live animal(s). Ownership of germplasm and any resulting animals should be clearly defined. Institutions acquiring or dispositioning germplasm or any animal parts or samples should consider not only its current use, but also future possible uses as new technologies become available.

IV(a). General Acquisitions: Animals are to be acquisitioned into an AZA member institution's collection if the following conditions are met:

1. Acquisitions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all acquisitions.
3. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals.
4. Animals that are acquired for the collection, permanently or temporarily, must be listed on institutional records. All records should follow the Standards for Data Entry and Maintenance of North American Zoo and Aquarium Animal Records Databases®.
5. Animals may be acquired temporarily for reasons such as, holding for governmental agencies, rescue and/or rehabilitation, or special exhibits. Animals should only be accepted if they will not jeopardize the health, care or maintenance of the animals in the permanent collection or the animal being acquired.
6. The institution must have the necessary resources to support and provide for the professional care and management of a species, so that the physical and social needs of both specimen and species are met.
7. Attempts by members to circumvent AZA conservation programs in the acquisition of SSP Program animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP Program in efforts to acquire SSP Program species and adhere to the AZA Full Participation policy.
8. Animals are only to be acquired from sources that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this policy. Any convictions of state, federal, or international wildlife laws should be reviewed, as well as any previous dealings with other AZA-accredited institutions.
9. When acquiring specimens managed by a PMP, institutions should consult with the PMP manager.
10. Institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved Regional Collection Plans (RCPs) when making acquisition decisions.

IV(b). Acquisitions from the Wild: The maintenance of wild animal populations for education and wildlife conservation purposes is a unique responsibility of AZA member zoos and aquariums. To accomplish these goals, it may be necessary to acquire wild-caught specimens. Before acquiring animals from the wild, institutions are encouraged to examine sources including other AZA institutions or regional zoological associations.

When acquiring animals from the wild, careful consideration must be taken to evaluate the long-term impacts on the wild population. Any capture of free-ranging animals should be done in accordance with all local, state, federal, and international wildlife laws and regulations and not be detrimental to the long-term viability of the species or the wild or captive population(s). In crisis situations, when the survival of a population is at risk, rescue decisions are to be made on a case-by-case basis.

V(a). Disposition Requirements – living animals: Successful conservation and animal management efforts rely on the cooperation of many entities, both within and outside of AZA. While preference is given to placing animals within AZA member institutions, it is important to foster a cooperative culture among those who share the primary mission of AZA-accredited facilities. The AZA draws a strong distinction between the mission, stated or otherwise, of non-AZA member organizations and the mission of professionally managed zoological parks and aquariums accredited by the AZA.

An accredited AZA member balances public display, recreation, and entertainment with demonstrated efforts in education, conservation, and science. While some non-AZA member organizations may meet minimum daily standards of animal care for wildlife, the AZA recognizes that this, by itself, is insufficient to warrant either AZA membership or participation in AZA's cooperative animal management programs. When an animal is sent to a non-member of AZA, it is imperative that the member be confident that the animal will be cared for properly.

Animals may only be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all dispositions.
3. Any disposition must abide by the Mandatory Standards and General Advisories of the AZA Code of Professional Ethics. Specifically, "a member shall make every effort to assure that all animals in his/her collection and under his/her care are disposed of in a manner which meets the current disposition standards of the Association and do not find their way into the hands of those not qualified to care for them properly."
4. Non-domesticated animals shall not be disposed of at animal auctions. Additionally, animals shall not be disposed of to any organization or individual that may use or sell the animal at an animal auction. In transactions with AZA non-members, the recipient must ensure in writing that neither the animal nor its offspring will be disposed of at a wild animal auction or to an individual or organization that allows the hunting of the animal.
5. Animals shall not be disposed of to organizations or individuals that allow the hunting of these animals or their offspring. This does not apply to individuals or organizations which allow the hunting of only free-ranging game species (indigenous to North America) and established long-introduced species such as, but not limited to, white-tailed deer, quail, rabbit, waterfowl, boar, ring-necked pheasant, chukar, partridge, and trout. AZA distinguishes hunting/fishing for sport from culling for sustainable population management and wildlife conservation purposes.
6. Attempts by members to circumvent AZA conservation programs in the disposition of SSP Program animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP Program in efforts to deacquisition SSP Program species and adhere to the AZA Full Participation policy.
7. Domesticated animals are to be disposed of in a manner consistent with acceptable farm practices and subject to all relevant laws and regulations.
8. Live specimens may be released within native ranges, subject to all relevant laws and regulations. Releases may be a part of a recovery program and any release must be compatible with the AZA Guidelines for Reintroduction of Animals Born or Held in Captivity, dated June 3, 1992.
9. Detailed disposition records of all living or dead specimens must be maintained. Where applicable, proper animal identification techniques should be utilized.
10. It is the obligation of every loaning institution to monitor, at least annually, the conditions of any loaned specimens and the ability of the recipient to provide proper care. If the conditions and care of animals are in violation of the loan agreement, it is the obligation of the loaning institution to recall the animal. Furthermore, an institution's loaning policy must not be in conflict with this A/D Policy.
11. If live specimens are euthanized, it must be done in accordance with the established policy of the institution and the Report of the American Veterinary Medical Association Panel on Euthanasia (Journal of the American Veterinary Medical Association 218 (5): 669-696, 2001).
12. In dispositions to non-AZA members, the non-AZA member's mission (stated or implied) must not be in conflict with the mission of AZA, or with this A/D Policy.
13. In dispositions to non-AZA member facilities that are open to the public, the non-AZA member must balance public display, recreation, and entertainment with demonstrated efforts in conservation, education, and science.
14. In dispositions to non-AZA members, the AZA members must be convinced that the recipient has the expertise, records management practices, financial stability, facilities, and resources required to properly care for and maintain the animals and their offspring. It is recommended that this documentation be kept in the permanent record of the animals at the AZA member institution.
15. If living animals are sent to a non-AZA member research institution, the institution must be registered under the Animal Welfare Act by the U.S. Department of Agriculture Animal and Plant Health Inspection Service. For international transactions, the receiving facility should be registered by that country's equivalent body with enforcement over animal welfare.
16. No animal disposition should occur if it would create a health or safety risk (to the animal or humans) or have a negative impact on the conservation of the species.

17. Inherently dangerous wild animals or invasive species should not be dispositioned to the pet trade or those unqualified to care for them.
18. Under no circumstances should any primates be dispositioned to a private individual or to the pet trade.
19. Fish and aquatic invertebrate species that meet ANY of the following are inappropriate to be disposed of to private individuals or the pet trade:
    a. species that grow too large to be housed in a 72-inch long, 180 gallon aquarium (the largest tank commonly sold in retail stores)
    b. species that require extraordinary life support equipment to maintain an appropriate captive environment (e.g., cold water fish and invertebrates)
    c. species deemed invasive (e.g., snakeheads)
    d. species capable of inflicting a serious bite or venomous sting (e.g., piranha, lion fish, blue-ringed octopus)
    e. species of wildlife conservation concern
20. When dispositioning specimens managed by a PMP, institutions should consult with the PMP manager.
21. Institutions should consult WCMC-approved RCPs when making disposition decisions.

V(b). Disposition Requirements – dead specimens: Dead specimens (including animal parts and samples) are only to be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions of dead specimens must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. Maximum utilization is to be made of the remains, which could include use in educational programs or exhibits.
3. Consideration is given to scientific projects that provide data for species management and/or conservation.
4. Records (including ownership information) are to be kept on all dispositions, including animal body parts, when possible.
5. SSP Program and TAG necropsy protocols are to be accommodated insofar as possible.

VI. Transaction Forms: AZA member institutions will develop transaction forms to record animal acquisitions and dispositions. These forms will require the potential recipient or provider to adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy, and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities.

Appendix D: Recommended Quarantine Procedures

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or AALAS accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Marine mammals: All AZA member zoological parks and aquariums should have a quarantine program for new marine mammal arrivals at the institution. A facility should be available which can provide for the isolation of newly acquired marine mammals in such a manner as to prohibit cross-contamination resulting from physical contact, disease transmission, aerosol spread, waste drainage, or the reuse of untreated water. Ocean pens must be located in a way that prevents the spread of any disease from animal to animal through natural water movement and at a distance from other penned animals deemed adequate by the supervising veterinarian. If a receiving institution does not have appropriate isolation facilities, the staff should arrange for quarantine at an acceptable alternate site or only receive animals which do not require quarantine. More stringent local, state, or federal regulations relating to marine mammal quarantine take precedence over these recommendations. Isolation practices should be instituted based on the prior medical history of the newly arrived animal. Those situations where isolation is recommended would have one or more of the following characteristics:

- Recently collected (less than 30 days prior to arrival).
- Recently exposed to a new arrival for which an adequate medical history is not available (less than 30 days prior to arrival).
- Lack of a documented medical history.
- Apparent medical problems at the time of arrival.
- At the direction of the supervising veterinarian.

Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). If during the 30-day quarantine additional

marine mammals are introduced into the isolation facility, the 30-day period must begin again for all animals already in quarantine and exposed to the new arrivals.

Attendants should be designated to care only for quarantine animals or to attend quarantined animals only after fulfilling their responsibilities for resident species. Attendants provided with quarantine clothing and washing facilities designed to prevent disease transmission may be allowed to attend to non-quarantine animals after working with quarantined specimens if approved by the supervising veterinarian. Equipment used to feed and clean animals in quarantine should be used only with those animals or should be thoroughly cleaned and disinfected, as designated by the supervising veterinarian, before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal personnel to zoonotic diseases that may be present in newly acquired animals if the attending veterinarian deems that such risk exists. These precautions should include using disinfectant foot baths, wearing appropriate protective clothing, and minimizing physical contact.

Quarantine protocol: During the quarantine period, certain prophylactic measures should be instituted with some species. Individual fecal samples should be collected, if required, at least twice and examined for gastrointestinal parasites. When indicated, treatment should be prescribed by the attending veterinarian. Successful parasiticide therapy may or may not be necessary prior to removal of the animal from quarantine. This determination should be made by the attending veterinarian based on the potential for contagion. Where indicated, the animals should also be evaluated and treated for ectoparasites.

In those species for which vaccines are available and recommended, vaccinations should be given as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a -94°F (-70ºC) freezer or a -4°F (-20ºC) freezer that is not frost free should be available to store sera. Such sera can provide an important resource for retrospective disease evaluation.

Where desirable, the quarantine period may present opportunities to permanently identify unmarked animals. A complete physical examination should be performed during entrance into and prior to exit from quarantine. Complete medical records should be kept and be available on all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed on them under the supervision of a veterinarian, and representative tissues should be submitted for histopathologic examination.

Following are the recommendations and suggestions for appropriate medical procedures relevant to polar bears to be performed during or immediately prior to the quarantine period:

Required:

1. Direct and floatation fecal exam
2. CBC/serum chemistry panel
3. Physical examination
4. Vaccination for canine distemper, feline panleukopenia, canine parvovirus, and rabies should be current as deemed necessary by the attending veterinarian.

Strongly Recommended:

1. Urinalysis
2. Blood zinc levels

Appendix E: IATA Polar Bear Transport Crate Requirements

CONTAINER REQUIREMENT 72

The illustrations shown in this Container Requirement are examples only. Containers that conform to the principle of written guidelines for the species but look slightly different will still meet the IATA standards.

Applicable to:

Bear species	Lion species
Binturong	Panther species
Cheetah	Puma species
Jaguar	Tasmanian devil
Leopard species	Tiger

Note:
The above species must be provided with space to lie comfortably but not turn around, except for bear species and binturong which must have space to turn around. There must be at least a 10 cm (4 in) clearance around the animal when standing in a normal position.

Note:
Should a veterinary certificate be provided stating that the large cat being shipped is suitable to be transported in a container which permits it to turn around, that container may be accepted for shipment.

STATE VARIATIONS: GBG-01/02/03/04, USG Variations

OPERATOR VARIATIONS: CO-04/05/09, QF-01, SV-01

1. CONTAINER CONSTRUCTION

Materials

Hardwood, metal, 1.3 cm minimum (½ in) plywood or similar material, welded mesh, iron bars.

Principles of Design

The following principles of design must be met in addition to the General Container Requirements outlined at the beginning of this chapter.

Dimension

The height of the container must allow the animal to stand erect with its head extended and the length must permit it to lie in the prone position. The measurements will vary with the species involved.

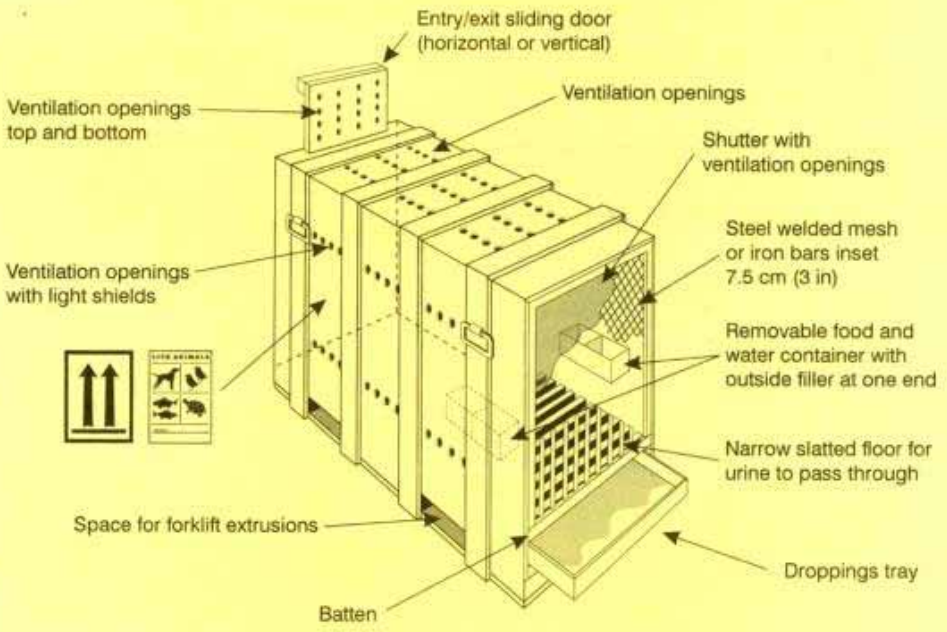
Frame

The frame must be made from solid wood or metal bolted or screwed together. The frame must provide the spacer bar requirement of 2.5 cm (1 in) depth to the sides for air circulation. When the weight of the container plus animal exceeds 60 kg (132 lb), or the animal is very aggressive the frame must have additional metal re-enforcing braces.

Sides

Suitable plywood or similar material must line the frame to give a smooth and strong interior.

EXAMPLE



IATA

Container Requirements

Floor

The floor must either be constructed in a narrow slatted form over a liquid proof tray in such a manner that all the excreta falls onto the tray or, if a slatted floor is not required for that species, it must be leak-proof and covered by sufficient absorbent material in order to prevent any excreta escaping.

Roof

Must be solid with ventilation openings.

Doors

Sliding or hinged entry and exit doors must be provided, the front exit door must be made of steel welded mesh or strong iron bars. The iron bars must be spaced in such a way that the animal cannot pass its legs between them.

The front of the container must also be provided with a light sliding wooden shutter with either ventilation openings of 10 cm (4 in) or be slatted with 7 cm (2 ¾ in) spaces between the slats over the upper two thirds of the shutter, in order to reduce the disturbance to the animal and to protect the handlers.

Both doors must be fastened with screws or bolts in order to prevent accidental opening.

Ventilation

Ventilation openings must be placed at heights that will provide through ventilation at all levels, particularly when the animal is lying down in a prone position. Exterior meshed ventilation openings, with a minimum diameter of 2.5 cm (1 in), must be made on the sides, entry door and roof, as shown in the illustration.

Spacer Bars/Handles

Must be made to a depth of 2.5 cm (1 in), and formed from the framework of the container.

Feed and Water Containers

Food and water containers must be fixed off the floor, to prevent soiling, at the front of the container. Safe outside access must be provided for filling in emergency.

Special Requirements

Bears and other strong clawing animals must have the container totally lined with sheet iron or other hard metal sheeting with ventilation openings punched through to the exterior.

Forklift Extrusions

Must be provided if the total weight of the container plus animal exceeds 60 kg (132 lb).

Multiple Containers

When more than one animal is to be carried in a container, multiples of the above requirements must apply. The container can be divided into compartments by the use of partitions made of metal grills. There must be a separate access into each compartment. Compatible animals that are not likely to harm each other during shipment need not be separated by a partition.

2. PREPARATIONS BEFORE DISPATCH (see Chapter 5)

Food intake must be reduced 2 to 3 days before shipment. A light meal may be given prior to dispatch and food must be provided in case of emergency.

These species must be kept in darkened containers to avoid stimulus from their surroundings. They have the tendency to become aggressive and belligerent if disturbed by outside interference or noise.

3. FEEDING AND WATERING GUIDE (for emergency use only)

Animals do not normally require feeding or watering during 24 hours following the time of dispatch.

If feeding or watering is required due to an unforeseen delay, feed once daily, preferably late afternoon, 1 kg of meat per 20 kg (1 lb per 22 lb) of live weight. Polar bears will also eat fish and brown bears like fish and fruit.

4. GENERAL CARE AND LOADING (see Chapters 5 and 10)

Animals covered by this Container Requirement prefer to travel in darkness or semi-darkness.

Appendix F: Statement on the Safety of Feeding Anadromous Fish

Fish are a standard part of polar bear diets in zoos and aquariums. Though most fish are frozen and thawed for feeding, some institutions have access to fresh fish such as salmon and trout. Recently, facilities have encouraged the feeding of live fish for enrichment purposes. In 1982, two polar bears living in a Pacific Northwest zoo were thought to have died of salmon poisoning. Salmon poisoning is caused by rickettsial agents, *Neorickettsia helminthoeca* and *Neorickettsia elokominica*, which live in the fluke *Nanophyetus salmincola*. This fluke is found only in the Pacific Northwest because its host, the *Oxytrema plicifer* snail, can only live in the coastal areas of Washington, Oregon, and northern California. This could include hatchery-raised fish.

Since that time, concern for polar bear health has lead institutions to question the feeding of anadromous fish (fish that swim up stream), like salmon and trout. Investigation of this issue has lead to new recommendations for feeding live or fresh anadromous fish from the Pacific Northwest to polar bears.

All anadromous fish (AF) can be carriers of this fluke in these locations, but 99% of the fish found to be infested are salmon. Trout, bluegill, and even Pacific salamanders have also been found carry the fluke with this *Neorickettsia*. The snails carrying the flukes are ingested by the fish, the fluke cercariae encyst in the muscle of the fish and a carnivore eats the fish and becomes infected if the fluke carries the rickettsia. The adult fluke penetrates the mucosal lining of the gut and releases/injects the rickettsial agent into the bloodstream of the host. This step is critical to initiating an infection. Dead flukes (in frozen or cooked fish) cannot spread the rickettsia and therefore salmon poisoning. Carnivores become infested because they are considered the natural host for the fluke. Normally they adapt to the presence of the fluke, the body can fight the rickettsial disease, and the animal does not succumb to the disease. It is reported that cats, raccoons, black bears, and grizzly bears eat infested/infected fish but do not experience salmon poisoning. The canid family, though, is a well-known exception where untreated rickettsial infections can act quickly and be fatal.

A paucity of salmon poisoning cases in wild or zoo housed ursids, and recommendations from veterinary pathologist Dr. Foryet at Washington State University School of Veterinary Medicine, have lead to some level of comfort in feeding fresh Pacific Northwest anadromous fish (PNWAF). The 1982 incidence in 2 female polar bears and the 2004 case in sun bears have raised some questions and will require further investigation. Until these cases are clarified, when feeding AF it is safest to feed fish that have been completely frozen (3 days of freezing for large salmon – longer for larger fish) if are harvested from any location or fresh AF harvested from areas other than the Pacific Northwest.

Detection and diagnostics: If an institution is going to feed PNWAF fresh or live, it is important to screen and deworm bears for the fluke that carries *N. helminthoeca* or *N. elokominica*. To detect *Nanophyetus* eggs (operculated ova), it is critical to use a floatation technique using a SUGAR solution NOT fecasol, which is traditionally used for fecal floatations. Fecal exams should then be performed on a monthly basis. If it is suspected that an animal has salmon poisoning, diagnostics should include:

- A fine needle aspirate of enlarged lymph nodes is necessary to make the diagnosis.
- Giemasa stain of macrophages in lymph node aspirate will show intracytoplasmic rickettsial bodies.

Common symptoms of salmon poisoning in canids:

- Vomiting
- Lack of appetite
- Fever
- Diarrhea
- Weakness
- Swollen lymph nodes
- Dehydration

Treatment:

- Antibiotic for the ricettsial organism:
  - Tetracycline 20mg/kg PO Q 8 hr for 3 weeks
  - Or Oxytetracyline 7mg/kg IV Q 12 hr until PO can be tolerated.
  - Or Chloramphenacol 30mg/kg PO IV Q 8hr
  - Or Trimethoprim Sulfadiazine 15mg/kg PO, SC Q 12 hr

  - Or SUlfadimethoxine/ormetoprim, initial dose 55mg/kg PO, then 27.5mg/kg daily
- Antiparasitic for the fluke
  - Fenbendazole 50mg/kg PO SID for 10-14 days
  - Or Praziquantel/pyrantel/febental (Drontal Plus) used according to manufacturers recommendations. Recommendations in canids warn against using in pregnant animals, dogs less than 2 pounds, or puppies less than 3 weeks of age.

Appendix G: Nutritionally Complete Food and Meat Mix Specifications

Specifications for appropriate nutritionally complete foods – when fed according the suggested ranges (5% minimum to 50% maximum) of the diet as fed will result in meeting the target nutrient range.

Nutrient	Unit	Nutrient levels on a dry matter basis.		
		Minimum Dietary Recommendations Polar Bear[a]	Minimum	Maximum
Protein	%	25	23	-
Fat	%	5-20	5	-
Fiber	%	-	-	4
Ash	%	-	-	11.5
Linoleic acid	%	1	1.8	-
Vitamin A	IU/g	5	5.6	-
Vitamin D_3	IU/g	1.8	2	-
Vitamin E	IU/kg	100	90	-
Thiamin	mg/kg	5	12	-
Riboflavin	mg/kg	4	7	-
Niacin	mg/kg	40	90	-
Pyridoxine	mg/kg	4	7	-
Folacin	mg/kg	0.5	1.0	-
Biotin	mg/kg	0.07	0.2	
Vitamin B_{12}	mg/kg	0.02	0.03	-
Pantothenic acid	mg/kg	5	11	-
Choline	mg/kg	1200	2000	-
Calcium	%	0.6	1.0	-
Phosphorus	%	0.5	0.8	-
Magnesium	%	0.04	0.05	-
Potassium	%	0.6	0.6	-
Sodium	%	0.2	0.2	-
Iron	mg/kg	80	90	-
Zinc	mg/kg	97	200	-
Copper	mg/kg	10	16	-
Manganese	mg/kg	7.5	8.0	-
Iodine	mg/kg	1.5	1.0	-
Selenium	mg/kg	0.1	0.13	-

[a]Suggested minimum polar values complied by the polar bear nutrition working group.

Specification for appropriate nutritionally complete meat mix - when fed according the suggested ranges (30% minimum to 75% maximum) of the diet as fed will result in meeting the target nutrient range.

Nutrient	Unit	Nutrient levels on a dry matter basis.		
		Minimum Dietary Recommendations Polar Bear[a]	Minimum	Maximum
Protein	%	25	30	-
Fat	%	5	5.0	40
Fiber	%	-	-	6.7
Ash	%	-	-	8
Linoleic acid	%	1	2.0	-
Vitamin A	IU/g	5	5.0	-
Vitamin D_3	IU/g	1.8	2.0	-
Vitamin E	IU/kg	100	300	-
Thiamin	mg/kg	5	11.0	-
Riboflavin	mg/kg	4	16.0	-
Niacin	mg/kg	40	200	-
Pyridoxine	mg/kg	4	20.0	-
Folacin	mg/kg	0.5	1.0	-
Biotin		0.07	0.3	
Vitamin B_{12}	mg/kg	0.02	0.08	-
Pantothenic acid	mg/kg	5	15.0	-
Choline	mg/kg	1200	2639	-
Calcium	%	0.6	0.7	-
Phosphorus	%	0.5	0.6	-
Magnesium	%	0.04	0.07	-
Potassium	%	0.6	0.8	-
Sodium	%	0.2	0.2	-
Iron	mg/kg	80	128	-
Zinc	mg/kg	97	110	-
Copper	mg/kg	10	15.0	-
Manganese	mg/kg	7.5	20.0	-
Iodine	mg/kg	1.5	1.0	-
Selenium	mg/kg	0.1	0.5	-

[a]Suggested minimum polar values complied by the polar bear nutrition working group.

Appendix H: Polar Bear SSP Program Necropsy Protocol

INSTITUTION_____
CONTACT PERSON_____
Phone_____FAX_____E-mail_____
ADDRESS_____
SPECIES_____
ACCESSION #_____TRANSPONDER #_____STUDBOOK #_____
DOB_____DOD_____CAPTIVE BORN_____WILD CAUGHT_____
CAUSE OF DEATH: SPONTANEOUS____EUTHANASIA____AGENT_____
ATTENDING VETERINARIAN_____
CARCASS: FRESH___ AMBIENT TEMP___HOURS REFRIGERATED___HOURS

HISTORY (include clinical signs, circumstances of death, clinical labwork/diagnostics, diet and housing, recent treatments, cagemate status, if in mixed species exhibits, temperature/humidity, etc)

_____

GROSS EXAMINATION

GENERAL CONDITION (physical condition, pelage, subcutaneous fat stores, body orifices)

MUSCULOSKELETAL SYSTEM (bones, marrow, joints, muscle)

BODY CAVITIES (fat stores, fluid accumulation, pleura, thymus)

RESPIRATORY SYSTEM (nasal passages, pharynx, larynx, trachea, bronchi, lungs)

CARDIOVASCULAR (heart, pericardial sac, great vessels, myocardium, valves, chambers)

DIGESTIVE SYSTEM (mouth, teeth, tongue, esophagus, stomach, small and large intestines, anus, liver, gall bladder, pancreas)

HEMOLYMPHATIC SYSTEM (lymph nodes, spleen)

URINARY SYSTEM (kidneys, utreters, bladder, urethra)

REPRODUCTIVE SYSTEM (testes/ovaries, uterus, cervix, penis/vagina, accessory sex organs, mammary gland, placenta)

ENDOCRINE SYSTEM (thyroids, parathyroids, adrenals, pituitary)

CENTRAL NERVOUS SYSTEM (brain, meninges, spinal cord

SENSORY ORGANS (eyes, ears)

LABORATORY STUDIES: (results of cytology, fluid analysis, urinalysis, serum chemistries, bacteriology, mycology, virology, parasitology, tissues saved and for whom, research requests addressed, x-rays, photography, etc)

PRELIMINARY DIAGNOSIS:

Prosector: Date:

Tissue checklist
Preserve as many of the following tissues as possible in 10 % buffered formalin at a ratio of approximately 1 part tissue to 10 parts solution. The tissues should be no thicker than 0.5-1.0cm. Formalinize one set of tissues for your primary pathologist and ask for an additional set of slides to be held at your institution for retrospective purposes. Wherever possible freeze 3-5cm blocks of all major organs in small plastic bags. These should ideally be kept in a -70°C/Ultracold freezer or conventional freezer temperatures if there is no access to an ultra cold freezer. Consult the AZA Polar Bear SSP Program Veterinary Advisory Group (via phone, e-mail, or the AZA/AAZV websites) for any special research sample requests.

Circle the tissues placed in formalin and attach this list to the gross necropsy and histopathology report. Make three copies 1) for your pathologist, 2) one for the AZA Polar Bear SSP Program Coordinator and 3) one for the AZA Polar Bear SSP Program Veterinary Advisor.

Brain	Diaphragm	Testes/Ovaries
Nerve (sciatic)	Liver	Uterus
Spinal cord	Gall Bladder	Mammary Gland
Eye	Spleen	Ureter
Tongue	Pancreas	Urinary Bladder
Esophagus	Stomach	Urethra
Trachea	Duodenum	Kidney
Thyroid	Jejunum	Adrenal
Parathyroid	Ileum	Thymus
Pituitary	Cecum	Prostate
Heart	Colon	Lymph nodes
Muscle (pectoral)	Rectum	Salivary gland
Lungs	Skin	
Bone with marrow	Aorta	

Guidelines for AZA Polar Bear SSP Program Neonatal Necropsies
The following list includes additional information that should be obtained in the event of a neonatal death (including aborted fetuses, stillbirth, and neonates). Examine all specimens submitted including partially consumed carcasses. Use this in conjunction with the Polar Bear SSP Program Necropsy Protocol for collecting all samples.

1. Obtain weight, sex and age or stage of development.

2. Examine the skin, pelage (texture, color and amount of fur – if any) and nails.

3. Examine for external malformations (cleft lip and palate, other facial/skull, trunk, or limb abnormalities).

4. Assess state of hydration (subcutaneous and serosal surfaces dry or moist) and nutritional status (record subcutaneous and body cavity fat stores as none, minimal, moderate, abundant).

5. Examine for internal malformations (diaphragmatic hernia, cardiac anomalies, etc).

6. Determine if breathing occurred. Place a piece of lung tissue in buffered formalin. If it floats (contains air), the animal probably breathed. If it sinks (contains fluid) the animal probably did not breathe (if the lung is not pneumonic).

7. Verify sex by examining gonads

8. Determine nursing activity by looking for and estimating amount of milk curd (white, cottage-cheese like mass) present in the stomach and presence of milk stool (yellow-white semisolid material in the colon) with absence of meconium (greenish-brown pasty material throughout GI tract)

9. Document degree of trauma induced by dam or other cage mates.

10. Proceed with the standard AZA Polar Bear SSP Program Necropsy Protocol. Be sure to fix any “placental/membrane material” if available.

Appendix I: Polar Bear Cub Formula Examples

San Francisco Zoo: Raised 1 bear from 1 day of age.

Day 1-5: Ratio of Esbilac:water by volume = 1:3

Item	Amount/100g (g)
Esbilac powder	11.6
Boiled water	88.4
Liquid pediatric vitamins	0.5ml
Karo Syrup	4ml

Beginning day 4 added cod liver oil at 5ml/day

Day 6-7: Ratio of Esbilac:water by volume = 1:2.5

Item	Amount/100g (g)
Esbilac powder	14.0
Boiled water	86.0
Liquid pediatric vitamins	0.5ml
Karo Syrup	4ml

Added cod liver oil at 5ml/day

Day 8-14: Ratio of Esbilac:water by volume = 1:2

Item	Amount/100g (g)
Esbilac powder	16.4
Boiled water	83.6
Liquid pediatric vitamins	0.5ml
Karo Syrup	4ml

Added cod liver oil at 5ml/day

Day 15-28: Ratio of Esbilac:water by volume = 1:1.5

Item	Amount/100g (g)
Esbilac powder	20.8
Boiled water	80.3
Liquid pediatric vitamins	0.5ml
Karo Syrup	4ml

Added cod liver oil at 5ml/day

Day 29+: Ratio of Esbilac:water by volume = 1:1

Item	Amount/100g (g)
Esbilac powder	28.2
Boiled water	71.8
Liquid pediatric vitamins	0.5ml
Karo Syrup	4ml
Neo-Calglucon	2.5ml

Added cod liver oil at 7.5ml/day (increased to 10ml/day Day 58)

The Brookfield Zoo: Raised 1 bear from 5 days of age.
Brookfield Zoo's cub had a host of medical issues in the first weeks of life, including a high white count, thrush (possibly antibiotic induced), and dehydration. The formulas listed below are what were actually used for this cub and may not all be appropriate for a healthy cub. Final formula is presumed to be appropriate for a healthy cub, but has not been tested.

Formula 1 day 5-7

Item	Amount/100g (g)
Esbilac powder	7.5
Multi-milk powder	7.5
Boiled water	85
Liquid pediatric vitamins (Poly-vi-sol)	1 drop
Liquid iron supplement (Fer-in-sol)	1 drop
Lactaid	3 drops

Formula 2 Day 8-17*

Item	Amount/100g (g)
Esbilac powder	15
Multi-milk powder	15
Boiled water	70
Liquid pediatric vitamins (Poly-vi-sol)	1 drop
Liquid iron supplement (Fer-in-sol)	1 drop
Lactaid	3 drops

*Hydration issues and illness required dilutions or combinations with Formula 1 until Day 14.

Formula 3 Day 18-24

Item	Amount/100g (g)
Esbilac powder	14.63
Multi-milk powder	7.32
Boiled water	75.61
Safflower oil	2.44
Liquid pediatric vitamins (Poly-vi-sol)	1 drop
Liquid iron supplement (Fer-in-sol)	1 drop
Lactaid	3 drops

Final formula used: Day 25 +

Item	Amount/100g (g)
Esbilac powder	11.26
Multi-milk powder	5.63
Boiled water	81.23
Safflower oil	1.88
Liquid pediatric vitamins (Poly-vi-sol)	1 drop
Liquid iron supplement (Fer-in-sol)	1 drop
Lactaid	3 drops

The San Diego Zoo: Raised 2 bears from approximately 90 days of age.

Day 90-100

Ingredients	Amount g/100 g
Esbilac Powder	11.5
Enfamil Powder	11.5
Corn Oil	4
Water	73

Day 101-222

Ingredients	Amount g/100 g
Esbilac Powder	13.5
Enfamil Powder	13.5
Corn Oil	4
Water	69

Day 223-343

Ingredients	Amount g/100 g
Esbilac Powder	14.5
Enfamil Powder	14.5
Corn Oil	2
Water	69

Appendix J: Contributors to the AZA Polar Bear Care Manual

Name	AZA Bear TAG	Institution/Experience
Belting, Traci		Marine Mammal Manager, Point Defiance Zoo & Aquarium; 6 years.
Briggs, Mike	Polar Bear SSP, co-Veterinary Advisor	Veterinarian
Burke, Mary	Polar Bear SSP Program Management Committee	Assistant Curator of Mammals, Brookfield Zoo; 15 years managerial experience with large carnivores, 12 years experience with four species bears including polar bears. Participated with hand-rearing of a polar bear, and the successful mother rearing of three other polar bears.
Cutting, Amy		Bear keeper, Oregon Zoo. Husbandry Advisor to Polar Bears International.
Dunn, Karen	AZA Bear TAG Steering Committee member.	Large Mammal Curator, Tulsa Zoo; 28 years experience with bears and large carnivores, including polar bears, black bears, brown bears, and spectacled bears.
Frank, Bess	Bear TAG Steering Committee member	Large Mammal Curator, Milwaukee County Zoo; 32 years bear experience
Gullott, Rebecca		Mammal and Conservation Collections Manager, Baltimore Zoo. Six years bear experience.
Hodge, Vicki	Polar Bear SSP Program Management Committee member	Lead Bear Keeper, Buffalo Zoo. Thirteen years experience working with bears.
Henry (Lintzenich), Barbara	AZA Bear TAG nutritionist	Curator of Nutrition, Cincinnati Zoo and Botanical Garden; 15 years nutrition experience. Experience with clinical nutrition for all bear species except sun bears
Meyerson, Randi	AZA Polar Bear SSP Program Coordinator	Mammal Curator Toledo Zoo. 8 yrs bears experience, 12 years large carnivore experience.
Moore, Don	Past-Chair AZA Bear TAG	Associate Director of Animal Care at the Smithsonian Institution's National Zoo. More than 25 years of experience with temperate bears and other large carnivores, 11 years curatorial management of multiple pairs of grizzly & Kodiak bears, and 8 years curatorial management polar bears.
Reed, Holly	Polar Bear SSP Program Veterinary Advisor	Head Veterinarian/ Point Defiance Zoo & Aquarium; 9 years veterinary management of polar bears.
Ward, Ann	AZA Bear TAG Nutritionist	Director of Nutritional Services at the Fort Worth Zoo; 18 years of nutrition experience. Experience with clinical nutrition for all bear species.

Name	AZA Bear TAG	Institution/Experience
Weinhardt, Diana		Director of Conservation and Wildlife Programs, Alaska Wildlife Conservation Center. 25 years experience in zoological institutions as keeper, manager and vet tech. Worked with all 8 species of bears, especially polar, spectacled, sun, black and brown bears.
Winhall, William R.	Past Bear TAG Steering Committee Member	Assistant Curator of Mammals with 11 years of polar bear experience and 30 years of marine mammal experience.