ASSOCIATION OF ZOOS AND AQUARIUMS

Standardized Animal Care Guidelines

POLAR BEAR

(Ursus maritimus)

Created by the:

AZA Bear TAG

In association with the:

AZA Animal Welfare Committee

Standardized Animal Care Guidelines for Polar Bears

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Disclaimer:
The use of information within the Standardized Animal Care Guidelines should be in accordance with all local, state, and national laws and regulations concerning the care of animals in captivity. The Recommendations contained herein are based on the current art and science of animal management, and are provided as best practices that may positively influence the welfare of the animals. The recommendations do not identify exclusive management approaches, diets, medical treatments, or procedures. The Standardized Animal Care Guidelines do not represent specific 'standards' of care. Flexibility in management and care is needed to address the specific needs of individual animals, and potential limitations of individual institutions. However, it is hoped that by identifying best practices and animal care recommendations that these guidelines will help to eliminate those limitations in the future, and maximize the welfare of the animals.

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Definitions:

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 facility where a polar bear may be viewed by the public and is considered as the bears' primary living space" (PBPA 2002); can be indoor and/or outdoor.

Off-exhibit area (also called "management area"): An area of a facility where public viewing of the polar bear is not permitted, that includes isolation areas, medical treatment areas, separation areas, individual animal dens and cubbing dens. Under the AWA (section 3.104(a)), all enclosure areas and pools are required to meet AWA space requirements. That is, the AWA space requirements apply to all portions of the animal exhibit and management areas. Smaller management areas can be available for use but cannot be used for extended holding of the animals.

1. Abiotic Environmental Variables (address both exhibit and off-exhibit holding)

1.1 Temperature:

There has been no scientific determination of minimum or maximum temperatures for polar bears. Though polar bears originate from an arctic environment, most are tolerant of fluctuating temperatures with certain provisions. During the summers in Churchill, Manitoba temperatures average 64°F, but can reach more than 79°F degrees. Animals kept outside should always have access to shade throughout the day, especially during warmer months of the year (PBPA 2002). Hills, trees, shrubs, branches, rocks, and stumps are good pieces of enclosure furniture that can be used for shade. Institutions in warmer climates need to consider how to provide cooler areas for their bears. These might include providing free-access to air-conditioning, chilled water, or ice piles. If these features are not available, access to indoor holding is recommended. The orientation of the exhibit and the features within the exhibit can affect the range of temperatures the bears will experience. It is important that multiple cooling areas be available if multiple bears are out on exhibit together.

Polar Bears without young require only minimal unheated shelter at night, although 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. Regardless of the temperature and level of acclimation by the bears, all outdoor enclosures should provide a shaded area for use during warmer weather.

1.2 Humidity:

There is currently no specific recommendation for humidity requirements for captive polar bears. In the wild, these bears 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), and so will likely have adaptations to cope with these humidity levels if provided with an appropriate environment. Although there is no specific humidity recommendation, great care must be taken to monitor the interaction between high temperatures and high humidity, and to ensure that bears are provided with a gradient of temperatures and humidity within their environment so that they have the ability to regulate their own temperatures at all times (see section 1.1 for additional information). A varied and complex environment provides the bears with choice 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, and fans, as well as the presence of pools for the bears to swim in. The use of self-draining substrates and provision of nesting materials (see section 1.4.5) can also minimize the impact that high humidity can have on skin and coat problems.

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 humidty range for captive environments. Research also needs to focus on what environmental resources polar bears need to be able

to regulate their temperatures within a wide range of environmental conditions. Until specific recommendations can be made, appropriate temperature and humidity guidelines should be outcome-based, ensuring that bears do not experience heat stroke or skin or hair-coat problems, and show no significant deviations in activity (e.g., increased lethargy, decreased activity), in environments where the ambient humidity is high.

1.3 Illumination

1.3.1. Identify light intensity, spectral, and duration requirements,

Because of their large size and activity patterns, polar bears should be generally maintained in outdoor enclosures under conditions of natural light. Any indoor areas of a facility, except cubbing dens, should have skylights to provide areas of natural lighting. Additional indoor lighting should mimic natural light patterns of the geographic area of the exhibit.

1.3.2. Address the impact of and need for daily changes in light intensity and seasonal changes in light intensity and duration

No information is available; more research is required on this topic.

1.4 Space

1.4.1. Behavioral repertoire, space requirements, and complexity.

The physical environment for any animal should provide diversity, change over time, and be rendered as complex as possible. With the aid of innovative exhibit design, different feeding strategies, appropriate use of environmental enrichment, and by developing a cooperative husbandry training program, polar bears can be housed in a dynamic and stimulating environment that is appropriate to ensure the welfare of the animals. All exhibits should contain structural features such as “resting platforms, water features, and nesting sites” (PBPA 2002). Elevated resting areas such as boulders will also be well utilized. Multiple elevated (high and/or low) resting spaces and long distance visibility should be included as an important element of polar bear exhibits. Elevated areas need to be designed so that they can be negotiated by all ages of animals being held to prevent accidents that could result in injuries particularly to young. Exhibits that have been redesigned to include features such as foraging pits and underwater boulders have been associated with a decrease in stereotypic behavior – based on reports by Karen Bucciarelli and Alison Ames Cronin (IPBHC 2004).

Species-appropriate behaviors: To promote species-appropriate behaviors, the landscape should be naturalistic (planted with grass, bushes and trees for shade) and functional, including as necessary elements: a pool, foliage, enclosure furniture (boulders, trees, logs), open/panoramic views, and substrate pits with various materials. The substrate should be “soft” (Ames 2000). To promote variability in the

enclosure, care should be taken to ensure that changes in the terrain, variable elevations, and the ability to physically modify (with crane and truck access) the habitat periodically (e.g., changes to trees, rocks, browse and substrate), are all possible. Elevated areas (plateaus) within the exhibit, which provide an overview of the exhibit and the locations of the conspecifics, are an important element of exhibit designs (Stephan 2006)

Within the enclosure, the habitat should stimulate all of the bears' senses (visual, olfactory, tactile, 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 (areas of reduced as well as enhanced sensory experiences may be desirable). The habitat should provide comfort and encourage exploration, offering the animals the choice between a variety of activities, for example: exploring the habitat, foraging for food, working at getting food from within an ice block, digging in the browse, rubbing in the snow, pouncing on a barrel, manipulating enrichment initiatives, tearing bark off a stump, attacking a traffic cone, hunting fish, swimming in the pool, resting and being alone. Using a wide variety of enrichment objects gives polar bears more choice and control in their environment (Ames 2000).

Bears benefit from a large enclosure that allows expression of their natural behavioral repertoire and the maintenance of individual distances when using the captive habitat. Important polar bear behaviors include swimming, resting, walking, running, climbing, hunting, foraging, and social interactions (avoidance behavior is also a social interaction but by far the most difficult to perceive and thus to observe/record).

Ensuring there is access to suitable substrates (see section 1.4.5.) in outdoor and indoor exhibit and off-exhibit areas will provide an opportunity for both male and female polar bears to make appropriate day and night nests. This is a behavior seen in wild bears. 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). Though many bears enjoy having substrates such as straw to make beds out of, even for short periods of time, it is especially important that soft substrate surfaces be offered in off exhibit areas, such as outdoor holding, if the bears are off exhibit for extended periods of time. This provides them with the option to get off hard surfaces (e.g., concrete) if they choose.

Exhibit size: 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. Clearly, no captive situation will be able to address the natural mobility of the species. What can be done, however, is to maximize the variety captive animals encounter in their surroundings,

and to compensate for lack of physical space with varied, daily enrichment opportunities (see section 5.7 for additional information) that promote species-appropriate behaviors. The AZA Bear TAG, in conjunction with the Manitoba Standards, state that 1-2 bears should be given access to 5400ft^2 of dry land, with an additional 1650ft^2 of land for each additional polar bear (PBPA 2002). The bears' normal gait 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. Exhibits should be designed to allow for walking and running opportunities. Research suggests that polar bears may be susceptible to the development of abnormal behaviors in captivity due to their wide-ranging nature in the wild (Clubb & Mason 2003). Enclosures with complex pathways and designs help reduce stress, stereotypic behavior, and other abnormal behaviors.

Polar bears are excellent swimmers, using their large front paws as powerful oars, and their rear paws as rudders. A polar bear may remain submerged for over a minute. The AZA Bear TAG recommends that large pools with an area of 760ft^2, and with a deep end that is 9 feet or more deep (PBPA 2002) should be incorporated into exhibits. The USDA Animal Welfare Act (AWA 2005) mandates that polar bear pools be a minimum of 5 feet deep, and a surface area of at least 96ft^2; the AZA Bear TAG recommendation supercedes these dimensions. It is recommended that pools are irregular in shape, containing both deep and shallow areas. Innovative pool designs, such as a donut-shaped pool, may be built to test if different patterns can decrease water-based stereotypies. The bears often utilize the shallow areas for wading and play. Cool water (55-70°F) with live fish, smooth pool walls and ledges, an island, rocking icebergs (polar themed floats), moving logs/trees, waterfalls or streams flowing to the pool, changing currents and a wave machine would be ideal. It is important to have freshwater (pond, stream, pool and/or drinking trough/s) available for the bears in addition to the pool. If floating objects are provided in the pool, care must be taken to ensure that they do not damage the pool structure (see section 1.4.9.). Refer to section 1.5.1 for more details on water quality issues.

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 captive environments, the cubbing den should be in a quiet area away from the exhibit. The female must 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 of cubs (D.Weinhardt, personal communication). This set-up allows the female to move the cubs if she wants to. The Manitoba standards state that maternity dens for pregnant polar bears (or polar bears with cubs under four months old) should be at least 8' x 8' x 8'

(PBPA 2002). AZA institutions often have a smaller maternity den with access to a larger shift area adjacent to it. If possible, males should not get access to the cubbing den prior to denning season. The scent of the male may discourage its use, or cause additional stress to the female.

1.4.2. Minimum inter-individual distances that must be maintained and that will influence size of space.

Polar bears are mostly-solitary animals in nature but have been observed many times in congregating groups, whether for a large food resource like a whale, or waiting for ice to 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 – have recorded that communicative signals (those perceivable by humans) occur when the distance between bears is 15m or less, but that many individuals seem to react much earlier (at a larger distance) by moving away from other bears (avoidance behavior), and looking for another location, without any obvious signal to human observers (L.Kolter, personal communication, 2006).

Polar bears have been managed historically in varying sex ratio groups. When exhibiting multiple animals, the exhibit 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). The ability to separate and shift individual animals is critical in any facility design. Bear behavior can change seasonally and with the age of individual bears. Regardless of the number of individuals living in the enclosure, each bear should have its own off-exhibit or holding area for sleeping or enclosure servicing. All enclosures should have shift facilities to permit safe cleaning, enclosure repair, or other separations; shift/holding cages available to individual bears should measure at least $130ft^2$ (PBPA 2002). The AZA Bear TAG recommends that the den space available to individual bears be $130ft^2$, even if it needs to be accomplished by access to multiple holding spaces.

Polar bears should have the ability to choose access to exhibit and off-exhibit areas at all times, unless housed inside at night, or when maintenance of the exhibit is performed (PBPA 2002). Twenty-four hour access to on-exhibit and off exhibit areas has been associated with a decrease in stereotypic behaviors in males and female polar bears (Ross 2006; T.Mengel, personal communication). The AZA Bear TAG recommends that where possible, polar bears be given 24-hour access to exhibit and non-exhibit areas throughout the year. Where appropriate for bear and human safety, bears should not be locked on exhibit during the day or locked into the dens at night.

1.4.3. Identify appropriate furnishings to accommodate an array of locomotory and foraging behaviors as well as resting and sleeping.

In the wild, the polar bear uses its large front paws to fish 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 opportunities that are functionally similar to this hunting behavior are important for polar bears. Enrichment opportunities for the bears should include, but are not limited to: live fish and invertebrates, rock-face cavities in which to hide peanut butter, lard, fruits, etc, kelp, browse (straw, alfalfa, bamboo, ficus, pine, willow, palm fronds, etc.), shrubs, trees, wood shavings, cardboard, ice (block, cubes or shavings in large piles, etc), snow, bones, dirt, sod, moss, sand, gravel, branches, tree stumps, as well as artificial enrichment devices. Large floating objects should also be available for play in the pool. These items should be rotated regularly, and many of them can be combined with other enrichment devices or food in an effort to create a more novel and interesting environment. Much of this 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 under water viewing windows.

Plant materials introduced into, or growing in animal enclosures should be evaluated to determine if the exposed animals will ingest them. Plants 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.

For information on exhibit structures and furniture to promote locomotion and foraging behaviors, see section 1.4.1.

1.4.4. Address the need for and appropriateness of visual, acoustic, and olfactory barriers within the space.

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 of both sexes are able to detect seal breathing holes up to half a mile away, even when covered by layers of ice and snow three or more feet thick. Care should be taken to monitor the effects that visual, auditory and olfactory stimuli have on the bears in captive conditions. Exhibits should be viewable by the public for no more than 180°, so that animals can hide from each other and the public (PBPA 2002). For each bear, there must be a visual barrier within the exhibit that allows them to avoid public viewing, if desired (PBPA 2002). Trees or snags in the exhibit provide the opportunity for climbing and resting, and also permit the animal to hide from view as desired.

The public should be kept at least 20 feet away from the polar bears, except where viewing is provided through a window (PBPA 2002). If glass partitions are used, the glass should be at least 2 inches thick, and positioned where the bears can avoid being viewed by the public if they desire (PBPA 2002). Further space is required for maternal nesting dens that are isolated from the public and other bears, and remain quiet.

Polar bears can generally be housed near other carnivores, but pregnant females should be given seclusion from the male and other animals (AZA Bear TAG recommendation, 2005). Isolation of females with cubs from males always occurs in the wild (Amstrup 2003). During maternity denning, care should be taken to keep the female isolated from other species, and to avoid disturbances/stimuli 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 pacing, head swaying, aggression towards keepers, and abandonment or cannibalism of the cubs.

1.4.5. Identify appropriate substrates and nesting/bedding materials if required.

Exhibits should be designed to minimize the amount of hard or rough surfaces provided to the polar bears. 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). Areas for the bears to excavate provide natural enrichment. 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). Bears enjoy and benefit from different substrates such as; dirt, sod, gravel, sand, moss, browse, snow, ice, shaved ice, wood chips, shavings and bark in large substrate pits. They will often dig, play, and make nests/beds within these pits. Appropriate nesting materials include hay, 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.

Providing a variety of browse and substrates in the animals' environment is recommended. Any browse and substrates must have veterinary and curatorial approval before being used.

1.4.6. Address mechanisms for the provision of change and variation in the environment.

While most enclosure "furniture" for polar bears is large and not easily moved, large rocks, logs and branches that can be moved should be placed in the exhibit and later moved, daily or weekly, to prevent pacing and initiate habitat exploration (PBPA 2002). Enrichment items

can also be hidden in the exhibit to further stimulate interest, exploration, marking and feeding behaviors. Enrichment items provided to the bears should be placed on a variable schedule to maintain the interest of the bears in these items. All enrichment items should be approved by managers and vets before use. See Appendix A for a list of possible enrichment initiatives for polar bears.

1.4.7. Address issues, such as scent marking, that may influence how and how often space is cleaned.

Dirt and grass substrates in outdoor enclosures should be spot-cleaned daily. Hard surface enclosures, 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 as required to maintain a wholesome environment.

Polar bears should be removed from the exhibit when chlorine or other chemicals are being used to disinfect/clean the exhibit or pool, and any time personnel are in the exhibit.

1.4.8. Identify number of air or water changes/hour required

Polar bears should generally be exhibited in outdoor exhibits where air changes are not relevant; however, for indoor exhibits, air change standards should meet or exceed federal standards for air changes in dog/cat/primate indoor facilities. See section 1.5.1 for information about water quality parameters.

1.4.9. Identify necessary measures for safety and containment.

Primary containment: Buildings, exhibits, and grounds must be structurally sound and maintained in good repair, protecting the animals and keepers from injury. Polar bears have been seen to jump 6 feet horizontally and 4 feet vertically (S.Amstrup, personal communication; D.Moore, personal observation). Animals should be separated from the public by at least 20 feet using barrier walls and dry moats (PBPA 2002). Dry moats or exterior walls are recommended to be no less than 16 feet deep or high (AZA Bear TAG recommendation, 2004). Dry moats should be 20ft deep with a distance of 20ft across from visitors to meet Manitoba standards. Glass may be used as a barrier if it is 2 inches thick (PBPA 2002). When providing enrichment objects in the pool, the effect of these objects on the pool glass should be considered before using them. It is recommended that bears be allowed to see beyond the bounds of their containment. There should be elevated areas in the enclosure so that the high walls do not result in a pit effect. 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

Enclosures may employ combinations 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. Zoos with outdoor enclosures using wire fence perimeters should consider the nature of the soils. Polar bears are capable of digging, therefore, chain link fencing that makes contact with a natural substrate should be to a depth of 36 inches along that perimeter in order to prevent digging or bending of the fencing at the bottom from pushing. 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.

A 'hot cable' can be installed at adult bear chest height to prevent polar bears from trying to manipulate fences. One institution has been successful using an electric fence box of 8000 volts strength. It should also be attached to a concrete footing. Animal access to the exhibit should be by remotely operated (manual, electric, or hydraulic) shift doors. Sliding or guillotine types are recommended. Enclosures should have multiple shift cages in order to hold polar bears safely while exhibit or other enclosures are being serviced. 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).

Secondary containment: Secure secondary containment of keeper areas directly accessible by bears from holding, should be used. All gates securing the bears from public and keeper access should have redundant security devices (i.e., 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.

1.4.10. Address issue of transport, identifying (in accordance with IATA)

Polar Bear transport is regulated by the USDA Animal Welfare Act (AWA 2005) Regulations – sections 3.112-3.118. It is highly recommended that these rules be reviewed prior to planning any polar bear shipment. Ideally, polar bears should be "crate trained" before relocation. This involves gradually acclimating the animal to the transport container over a period of time using positive reinforcement (see section 5 for additional information on training). For shipment purposes, all transport crates should meet IATA (International Air Transport Association) guidelines (see Appendix B).

1.4.10.1. Type of transport container

Crates for polar bears are heavy, durable containers made of hardwood, metal, aluminum, welded mesh, and/or iron bars. The following crate parameters are recommended:

- *Frame*: The frame must be made from solid wood or metal bolted or screwed together and must include a spacer bar 1 inch 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 with either 4 inch ventilation openings, or be slated with 2.75 inch 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 inch deep and formed from the framework of the container.
- *Ventilation*: Ventilation openings must be placed at heights that will provide ventilation at all levels, particularly when the animal is lying down. Exterior mesh ventilation openings, with a minimum diameter of 1 inch, must be open on all sides, entry door, and roof.

The design of the crate and ventilation openings should include an access area for use by a pole syringe

1.4.10.2. Appropriate size of transport container

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 not be able to turn around, although there must be at least 4 inches clearance around the animal when standing in a normal position.

1.4.10.3. Provision of food and water during transport

Food intake should be reduced 2-3 days prior to shipment to decrease fecal contamination of the crate during transfer. Any reduction in food should be approved by the veterinarians, curators and nutritionist and will be dependent on the length of time if transit. A light feeding may be given

prior to shipment if approved by a veterinarian. Polar bears do not normally require feeding during transport. Watering during transport should be done as needed. Water containers must be positioned at the front of the crate and fixed off the floor to prevent soiling. Safe outside access must be provided for filling in an emergency.

1.4.10.4. Provision of bedding or substrate in transport container

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 insure that plant material is acceptable to receiving countries. See IATA regulations (Appendix B) for additional information.

1.4.10.5. Mechanism(s) for separating animal from urine and feces during transport

The floor must 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 must be leak-proof and covered by sufficient absorbent material to prevent any excreta from escaping.

1.4.10.6. Identify appropriate temperature range during transport

Temperatures should be between 25-70°F for shipping polar bears by air or ground. Polar bears being transported in warmer weather must be transported in air-conditioned vehicles. The AWA requirement, as found in section 3.112, requires that animals transported outside the specified temperature range must be accompanied by a certificate of acclimation, signed by the attending veterinarian, that states the animal is acclimatized to the specific temperature range under which it will be transported. This certificate must accompany the animal in transport.

1.4.10.7. Consider appropriate light levels and how to minimize noise during transport

Polar bears should be kept in darkened containers to avoid aversive stimuli from their surroundings. Crate doors should be secure to prevent rattling. Some polar bears tend to become aggressive under stress from outside noises and activity. When shipping via air, animals may 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.

1.4.10.8. Address appropriate group size or need for separation of individuals during transport

Polar bears should be shipped individually due to their size and carnivorous nature.

1.4.10.9. Consider need for handler/veterinarian access to animal during transport

Due to the size and dangerous nature of polar bears, they should not be released from their transport containers under any circumstances. The USDA Animal Welfare regulations mandate that any transportation of two hours or longer requires a transport plan approved by the attending veterinarian (AWA 2005), which should address the need for the presence of a veterinarian during the transport. If the attending vet does not accompany the animal, a qualified staff member is required to accompany the bear, and communication must be maintained with the veterinarian.

1.4.10.10. Consider maximum duration of transport allowable before temporary transfer to "normal housing" is required.

Polar Bear transport should not last longer than three days. Water must be offered daily. Dry food may be offered. Increasingly, specialized truck or van transportation is often the only means of transfer. Ice cubes can be used to provide water and also a secondary means of cooling the animal.

1.4.10.11. Address appropriate timing of release, size and type of enclosure at transport destination

It is important that the crate be securely anchored before releasing the bear into the holding area.

1.5 Water

1.5.1. Acceptable water quality parameters.

When testing water quality, water samples should be taken 2-3 feet below the surface. Bacteria levels should be checked weekly, and should not exceed 1,000 MPN (most probable number) per 100ml of water. A high coliform bacteria count 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 dropping and cleaning the pool.

Tests for pH, salinity (for saltwater pools), and any chemicals that are added to the water should be performed daily. Any chemicals added to the water must in no way harm or cause discomfort to the bear. A pH of 7.5-8.2 and salinity 15-36 parts per thousand is recommended for marine mammals that require salinized water for their good health. At

the present time, the Marine Mammal Standards of the USDA and the Manitoba Standards do not require salt water for polar bear exhibits. All water quality tests should be recorded, and the records should be readily available for inspection. Filtration of water flow must keep the quality of water within the standards specified. Placement of enrichment substrates should be a reasonable distance from major water sources as to not interfere with pool filtration. The following publications from the USDA provide more information on pool sterilization and water quality for marine mammals: "Sterilization of Marine Mammal Pools" (www.aphis.usda.gov/ac/mmsterile.pdf), and Technical Bulletin No. 1868, "Marine Mammal Water Quality: Proceedings of a Symposium".

1.5.2. Appropriate means of presentation of water, and appropriate placement of water sources for terrestrial and semi-aquatic organisms.

See section 1.4.1.

1.5.3. Address issues of depth and need for variation in depth and/or current

See section 1.4.1.

2. Biotic Variables

2.1 Food and Water

Complete nutritional information on polar bear diets, and on the handling, processing, storing and presentation of these diets can be found in the AZA Polar Bear Nutrition guidelines (Lintzenich et al. 2006). Extracts from this document are presented in these guidelines.

2.1.1. Identify appropriate containers and protocols for the provision of food and water

Food: Carnivore-style feeding containers (flip dishes, feeding tubes) are appropriate for polar bears when food is not hidden or placed within the exhibit.

Water: Clean, potable drinking water should be available at all times. The AZA Bear TAG defines "potable water" as that which would be appropriate for human consumption as it exits the tap. Watering devices may consist of exhibit/enclosure built-in containers. Automatic watering devices (Lixit-type) can be used with polar bears with caution 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 approved filtering system.

2.1.2. Identify appropriate foodstuffs and feeding schedules

The diet items polar bears consume in the wild are not available for feeding in captivity. Thus, it is the nutrients, and not their packaging, that should be considered. All bears should be offered a diet that would maintain appropriate body condition across all seasons (see section 3.1). A captive, balanced diet should include a combination of: nutritionally complete items (dry, raw, and/or gel), saltwater fish, bones, whole prey, produce, and enrichment food items. When fed in combination, these foods should result in nutrient levels that meet the minimum dietary recommendations (see section 3.1.2). Bears should consume about 1.5-2% of their body weight per day in dry matter, but there may be significant seasonal fluctuation in food intake. If the diet consists entirely of dry dog/omnivore product, a 600lb bear should receive about 9-12lb of dry food per day. 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 section 3.1 and Appendix C).

Polar bears have been observed to ingest vegetation in the wild and captivity (Russell 1975; Knudson 1978). Plant materials introduced into, or growing in, animal enclosures should be evaluated as if the exposed animals will ingest them. Plants should be screened for a number of criteria, including, but not limited to: known toxicities to comparable

species such as dogs, cats, humans (see Burrows & Tyrl 2001), potential to cause obstruction of the gastrointestinal tract, physical irritation and exposure to pesticides, herbicides, and other noxious chemicals.

Feeding schedule: Polar bears are traditionally fed one-two times daily, often in the early morning and later afternoon to facilitate shifting or other management needs, but this is up to the discretion of the facility. A regular feeding schedule for polar bears must be supplemented by irregularly timed feeding opportunities, in novel locations within the exhibits, utilizing foods that are not normally provided (PBPA 2002), to meet the behavioral needs of the bears. Some facilities have found that scatter feeding or feeding smaller amounts more often decreases stereotypic behavior. If significant amounts of enrichment foods, skins, etc., are offered, their caloric content should be factored into the overall diet, as polar bears are known for weight problems. Many facilities feed the morning diet as an enrichment "scatter feed" throughout the public exhibit.

2.1.3. Address the provision of variability in food type and presentation (e.g. spatial and temporal dispersal of food resources)

Variation of the food type, different presentation styles of food items, the placement of the food, and the timing of food provision, should all be considered when providing the diet to the bears. In order to avoid ultimate dependence on one particular food item (especially fish), it is prudent to offer a variety of items to the animal. 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. If that item becomes unobtainable, it may be very difficult to coax the animal to eat a new species. In addition, offering a variety of food items helps to ensure a complementary nutrient profile in the diet. Geraci (1978) emphasizes the need to feed more than one food type, including high- and low-fat fishes, in order to help ensure a balanced diet.

Polar bears should be separated into individual enclosures for feeding, in order to prevent fighting as well as to allow accurate measurement of food consumption. Multiple enrichment feedings may be hidden or otherwise added to enclosures, usually without risk of conflict.

The order or food presentation must also be considered. In order to promote oral health, food items that are soft, or that could become soft, should be fed first to bears (AZA Bear TAG recommendation, 2005). Food items such as bones, fish, or those with hair/skin should be offered last. Harder food items 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). Additionally, bears may need bones more then once a week for assistance in dental health.

2.1.4. Address opportunities for animals to process food in ways similar to their wild counterparts, and consider mechanisms that enable animals to work for food

In order to provide opportunities to exhibit species-appropriate behaviors or otherwise enable animals to work for food, a number of enrichment items can be added to their outdoor or indoor enclosures and exhibits. It is recommended that polar bears be offered edible (or other) items on an ongoing but random schedule in order to combat stereotypic behaviors such as pacing, as well as to add more interest to their daily lives. Offering items at random is important, as polar bears can easily habituate to a regular schedule

The manner of presentation of the prescribed diet should be varied for behavioral enrichment purposes (e.g., scattered, chopped vs. whole, frozen in blocks, presented in feeder balls or barrels, training sessions). Supplemental enrichment foods (e.g., raisins, peanut butter, honey etc.) may be offered but should vary, and should not exceed 3% by weight of the total diet offered. This is critical to providing a balanced diet. All enrichment items should go through institutional approval processes, including a review by nutritionists and veterinarians. All new items should be watched closely. Storage and handling of food enrichment items should follow the same standards as those for other diet ingredients. The following food and non-food items may be considered as suitable enrichment initiatives. This is by no means a complete list and many other options and ideas can be used and should be considered (see also section 5.7 and Appendix A).

- 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
- Cardboard box
- 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
- Snow
- Melons, gourds, pumpkins
- PVC tubes (smaller than head size)
- Raccoon, deer or elk urine - commercially purchased
- Spices & herbs: Russian sage, mint, cumin, nutmeg, catnip, cloves, basil, oregano, rosemary, rose hips/petals, allspice, cinnamon

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). While whole carcasses promote a wide

range of feeding and foraging behaviors in captivity, there are various issues to consider. The feeding of road kill should be done only under close veterinary consultation or supervision. If road kill are used, they must be fresh, wholesome, in good condition (well-fleshed, not bloated), free from obvious disease (no external lesions or wasted appearance), and fed to the bears as soon as possible. The carcass must be removed when spoilage begins, or 12 hours after it has been placed into the enclosure (based on USDA recommendation from carcass feeding for Big Cats, and subject to environmental temperatures), whichever comes first. All carcasses should be opened (abdominally then up through the diaphragm), and the organs inspected by a veterinarian/pathologist for internal lesions or abnormalities that might indicate presence of infectious disease (e.g., abscesses, parasites, etc). For issues surrounding the practice of feeding whole fish to polar bears (including the use of live fish) see Appendix C.

Sick animals, or animals that have died of illness or unknown causes, must not be used for food. Animals euthanized with chemical euthanizing agents must not be used for food because of danger of poisoning. When food animals have been euthanized by gunshot, the lead should be removed to prevent lead poisoning from ingestion of the pellets. Downer animals exhibiting signs of central nervous system disorders, including dairy and beef cows, horses, other livestock (particularly sheep), and wildlife, must not be used for food because of the risk of transmissible spongiform encephalopathies. This includes animals suffering from scrapie and any chronic wasting disease. If the downer animals were clearly harvested because of physical injuries only, they may be used for food when properly processed. In addition, animals known or suspected of being affected with Johne's disease should not be fed.

2.2 Social Considerations.

2.2.1. Group Composition, including as appropriate

2.2.1.1. Suggested age and sex structure of social group

For exhibit and breeding purposes, the simplest grouping of this solitary species is one male and one female. Depending on the space available in the exhibit and holding areas, more bears may be kept. Trios (one male/two female) and other groups of polar bears have been successfully maintained. Larger groups of females may be maintained, but such groups are best established if the bears are siblings, young (between 2-3 years), or raised together. Shepherdson et al. (2005) found that bears in multiple female groups showed decreased pacing. Multiple males may 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. 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 (see section 2.2.5 for additional information).

It is important to remember that stable social groups may become incompatible seasonally or over time, and the holding facility and exhibit should be designed to address any changes in indoor and outdoor housing needs.

2.2.1.2. Temporary isolation of parturient females and young, or of males, and corresponding adequate and appropriate space for animals when removed

Pregnant females become less tolerant of the male as parturition approaches. The male should be separated at this time. Based on the female's behavior and known breeding dates, the female should be locked into the familiar cubbing den, and should remain there for 2-3 months before introducing the female and young back into the exhibit. Dens in the wild vary in size, but the maternity den chamber occurs at the upper end of an entrance tunnel 3-7 feet long, and has an average diameter of 5 feet, and a height of about 3 feet in the middle. See section 1.4.1 for discussion of the size of the cubbing den.

Keeping the daily routine and regular staff as close to normal as possible is recommended. The use of video and audio equipment in the den has proven to be an excellent resource in the management of the cubs and sharing the experience with the public in a controlled forum. Additional heat should not be required within the cubbing den; however, additional cooling may need to be provided. If ambient temperatures are abnormally high when the cub is born, the female may become overheated and abandon the cub. As the female's appetite decreases, consideration should be given to only offering dry food as a way to lessen the chance of bacterial overgrowth, if care is taken to avoid disturbing the area. See section 4.4 for additional information.

2.2.1.3. Seasonal separation of sexes. For those species that are truly solitary, seasonal introduction of sexes

Separation of sexes is only necessary if the female is pregnant.

2.2.1.4. Nursery groups (groups of mothers with most recent young)

Not appropriate for polar bears.

2.2.1.5. Forced “emigration” of adolescents

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 years. In the wild, mothers drive off the cubs or abandon them suddenly. Although gradual separation may be desired, some polar bears exhibit increased anxiety if this is tried. It may be best for polar bear cubs and mothers just to be separated.

2.2.1.6. Multigenerational groups (e.g. many primates, elephants)

Not applicable for this species.

2.2.1.7. Groups deriving from cohorts (e.g., dolphin male pairs)

See section 2.2.1.1.

2.2.1.8. All male groups

Compatible intact 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 personality of the individual bear should be taken into account.

2.2.1.9. Daily and life stage variation in patterns of social affiliation

The family group breaks up when the cubs are about two and a half years old. Occasionally, cubs remain with their mothers until they are three and a half years old, and in western Hudson Bay, some mothers wean, or stop nursing, their cubs only when the cubs are one and a half years old. See section 2.2.1.5 for additional information.

2.2.2. Group Size, including

2.2.2.1. Minimum and optimum group sizes

Polar bears typically do well alone or in groups, given appropriate amounts of enrichment and space. Individual bear temperaments play a big role in this. Young bears do enjoy having other bears to interact with. One study has shown that males exhibit decreased levels of stereotypic behavior with increased numbers of females present (Shepherdson et al. 2005).

2.2.2.2. Inter-individual distances required

When exhibiting multiple animals, the exhibit 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, and contains the substrates and structures necessary for thermoregulation. Regardless of the number of

individuals living in the enclosure, each bear should have its own enclosure/den for sleeping or enclosure servicing, if separating the bears is necessary. See section 1.4.2 for additional information.

2.2.3. Conspecific groups, consider the need for/influence of adjacent groups, or similar taxa, on territorial species

Polar Bears can generally be housed near other carnivores. During maternity and denning, care should be taken to keep the female isolated from other carnivore species. If other species are typically housed in the building, 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 female's enclosure.

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

2.2.4. Mixed species groups

2.2.4.1. Identify appropriate species

Polar bears should not be mixed with other species.

2.2.4.2. Identify key environmental elements for each species

Not applicable for this species.

2.2.4.3. Identify interspecific inter-animal distances required

Not applicable for this species.

2.2.4.4. Address appropriateness of single-sexed groups

Not applicable for this species.

2.2.5. Introductions

Because of the potential for serious or fatal injuries to the bears, all introductions should be well planned, not rushed, and intensely monitored. Polar bears do have the ability to kill each other with little or no warning. Management challenges usually center on animal incompatibility. The personality of the individual bear can prolong the steps of the introduction. When introducing more than two bears, it is advisable to introduce two at a time before putting the whole group together. The individual's previous experience with conspecifics can influence the rate of introduction. Basic steps for introducing polar bears should include the following:

1) Staff working with polar bears should establish a familiar routine when a new bear comes into a facility. Diet changes

should be introduced gradually. Before introductions are started, the staff and new bears should become familiar with each other.

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. The bear should shift, eat regularly, and respond to its trainers before starting introductions. All bears need to be familiar with the entire exhibit and holding areas as individuals, before starting introductions to new animals.

3) Only two bears should be introduced at a 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 injury. They should not be able to get paws, or other body parts through the access portal 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 do need to be there to observe initial interactions-even from afar. Positive signs at this stage include chuffing and bouncing on front legs. Negative signs are roaring, growling, and biting at the barrier. Individuals may exhibit their own signs of stress. If any negative signs are seen, end the introduction at that point. It is best to go back to the previous step and allow the bears to acclimate further before proceeding. If the female is in estrus, as demonstrated by 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. Diligence in observation of all introductions is critical.

5) When doing physical introductions, limit the number of people present and keep disturbance in the area 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.

6) Introductions 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. It is critical that enough is offered so that there is not 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.

7) When selecting an area for physical introductions, make sure there are no dead ends where one animal can corner another.

8) When the pair appears to be at ease at the visual access point, as demonstrated by lying side-by-side, nose-to-nose, or one animal presenting itself in a vulnerable position while the other animal reacts non-aggressively, they are ready for physical introductions. A partial introduction, allowing bears to get a paw or part of their muzzle, through the access point may be done, if the facility allows. All parts of the enclosure should be clearly visible to both animals. Ample escape routes should exist for both bears so that neither can be trapped or cornered by the other. This full access should only be done with staff members 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. Introductions should be done in places where the animals can be separated if things go 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 introductions.

Reintroductions: Care must also be taken when reintroducing pairs that have been separated for prolonged periods of time, such as when a female has been separated with a cub. Usually, reintroductions of bears familiar with each other take less time. A short visual introduction will tell the staff if the animals are ready to be reintroduced.

2.2.6. Human-animal interactions

2.2.6.1. Identify acceptable forms of human/animal interaction

Most animals quickly adapt to daily routines, shifting readily as well as accepting training to allow routine and non-routine veterinary tasks. They also quickly recognize familiar keepers by their voice, movement, and other behaviors. Feeding food through bars, wire, or other containment surfaces also allows for animal/staff reinforcement, as well as providing an opportunity for medication. Operant conditioning and protected contact training, following the established protocols within each institution, will greatly assist veterinary examinations and procedures. The AZA Bear TAG strongly suggests the use of ‘meat sticks’ for protected contact food presentation to bears. If keepers do not use meat sticks during training sessions, care should be taken that fingers do not enter the bear’s space.

2.2.6.2. Address both animal and keeper safety

The AZA Bear TAG recommends that all polar bear training be done in a protected contact setting (AZA Bear

TAG recommendation, 2005). Polar bears can easily cause injury or death to other polar bears or humans. Great care should be used when working with hand-reared cubs, as they may appear very tame toward humans. It should not be forgotten that they are very capable of injuring their caretakers, and staff members should never enter cages of juvenile or adult individuals no matter how tame they used to be as cubs. Direct human contact with cubs should be ended when the cub is four months to prevent injury to caretakers. It is imperative that keepers follow the safety protocols set up by their institution when working with hand-reared animals.

Insuring that doors, gates, and guillotines are secure is critical when working polar bears. A system of redundant locking mechanisms and keeper labels on entrances, gates, and doors will help insure that staff members do not enter animal enclosures while animals are present. Keepers must follow their institution's lock check protocol when working dangerous animals. Some zoos require keepers to carry pepper spray as personal protection. Others require two keepers to physically check animal locations and locks before someone enters a bear area. Where possible, the presence of two keepers is recommended, especially when shifting the animals. In addition to staff safety concerns, two doors should separate bears from the public.

3. Health and Nutrition

3.1. Diet

Complete nutritional information on polar bear diets, and on the handling, processing, storing and presentation of these diets can be found in the AZA Polar Bear Nutrition Guidelines (Lintzenich et al. 2006). Extracts from this document are presented in these guidelines.

3.1.1. Identify existing standards for nutrient requirements for all life stages if available

Polar bears, the most carnivorous of the Ursidae family, prey primarily on ringed seals in the wild (Stirling & Archibald 1977; Best 1985; Derocher et al. 2000). Due to the lack of in-depth, species-specific research, the feeding of bears in captivity is based on known requirements of related domestic animals, and the diets and nutrients consumed by healthy captive bears, to formulate dietary recommendations for polar bears. Domestic cats and dogs are used as models for polar bears (NRC 2005; AAFCO 2004). Although cats, dogs, and bears are all members of the order Carnivora, they all will eat plant matter on occasion. Their nutritional requirements, however, do differ. Cats are obligate carnivores because there are certain amino acids that they cannot manufacture themselves, and must therefore derive from their food. Even though their diets may be totally carnivorous, neither dogs nor bears are obligate carnivores, as they do not have this inability to manufacture certain amino acids. Therefore, bears could do well on a totally plant based diet, if it included enough protein, fat, and carbohydrate, along with necessary vitamins and minerals etc. Polar bears in the wild are primarily carnivorous, but occasionally consume plant matter (Russell 1975; Knudson 1978). Captive polar bears will also readily consume plant matter. Consequently, a range of nutrient levels encompassing both feeding strategies is appropriate for formulation of captive polar bear diets. Appendix D features the nutrient profile of dog and cat diets compared to dietary recommendations for polar bears.

Similar to other carnivores, polar bears efficiently digest protein and fat (Best 1985). Their simple digestive tract is well suited for their meat diet. Many polar bears in the wild consume predominately the blubber of seals, or the whole seal if 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. A balanced diet for captive bears could include a combination of nutritionally complete items (dry, raw, and/or gel), saltwater fish, bones, whole prey, produce, and enrichment food items.

Vitamin supplementation: The very high serum levels of fat-soluble vitamins in wild polar bears have led many to hypothesize that captive polar bear diets should be heavily supplemented with vitamins A, D and E. However, thus far there has been no consistent improvement in the health of captive polar bears when supplemented with large doses

of these vitamins. 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 captive polar bears could be a factor in high 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. 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. Researchers are suggesting 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 feel the need to supplement those 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 stored frozen fish (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 food items are most likely providing the needed nutrients. It is still best to analyze the diet in question to determine the need of any supplementation. A safe approach would be to always supplement the fish portion of the diet, regardless of the inclusion rate of fish (30mg thiamin and 100 IU vitamin E per kg fish offered). This would ensure a balanced diet even if/when content of fish in the diet fluctuates.
- *Vitamin D and calcium*: Due to a small number of reported fractures in captive polar bears, there is speculation that there is a need for supplementing vitamin D and calcium. However, the data presented are on a small percentage of bears and do not appear to give indication of compromised bone density. Proving supplementation in excess of suggested guidelines (see

Appendix D) is not warranted for any life stage, including pregnant or nursing females.

3.1.2. Provide sample recommended diet(s) for all life stages based on nutritional requirements and identify body condition norms as determined from wild animals, if possible

Sample diets: Over a 12-month period, daily food quantities offered and weekly body weights were monitored as part of routine animal care for three female and one male polar bear housed in southern California. Food quantities, and subsequently the caloric energy, offered to these individuals were regulated based on weight trends, visual assessment of body condition, and behavior. Root vegetables (e.g., carrots, sweet potatoes, turnips) were offered in addition to these foods, as a non-nutritive source of occupational foods and for satiety. The results of this study can be found in Table 1 below:

Table 1: Calculated metabolizable energy content (kcal/g) of food items offered to 3 female and 1 male polar bear over a12-month period.

Food item	**Calculated kcal ME/g**
Regular Dog Chunks, Dry (The Iams Company)	4.06
Weight Control for Dogs, Dry (The Iams Company)	3.85
Omnivore, Dry (Mazuri 5635)	2.80
Zoo Carnivore Diet 5 (Natural Balance Inc.)	1.19
Fish Analog (Mazuri Test Diet)	1.15
Rabbit, whole	1.35
Trout, whole	1.09
Herring, whole	1.78
Mackerel, whole	1.00

The following table (Table 2) provides suggested proportions of various food categories for polar bear diets that would meet the nutritional needs of the polar bears (see Appendix D) throughout the year:

Table 2: Food categories & suggested ranges with flexibility for seasonal changes

Ingredient	**As Fed % of the Diet**[1]	
	Maintenance/Growth/Lactation	
	Minimum	**Maximum**
Dry Nutritionally Complete Food	5	50
Raw Meat Mix Nutritionally Complete	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).

Based on providing a nutritionally balanced diet, the examples of polar bear diets given at Brookfield Zoo and San Diego Zoo are provided here (Table 3) to illustrate the proportion of food categories offered. The nutritional analyses of these diets, compared to the minimum dietary recommendations for polar bears, can be found in Appendix E.

Table 3: Food categories and quantities of sample diet as fed

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

Body condition: The scale below shows the standard body scoring scale for polar bears used by field biologists (provided by Polar Bear Specialist Group - S.Amstrup):

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 captive bears. It is appropriate for females to put on additional weight prior to denning-up if they have been bred and are expecting cubs, and this mirrors what occurs in the wild.

3.1.3. As appropriate address the influence of the following variables on dietary requirements

3.1.3.1. Age (infant, juvenile, reproductive adult, senescent adult)

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 are unusual among large mammals for their extreme body weight fluctuations between periods of hyperphagia (gorging) and periods of relative food deprivation. 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).

3.1.3.2. Body size

Seasonal weight targets may be desirable, based on body size of individual bears, and the information on seasonal hyperphagia provided in section 3.1.3.1 above.

3.1.3.3. Reproductive status

In the wild, the meat and the skin or the whole seal carcass is more often consumed by pregnant females with cubs and sub-adults, rather than blubber alone. During these life stages, protein requirements are increased. Thus, 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 has little influence on diets offered. The motivation of male bears to eat may be reduced during the breeding season.

3.1.3.4. Seasonal changes in ambient temperature

No information available.

3.1.3.5. Seasonal changes in body condition

Dramatic seasonal weight changes demonstrated in this species can be modulated through active management of 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).

3.1.3.6. Seasonal changes in nutritional requirements

In the wild, consumption varies depending on season and location. Most polar bears worldwide, including high arctic and polar basin polar bears, prey on seals year-round (Derocher et al. 2002; Amstrup 2003). 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).

The goal of all captive diets throughout the seasons is good physical and psychological health and condition. Each institution should assess seasonal diet changes based on the body condition (see section 3.1.2) and appetite of their bears. General feeding patterns in wild bears are largely irrelevant to the captive situation. Feeding in captivity must be regulated by the health and condition of each individual. Preliminary consumption data for polar bears across the U.S. were collected from 1996-2001 as part of an AZA Bear TAG diet survey, and as a part of regular diet analysis (Lintzenich et al. 2006).

3.1.3.7. Activity levels

During periods of increased activity, bears may need to have their caloric intake increased to maintain body condition.

3.1.3.8. Health status

No information available.

3.1.4. Address issues of palatability, texture, processing, etc. that will encourage species-appropriate appetitive behaviors.

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). Supplemental enrichment foods (e.g., raisins, peanut butter, honey etc.) may be offered, but should vary and should not exceed 3% by weight of the total diet offered. This is critical to providing a balanced diet. All food enrichment items should go through institutional approval processes, including review by nutritionists and veterinarians. All new items should be watched closely.

Dental issues: Specific food items, presentation, and presentation order may all have implications for dental health in polar bears. Dry biscuits are better for dental health than soft diets. Bones should be fresh and pliable. Rawhides, ox tails and hides may also have tooth-cleansing properties. Synthetic hard bones, ice blocks, and hard frozen food items may contribute to tooth damage, and their use should be monitored. Biscuits should be fed dry, and attempts should be made to prevent bears from wetting them. It would seem that by far the worst culprits in the diet for stickiness are ground meat products. The presentation order of food items can potentially help in removing organic buildup. 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 item (hide, carcass).

Food storing, handling, and processing: Storage and handling of food enrichment items should follow the same standards as those for other diet ingredients. For a complete description of the proper handling and processing of meat products (e.g., meat and fish), see Crissey (1998) and Crissey et al. (2001).

3.2. Medical management

In general, polar bears tend to be fairly hardy animals. Reported problems include parasites, skin and hair problems, and dental issues. Following the husbandry/nutritional guidelines, implementing a routine preventative medicine program, and keeping in touch with SSP recommendations will help institutions maintain healthy polar bear populations and facilitate transfers between institutions. Report any medical problems and forward necropsy reports to the Polar Bear SSP veterinarian for summary and analysis so that all facilities can benefit from the information.

3.2.1. Quarantine and hospitalization

Polar bears should be maintained in quarantine as newly acquired animals, or if they have an infectious issue that requires isolation from other ursids or carnivores. Upon arrival, 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 enclosure in the exhibit area 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.

Polar bears new to a facility should be quarantined for a minimum of 30 days. Prior to receipt of the new animals, the shipping institution should provide the following:

Current within last 12 months

- Physical exam
- Complete blood count (CBC)
- Serum chemistry panel
- Documentation of immunization if required by receiving institution
- Rectal culture negative for intestinal pathogens

Current within last 14 days

- Weight
- Fecal floatation/direct negative for parasites
- Rectal cultures

Salmonella positive cultures should be evaluated considering a possible diet of raw meat products. By detecting its sub-clinical presence, pre-treatment of pathogenic forms or 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 above would be completed within 14 days of transport to provide baseline information, and decrease the odds of transport of an ill animal that could have complications during transport. Complete medical records should be sent to the receiving institution no later than 14 days prior to the actual shipment 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.

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. This may mean that the sending institution has to 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.

Quarantine medical examination: During quarantine, examination of feces for parasites via direct examination and floatation should be performed, and any necessary deworming treatments administered. The bear should have three consecutive negative fecal exams in order to be released from quarantine (once a week for three collections). After an acclimation period within quarantine, the bear should receive a complete physical exam that should include:

- 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 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.

Before immobilizing a polar bear, the Polar Bear SSP Veterinarian should be contacted for a list of current sample requests that can be obtained during the exam.

3.2.1.1. Identify problems arising from isolation of social taxa and suggest possible mechanisms for avoiding these problems

Polar bears are not generally a social species, and so isolation during quarantine is usually not a problem for these animals. An exception to this may be when cubs are separated from mom for the first time.

Enrichment should be an important part of their quarantine care to keep life engaging and interesting and decrease the chance of the bears developing stereotypic behaviors. 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 or new environment.

3.2.2. Preventive medicine (testing, vaccinations, parasite control, etc.)

Routine medical assessments: Routine evaluations should be performed. Health assessments may be visual or more extensive. The USDA requires marine mammals to have at least a visual exam by the attending veterinarian every 6 months (AWA). The type of exam 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 3.2.1). These exams will be the most thorough and yield the most valuable and practical information. Alternatively, other exams can be conducted with the keepers at the animal's enclosure, reviewing nutrition and husbandry, 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 sections 5.1 and 5.2). In this case, follow-up immobilizations can be scheduled to address any medical issues. A complete physical examination under anesthesia should include everything listed for the quarantine exam (see section 3.2.1), in addition to addressing individual specific diagnostics and collecting Polar Bear SSP sample requests.

Dental assessments: Every routine examination of a polar bear should include a dental evaluation. The dental formula is I 3/3, C 1/1, P 4/4, M3/3. Reported dental issues 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)

Fractured teeth are usually a husbandry issue (e.g., chewing on enclosures), and can be addressed at that level. Fractures do not necessitate action. Only if the pulp cavity is exposed, increasing the chance of packing the cavity with food leading to infection, will treatment need to be arranged. All other issues should be evaluated by the veterinarian, often with a consulting dentist, endodontist, periodontist, or oral surgeon present. This professional relationship can enhance the quality of care offered, as the consultants will provide expertise and equipment not readily available in zoo and aquarium practice. The relationship is productive and beneficial for all involved.

Typical polar bear health parameters: The average life span of polar bears in zoological settings is approximately 18 years (based on studbook data). The oldest recorded zoo or aquarium polar bear is 41 years. In the wild, biologist Steve Amstrup worked on a 33 year old polar bear, and Ian Stirling reported working on a 31 year old bear (S.Amstrup, personal communication, 2005).

Table 4: Physiological information (adult polar bears):

	Immobilized	**Awake (wild)**
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) 45-60bpm (awake/inactive) 80-150 bpm(active/moving)
Respiration	17 resp/min*	15-30 resp/min

*Data from Point Defiance Zoo & Aquarium polar bears under Telazol® anesthesia

Adult male polar bears weigh between 770-1320lb (350-600kg). Adult female polar bears can weigh between 330-660lb (150-300kg) At birth, cubs weigh between 1-1.5lb (0.454-0.68kg).

Immunizations: According to the 1999 AZA Bear TAG Survey and recent Polar Bear SSP Veterinary Advisor Group Annual Reports, immunization protocols have varied depending upon whether the bears are housed indoors or outdoors, and on the vector control programs used. Viral infections in polar bears have been limited. 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. Polar bears are also susceptible to leptospirosis infections, but vaccination may not be necessary if rodent populations are not a problem or rodent control is effective. The current polar bear immunization recommendations are as follows:

Table 5: 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).

Adults should receive annual vaccinations of tetanus toxoid, and a booster every three years after the initial annual dose. Adults should also receive an annual vaccination of Leptospira bacterin if there are concerns about rodent vectors in the area.

Parasite control: The following preventative care and treatment protocols are recommended for endo- and ecto-parasites that are common in captive polar bears:

- *Nematodes* (round worms): A very common problem in polar bears, often requiring a regular every 6-8 week deworming program to control. The following deworming medications can be used on a rotational basis to effectively manage this parasite. This is not an exclusive list.

  Table 6: Recommended de-worming medications for polar bears

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

  Nematodes of particular interest for polar bear management include *Baylisascaris sp*. 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, though these animals can be negative in an area where local

populations of canids have commonly been diagnosed with the disease. Heartworm ELISA antigen tests should be conducted annually in polar bears exposed to mosquitoes in heartworm endemic areas. If heartworm is a documented problem in pinnepeds in the local area, it is suggested that polar bears be tested for heartworm. If the animal 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 pinnepeds 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.

- *Baylisascaris*: *Baylisascaris* have been documented as the cause of illness or death in many different species in zoo collections, and is of current interest in polar bears. *Baylisascaris transfuga* and *B. multipapillata* have been identified in polar bears, and they differ from the species found in raccoons. Clinical signs include loose stool to diarrhea and rough hair coat. Severe cases can lead to severe weight loss and intestinal obstruction. This parasite can be diagnosed by fecal float or visualization of the parasite (Briggs 2001). Deworming medication and doses are listed above. See 'Zoonotic Issues' below for information on potential human exposure to this parasite.
- *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. In humans, treatment with albendazole or mebendazole, along with corticosteroids in severe cases, has been recommended. Polar bears get the parasite when ingesting seal meat. Avoiding or cooking potential meat sources of the parasite is the best method of control.
- *Tapeworms*: Tapeworms have been found in polar bears fed salmon (S.Amstrup, personal communication, 2006).
- *Mites*: *Demodex* and *Sarcoptes* may be responsible for some of the seasonal dermitis seen in polar bears. Symptoms include pruritis (itching), localized hair loss, thickening and crusting of skin. To diagnose the problem, deep skin scrapings at the edge of the lesion must 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 used on dogs.

Zoonotic issues: When working with animals, keepers should always be aware of potential diseases that can be transmitted from animal to man, otherwise known as zoonotic diseases. When working with polar bears, all animal staff should be educated about the preventative measures necessary to prevent spread of these kinds of diseases. These organisms can be spread by fecal-oral transmission, contamination of human mucus membranes with polar bear excretions or secretions (feces, saliva, blood, pus, etc.), and contact with infected/infested tissues. Pathogens of concern 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 enclosures; and 3) wearing gloves when handling tissues.

Salmon poisoning: For issues of parasite control and 'poisoning' linked to the use of live fish as food/enrichment, see Appendix C for more details.

3.2.3. Management of diseases or disorders

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 both surfaces, punctures, abcesses, and localized swellings. Contributing factors to these conditions include warm environmental temperatures, constantly moist environment with no chance to "dry out" (considering that the arctic is actually a very dry environment), lack of disinfection, residue disinfectants that cause inflammation, rough substrate, broken wire brush bristles, and trauma. Some conditions are responsive to change in husbandry practices, a simple course of antibiotics, or require an immobilization for diagnostic assessments and treatment. Training the bears for "paw presents" can be a valuable diagnostic tool that can minimize the need for immobilizations (see section 5.1).

Alopecia: Alopecia is one of the more commonly reported conditions in polar bears. An in-depth evaluation of polar bear nutrition, conducted by the Polar Bear SSP 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, behavioral modification, enrichment, or scrutiny of life support systems and water quality. The issue of reproductive hormonal balances 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). It is important to report all cases of alopecia, diagnoses, and treatment successes or failures to the Polar Bear SSP Veterinary Advisor, as this topic is currently under investigation.

Greening of hair coat: Caused by the growth of a cyanophyte (blue-green algae) within the hair shaft (Ramsay 2003). Treatments have included salt-water treatments and peroxide baths.

Other medical issues: Other reported problems for polar bears include the following:

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
12. Osteomyelitis
13. Glomerulonephritis
14. Hypothyroidism

15. Umbilical hernia

3.2.4. Appropriate capture, restraint and immobilization techniques and training for routine and non-routine procedures.

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 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 (Tel-inject, Dan-Inject, Pneu-Dart). Captive bears in culvert traps, or small enclosures 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., add only half the amount of diluent to make condentrated Telazol®, use lyophilized ketamine, or purchase concentrated forms of medetomidine or midazolam). Bears will demonstrate seasonal variation in fat distribution. Most often the thickest fat layer is over the rump and thighs, requiring a minimum 2.5-inch needle to penetrate. Otherwise, the favored target for darting is the neck area.

Drug dosages: Routinely, polar bears will be induced with injectable anesthetics. Short, non-invasive procedures can be accomplished with injectables alone. Longer procedures may require maintenance on gaseous anesthesia such as isoflurane via facemask or endotracheal (ET) tube (adults on 11-14mm ET tubes).

Table 7: Recommended anesthetic agent and dose for polar bears

Anesthetic Agent	**Dose**	**Reversal**	**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.

Monitoring anesthesia and supportive care: Depth of anesthesia should be closely monitored. In xylazine-ketamine, medetomidine-ketamine and etorphine anesthesias, 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. 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 breath 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.

The eyes should always be lubricated, and caution must be exercised to avoid corneal abrasions or ulceration. A blindfold should be placed to protect the eyes and decrease visual stimuli of anesthetized bears. 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. An ambulance type regulator (Easy Reg®; Precision Medical, Inc. 300 Held Drive, Northampton, PA 18067) and aluminum D-cylinder is lightweight, portable, and sturdy. 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, 50-70 beats/min. Bradycardia is common with medetomidine-ketamine, 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 was 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.

Bears may be translocated as part of management procedures. Translocation of bears via handling in a cargo net can induce hypertension and hypoxemia via airway obstruction. Ideally, these 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. Furhman Stretchers can be designed to support the weight of a polar bear. These stretchers also come with the straps and poles that allow proper support and positioning of the bear during a forklift or boom truck short move. If bears are to be relocated or moved, they should be awake before transport. An anesthetized bear can gravitate towards the door of the crate, pressing the nose downward and compressing the airway resulting in suffocation.

3.2.5. Management of neonates and geriatric animals

Neonates: Though 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, aggression, maternal neglect, and injury/illness. In these cases the cub should be removed for treatment and/or hand rearing. Refer to section 4.5 for hand-rearing protocols. Veterinary staff should perform an exam soon after retrieval of cubs to be hand-reared, which should include the following:

- Temperature, pulse, respiration, and weight
- Make sure respiratory tract is cleared
- Umbilical stump cleaning, apply chlorhexidine solution. If no stump is seen, examine for herniation
- Examine for abnormalities (cleft palate, imperforate anus, hernias, etc)
- Assess hydration
- Administer colostrum if possible. For alternatives see section 4.5

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. There should be no need to handle a healthy looking polar bear cub.

Neonates may show only subtle clinical signs in the early stages of illness and deteriorate rapidly. Close monitoring and quick action may be necessary to deal with illness. Some of the following medical issues may arise in neonates:

- *Hypothermia/hyperthermia*: Warm or cool cub to within 3° of normal body temperature (99.6°F/37.5°C) as momentum will

carry the temperature the rest of the way. Use caution 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. Though one could apply 50% dextrose to the gum, hypothermic cubs may require warming up before oral or subcutaneous administration of glucose can be effective.
- *Aspiration/pneumonia*: This can occur as a result of bottle-feeding, though cubs should always be checked for presence of a cleft palate.
- *Dehydration*: Dehydration can be rectified with oral liquids (Pedialyte®), powdered electrolyte solutions, or subcutaneous electrolyte solutions. A veterinarian should evaluate skin turgor and calculate fluid needs.
- *Diarrhea*: Multiple causes include, bacterial, viral, parasitic, nutritional (food allergy, dietary changes, inappropriate formula concentration), or husbandry. Establishing a quarantine protocol (including foot baths changed daily, dedicated quarantine/nursery keepers, hand wash and disinfection protocols) for care of the neonate may help prevent some of these causes of diarrhea.
- *Constipation*: Treated by feeding a more dilute formula (about half strength) for a 24-hour period, then increasing the formula concentration over a couple of days once constipation is resolved. The situation 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). In the case of hand-rearing, refer to Appendix F, and to Chapter 8 of the Polar Bear Nutrition Guidelines, which can be found by visiting: (www.polarbearsinternational.org/rsrc/pbnutritionguidelines.pdf)

Geriatrics: The following list details medical conditions common for geriatric polar bears, and recommended management protocols:

- *Body weight and condition*: This should be monitored and may need to be managed by adjusting diet. It can be very helpful to chart monthly body weight and intake, then compare annual

and seasonal changes and make dietary adjustments accordingly. Older bears may not be as active, thereby requiring fewer calories on a daily basis. Obesity can contribute to development of joint and back ailments. Diet should also be adjusted as medical issues (e.g., renal or liver disease) arise, and require varying levels of nutritional management. Geriatric bears should be monitored through their preventative health program. The earlier the detection of degenerative organ disease, the more effective the medical or nutritional management.

- *Arthropathies*: This can lead to decreased activity that will 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 bedroom areas, so as to decrease the incidence of injuries related to falling or aggravating existing arthopathies. Treatments used on ursid arthropathies are listed below with their reported success. A dose was given in only one case.

Table 8: Treatments for ursid arthropathies

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.

- *Dental problems*: The problems described in section 3.2.2 may be encountered in older bears. Vital pulpotomies and fillings are usually preferred rather than extractions. Worn teeth may require more easily ingested/digested diet, as well as dental monitoring.
- *Neoplasia*: Most commonly seen in the liver of older bears. See section 3.2.3.
- *Parasites*: Trichinosis has been seen in geriatric bears where signs have been difficult to define as the bears have had multiple medical problems.

Necropsies: Because of great daily care and husbandry routines, high quality diets, and regular veterinary care, polar bears live much

longer in captivity than they do in the wild. In the event of a death, thorough necropsies should be performed to clarify the cause of death and add to the building database of information that is helping zoos continue to enhance the lives bears in zoos and the wild. The AWA requires that full necropsies are performed on all marine mammals by, or under the supervision of, the attending veterinarian or a marine mammal expert. Please see Appendix G for the formal Polar Bear SSP Necropsy protocol. Remember to check AZA and AAZV web site for any Polar Bear SSP approved active research requests that could be filled from a necropsy. Please submit gross necropsy and associated histopathology reports to both the Polar Bear SSP coordinator and veterinary advisor.

3.2.6. Management during pregnancy

Female polar bears need to be separated from other bears before parturition. Currently there is no pregnancy test for female polar bears. Any female that is suspected of being pregnant should be denned up until proven otherwise. No specific medical management of pregnant polar bears is recommended. See section 4.4 for husbandry management recommendations.

4. Reproduction

4.1. Identify seasonal changes in physiology and behavior associated with reproduction and address management implications of such changes

Polar bears will start to show courtship behavior as early as January, with breeding seen in February and lasting sometimes into May. Cubs are born usually in November-December, though cubs have been born as early as late October and as late as the end of January. Transfers or introductions of potential breeding animals should be completed in a timely manner to insure that potential mates have finished quarantine and are fully introduced prior to courtship.

4.2. Address hormonal tracking as a mechanism for identifying reproductive state, and assessing feasibility of introduction for solitary species

Not enough information available for this species.

4.3. Address timing of introductions for individuals of solitary species

See section 2.2.5.

4.4. Address provision of and describe facilities for parturition and as appropriate, management of females during isolation or denning.

Female polar bears need to be separated from other bears before parturition. Currently there is no pregnancy test for female polar bears. Any female that is suspected of being pregnant should be denned up until proven otherwise. A female may settle down in the cubbing den and then become more active. Reviewing the behavior of the female is necessary in making the decision to release the female from the cubbing area. 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 be let out on exhibit.

Cubbing dens are normally smaller, confined spaces adjacent to larger holding areas. Cubbing facilities should have a layer of heavy bedding, such as straw. Female polar bears may start to leave food or stop eating before the cub is born. Cubbing dens should not be disturbed at all. Remote monitoring of the cubbing den via video camera is strongly recommended, accomplished by modifying the nest box to include a camera and low-level lighting prior to parturition.

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. However, first time mothers carrying only a single young may give little warning. Once birth has occurred, access to the female's den and the holding area should be strictly limited and the female left completely alone. 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. 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). Access to the area must be limited to necessary personnel and only for short periods of time.

Fresh water should be available at all time. 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. Use the remote camera to evaluate if the female is coming out looking for food. Some females may not eat for weeks after the birth.

Females and cubs should be left undisturbed for at least the first month, maybe longer. Females should be given every opportunity to raise their cubs. It is necessary to monitor the female's behavior and listen to the cubs' cries. Cub cries can be very loud, and cubs make a distinctive sound (described as a hum or trill) during a nursing session. Observations by Dr. Karin Linke, Rostock Germany have shown that the humming vocalization is generated during breathing out, with the tongue pressed against the palate. 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 on the criteria to be used to determine if and when intervention will happen.

4.5. Address what, if any, circumstances might warrant hand-rearing and identify acceptable hand-rearing and reintroduction protocols.

If it is necessary to hand-raise 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 cubbing. Each institution will have to develop a protocol that works best for them. Institutions that have successfully hand-reared polar bears include: Brookfield Zoo, San Diego Zoo, and San Francisco Zoo.

Formula selection: If the cubs have not had the opportunity to nurse, then polar bear serum should be administered. It is recommended to supplement 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®). In captivity, medical problems have been noted in some cubs associated with formula composition including rickets/vitamin D deficiency (Kenny et al. 1999), thiamin deficiency (Hess 1971), lactobezors, constipation, dehydration, and bloating (Kenny et al. 1999). Pediatric vitamins were added by most institutions, 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 employed by some institutions. Cod liver oil was frequently added to formulas, however, a number of cubs have been raised successfully without it. Ursids can form indigestible lumps of casein called lactobezoars, which can have serious health implications. Reducing casein (a milk protein) and increasing whey in the formula can help prevent this problem.

Examples of formulas used successfully to hand rear polar bears cubs at San Francisco Zoo, Brookfield Zoo, and San Diego Zoo are provided in Appendix F. 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 to weigh the cub at the same time each day. Quantities can gradually taper 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 may be reduced to 5-7 times per day. 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 must 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, syringes have been used successfully to offer formula.

- *Feeding position*: When feeding young bear cubs, they should be placed on their stomach on a flat surface (table). Holding a cub during feeding results in the cub not being in the correct position (in an upright or head back position which increases the chances of aspiration and death). It is best to immediately start feeding the cub on a table with the animal in a sternal position (i.e., laying on its stomach). At first it will tend to paddle forward, but in time it will become adjusted to this routine. Adding a rolled towel for the cub to push against during nursing will help with this movement.
- *Elimination*: To accomplish this, 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. Only slight pressure is needed to help guide the fecal material through the digestive tract and out the anal canal. After a week, this procedure can be reduced to two times a day. After the cub begins eating solid food, this procedure can be reduced to one time per day. Most cubs will defecate on their own at 8-10 weeks, if not sooner.

Weaning: Polar bear cubs nurse for up to 2-3 years in the wild. The age at which the contribution of nursing transitions from nutritional dependence to social bonding with the sow is unclear. Weaning in the wild involves both nutritional and behavioral processes, while captive weaning typically refers to cessation of bottle-feeding. The captive weaning off the bottle process (i.e. introduction to solids) can begin as early as 60 days, though 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 biscuit, ground or soaked foods can be added, then progressing to dry. Fish or fresh meats have been offered as early as 100-110 days. The weaning process should be gradual, with only one variable changing at a time so as to track cause/effect for any change.

Exercise: After the cub starts walking, it is vital that sufficient space and time be provided to allow it to run and climb, and should be provided with low climbing structures and a shallow child's swimming pool (3-4 months of age). Cubs should be provided with a non-slip surface when learning to walk to prevent splaying. Safe enrichment items 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. Imprinting to specific individuals should be avoided.

4.6. Recommend means and duration of contraception for taxon; include all acceptable alternatives and identify the benefits and drawbacks of each

Contraception methods: The AZA Contraception Database (AZA Wildlife Contraception Center) shows that bears have been treated with MGA implants, Depo-Provera injections, Ovaban, Megace, Ovarid, oral MGA (progestin-based methods), and more recently with deslorelin (GnRH agonist). However, because no controlled studies have been conducted with bears, recommendations must rely to a large extent on information from other carnivores. Of particular concern is that the uterine endometrium of female carnivores is stimulated by progestin treatment, and even more so by estrogen and progestin in combination, or progestin administered to pro-estrous or estrous females who have high levels of endogenous estrogen.

- *Progestin-based contraceptives*: In felids, long-term progestin treatment has been associated with uterine pathology, including cancer (Kazensky et al. 1998). In addition, progestins may cause pathology of mammary tissue or favor the onset of symptoms of diabetes mellitus. For these reasons, synthetic progestins, either alone or in combination with estrogen, are not recommended for more than short-term contraception in any carnivores, including bears. Progestin-based contraceptives include: melengestrol (MGA) in implants or in solution, megestrol acetate (Ovaban, Ovarid or Megace), medroxyprogesterone acetate (Depo-Provera), levonorgestrel (Norplant), and altrenogest (Regu-Mate).
- *Vasectomy/castration*: Repeated exposure to endogenous progesterone that is not associated with pregnancy is believed to carry risks equivalent to exogenous progestins. Thus, because at least some species of bears are considered induced ovulators, vasectomy of males is NOT recommended. Vasectomized males would be expected to continue mating with females, and those sterile matings would likely induce ovulation followed by pseudopregnancy, a condition

accompanied by high endogenous progesterone. Castration of males or ovariohysterectomy of females are preferable methods for permanent sterilization. It should be noted that breeding behavior has been seen in some bear species post castration (L.Kolter, personal communication, 2006).

- *Porcine zona pellucida vaccine*: The porcine zona pellucida vaccine is not recommended as a contraceptive for any of the carnivores, because it has been associated with potentially permanent damage to ovarian tissue that results in infertility. However, that damage is not reliable enough for PZP vaccine to serve as a permanent sterilant in these species. A possible exception is a product from Canada (SpayVac), but adequate information about its efficacy and safety are not yet available.
- *Gonadotropin-releasing hormone*: Gonadotropin-releasing hormone (GnRH) agonists provide an alternative to steroid hormones (progestin and estrogen) by producing a condition analogous to reversible castration or ovariohysterectomy; that is, they can be effective in both males and females of many species. GnRH agonists first stimulate the reproductive system, potentially resulting in ovulation in females or enhanced testosterone and sperm production in males. However, that stimulation is short-lived (2-3 weeks) and is followed by down-regulation that lasts a varying length of time depending on the product used and the individual response. Suprelorin (deslorelin implant) has been effective a minimum of 6 months in the species treated, but suppression may last a year or more, depending on the dosage and individual differences. A newer product, leuprolide acetate, which forms an implant after injection can be formulated to last 1, 3, or 6 months, but individual responses may also vary. The primary disadvantage to these products is that time of reversal cannot be controlled, since the implants cannot be easily removed as can the silastic MGA implants. However, the major advantage of GnRH agonists is that no side effects have been found other than changes that would be expected following castration or ovariectomy. The most common observations are either weight gain or loss.

Contraceptive timing: The following recommendations provide details on the appropriate timing for administering contraceptives to polar bears:

- *Contraception for seasonal breeders*: The GnRH agonists are particularly well suited for seasonally breeding species, since the duration of efficacy can be at least 6 months. However, treatment should be initiated in advance of the breeding season to avoid the effects of the initial stimulation. Ideally, treatment should begin about 2 months before earliest possible mating. For females, even if ovulation might result, it is less likely that they will be fertile. For males, time must be allowed for any sperm that might be produced to be eliminated, as would be necessary following a vasectomy, i.e., at

least 6 weeks before infertility can be assumed. It is possible to prevent the initial ovulation in females by treating them for about 10 days with a progestin such as Ovaban pills around the time of GnRH agonist implant insertion (such short-term use of Ovaban followed by steroid hormone suppression is not considered a risk).

- *Contraception for pubertal animals*: The limited data available for pubertal animals suggest that contraception probably does not affect future fertility, but this is not certain.
- *Contraception for pregnant females*: Progestins should NOT be used in pregnant females, especially near the time of expected parturition because they can inhibit uterine contractions and thus impede the progression of labor. Although Depo-Provera injections may only be effective for 2 months, in some individuals that suppression can last up to 2 years, so it should never be used in females that might already be pregnant. GnRH agonists may cause abortion. PZP vaccine seems to be safe to use during pregnancy. Many bears have a period of embryonic diapause (delayed implantation) following conception, and gestation is initiated later by an increase in progesterone. Thus, treatment of a female in diapause with a synthetic progestin would be expected to stimulate initiation of gestation and result in an earlier than normal parturition date.
- *Contraception for lactating females*: Progestins can be secreted in milk but appear to be safe to nursing infants. PZP vaccines seem to have no effect on lactation. GnRH agonist treatment initiated after parturition may not affect lactation, but this has not been carefully tested.

Behavioral impact of contraceptives: Progestins may prevent estrous behavior, although some females adequately contracepted with progestins may still be attractive to males and show signs of estrus. PZP should not interfere with estrous behavior. GnRH agonists should eliminate estrous behavior in females and may reduce aggression in males.

Further information: More details on contraceptive products and their application plus information on ordering them can be found at the AZA Wildlife Contraception Center website: www.stlzoo.org/contraception.

5. Behavior management

5.1. Identify procedures that have been successful in managing the taxon for routine husbandry.

Animals should be managed by using positive reinforcement and patience. A husbandry-training program, using operant conditioning with protected contact, should be implemented for better health care if the facility allows. This husbandry-training program can include training for separations, gating, crating, physical/medical exams, x-rays, sonography, injections, weights, and possibly unrestrained blood sampling, as agreed and prioritized by veterinarians and curators. A husbandry-training program not only aids in the early diagnosis and simple treatment of minor injuries or medical problems, but also is enriching because it mentally and physically challenges the bears to solve problems and perform specific activities. Operant conditioning can also be used to promote natural behavior, and encourage better utilization of the exhibits by the bears.

Most polar bears are very food oriented and can be trained to shift to other quarters when offered favorite food items. Training can be accomplished by baiting with food and putting the behavior on a cue. The appetite of the bears can vary seasonally, and training must be adjusted to accommodate this change. Zoo studies also show that predictable feeding schedules may lead to stereotypic behavior or anticipatory pacing, and this should be avoided.

Polar bears are easily trained to tolerate close proximity to caretakers and visual inspection, etc. With training, they also respond well to cow bells, dog whistles, clickers, targets, and hand signals if food is used as a motivational tool. The same is true for inducing individuals to approach enclosure sides for visual inspection and vaccination or contraceptive injections.

5.2. Identify procedures that have been successful in managing the taxon for non-routine husbandry.

Training through operant conditioning (see also section 5.1.) may be used for polar bears. Adults should be separated from other adults prior to and during training sessions. Examples of non-routine processes include: regular weighing, hand injection, sample collection, blood pressure monitoring, crating, walking into a small stall/funneling space, transport, etc.

5.3. Identify procedures that have been successful in facilitating introductions. These may include separation of individuals from group, stationing, tolerance while feeding, “howdy” units, visitation gates, etc.

See section 2.2.5.

5.4. Identify facility design considerations, husbandry training techniques, and implementation plan that can be used to elicit desired behaviors in a way that is safe for both caretakers and animals.

Polar bears respond quickly to voice commands, and can be trained to a target pole. The facility should allow for the bear and keeper to interact at a safe distance. Institutions with multiple holding areas and exhibits could consider

installing a squeeze cage (as in Sea World San Diego and Seneca Park Zoo), and perhaps a mesh door to facilitate training demonstrations. This area, or any door to holding, should not be hidden, as bears are likely to sit there and 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 will also allow 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" 6-gauge mesh allows for bears to put a nose or claw through. The opening should allow the trainer to see the oral cavity when mouths are opened.

Veterinary and medical specialists should also be included in the planning of animal training. Where possible veterinary staff should also be involved in the training process so that the bears experience positive reinforcement from the veterinary staff as well, and have less apprehension to their presence.

5.5. Identify those techniques that have been shown to be most effective.

Teaching animals how to problem solve, increasing their level of activity and making learning fun/enjoyable 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. The keepers 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.

Before starting to train a new behavior, it is important to develop a training plan for shaping the desired behavior. The training plan should include the identity of the primary trainer, steps needed to reach the desired end, the proper cue, 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 beneficial to include the veterinary and management staff in the development of the training plan. In order to consider the training a success, the primary trainer should be able to turn the behavior over to other trainers.

Unwanted behaviors: No punishment should be used during polar bear training; 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 just ignore them and reinforce those that approximate the goal. Animal care staff should consult with the training community to determine what tools are available to minimize unwanted behaviors. Trainers should be careful to avoid inadvertently reinforcing undesirable behaviors like stereotypy and aggression.

5.6. Identify technical skills and competencies needed by staff

All animal care staff members need to be familiar with the husbandry and daily routines necessary for maintaining large, dangerous carnivores, as well as with operant conditioning techniques. Websites such as www.animaltraining.org and www.animalenrichment.org provide the comprehensive frameworks for developing training and enrichment programs.

There are professional organizations devoted to behavior and training, which can offer assistance to trainers. Examples include the American Behavior Management Alliance (ABMA), and the International Marine Animal Trainers Association (IMATA).

5.7. Appropriate methods of enrichment for the taxon should be identified if not included in categories 1-3 above.

Planning enrichment should take into account the natural history of the species, the individual needs of the animal, and facility constraints. Enrichment should be planned based on desirable behavioral goals for the animal and evaluated on a regular basis. All enrichment ideas need to be approved by the veterinary and curatorial staff before implementation.

Enrichment should be offered multiple times a day, but not on a rigid schedule, in order to be truly effective. Enrichment initiatives may also lose their novelty if provided too regularly. Enrichment items should offer the bears with choices of what to do or how to interact.

The constraints of the facility need to be taken into account when planning an enrichment program. Providing certain enrichment initiatives can be difficult in moated exhibits, since enrichment items often end up in the moat. The filter system must also be able handle any enrichment items provided.

Each institution needs to create a written plan for enrichment of polar bears and maintain records of enrichment, as required by the AZA Accreditation standards. As enrichment studies are completed, the results should be incorporated into institutional plans, and shared with the zoological community. Ideas for enrichment can be found in various publication and on the following websites: www.animalenrichment.org and www.enrichmentonline.org. See Appendix A for enrichment items used at other institutions. As noted above, any new enrichment item should be approved by veterinarians, curators, and managers before use.

6. Documentation

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www.aphis.usda.gov/ac/mmsterile.pdf

www.animalenrichment.org

www.animaltraining.org

www.enrichmentonline.org

Complete polar bear bibliography and reference list:
http://www.polarbearsinternational.org/guravich-memorial-bibliography/all/

APPENDIX A

Enrichment initiatives for polar bears (all new enrichment initiatives need approval from area managers and veterinarians)

Objects
- 55 gal barrels
- Cut-up lengths of rubber and canvas hoses
- PVC pipes
- Beer kegs
- Plastic buckets
- Burlap bags
- Tires: tractor, car, and golf cart – not steel-belted
- Cardboard boxes and carpet tubes
- Plastic garbage cans and lids
- "Jolly" brand balls (marketed for horses)
- Donated used sports balls: soccer, volley, basket, footballs
- "Fortex" brand rubber tubs
- Plastic water cooler jugs
- "Boomer" brand balls w/ and w/o sawed holes for foraging
- Heavy duty plastic children's outdoor play equipment with hardware removed: such as 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
- Card board piñatas
- Papier-mâché balls
- Traffic cones

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

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

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

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

Other
- Seal vocalizations

APPENDIX B

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.

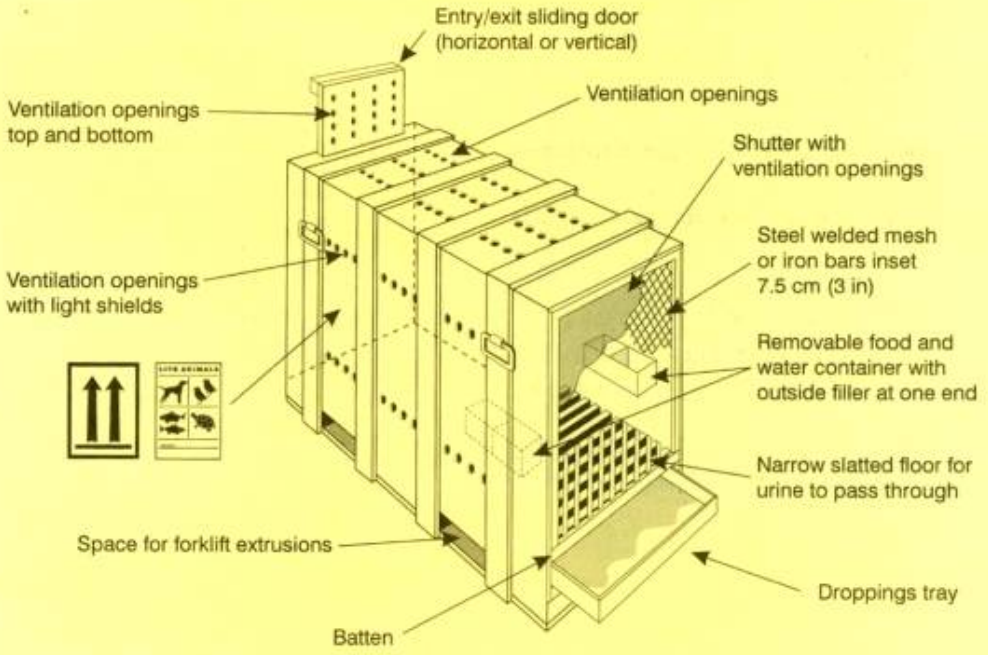
Frame

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 C

Statement on the Safety of Feeding Anadromous Fish to Polar Bears

Fish are a standard part of polar bear diets in zoos and aquaria. 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. Since that time, concern for polar bear health has lead institutions to question the feeding of anadromous (fish that swim up stream) fish, like salmon and trout, which can carry the fluke and rickettsial organism responsible for the disease. Investigation of this issue has lead to new recommendations for feeding live or fresh anadromous fish from the Pacific Northwest to polar bears.

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. 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 sunbears 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 frozen through and through (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 will be 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 D

AAFCO nutrition recommendations for cats, dogs, and polar bears

AAFCO (2004) cat and dog nutrient profile minimum for all stages compared to suggested dietary recommendations for polar bears

		Minimum Nutrient Profile **bold = require for repro/growth**		Minimum Dietary Recommendations[b]
Nutrient	**Unit**	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] NRC 2005
[b] Values should be adequate for growing cubs

APPENDIX E

Nutrient analysis of polar bear sample diets

Nutrient analysis of sample diets on a dry matter basis

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.

APPENDIX F

Examples of polar bear cub formulas used at San Francisco Zoo, Brookfield Zoo, and San Diego Zoo.

San Francisco. 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)

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

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 G

Polar Bear Species Survival Plan 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 Polar Bear SSP 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 Polar Bear SSP Coordinator and 3) one for the Polar Bear SSP 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 Polar Bear SSP 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 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 Polar Bear SSP Necropsy Protocol. Be sure to fix any “placental/membrane material” if available.

APPENDIX H

Contributors to Polar Bear Standardized Guidelines:

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, Brookfield Zoo
Burke, Mary	Polar Bear SSP 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 Management Committee member	Lead Bear Keeper, Buffalo Zoo. Thirteen years experience working with bears.
Lintzenich, Barbara	AZA Bear TAG nutritionist	Animal Nutrition Manager, Cincinnati Zoo; 12 years nutrition experience.
Meyerson, Randi	AZA Polar Bear SSP 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. 25+ years' experience with temperate bears and other large carnivores, 11 years curatorial management of multiple pairs of grizzly & Kodiak bears, 8 years curatorial management polar bears.

Reed, Holly	Polar Bear SSP veterinary advisor	Head Veterinarian/ Point Defiance Zoo & Aquarium; 9 years veterinary management of polar bears.
Ward, Ann	Bear TAG nutritionist	Director of Nutritional Services at the Fort Worth Zoo. Experience with clinical nutrition for all bear species.
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